CITY OF PHOENIX, ARIZONA
OFFICE OF THE CITY ENGINEER
DESIGN AND CONSTRUCTION PROCUREMENT

PROJECT SPECIFICATIONS AND CONTRACT DOCUMENTS

WATER SERVICES DEPARTMENT
VOLUME 1 OF 3

LIFT STATION 76 PHASE II EXPANSION DESIGN BID BUILD

PROJECT NO. WS90400067

PROCUREPHX PRODUCT CATEGORY CODE 912000000
RFx 6000001511

AGREEMENT _____

TABLE OF CONTENTS

00020	Call for Bids	00020-1 to 00020-2
00100	Instructions to Bidders	00100-1 to 00100-17
00300	Bid Form	00300-1 to 00300-6
00310	Bid Bond	00310-1
00320	Bidder's Questionnaire	00320-1 to 00320-7
00330	List of Major Subcontractors and Suppliers	00330-1
00331	List of All Subcontractors and Suppliers	00331-1
00340	Schedule of Manufacturers and Suppliers of Major Equipment and Material Items	00340-1
00350	SBE Goal Memo, EOD SBE Clause and Forms	00350-1 to 00350-14
00360	Bidder's Disclosure Statement	00360-1 to 00360-4
00370	Affidavit of Identity	00370-1
00500	Agreement	00500-1 to 00500-5
00610	Performance Bond	00610-1
00620	Payment Bond	00620-1
00700	General Conditions	00700-1 to 00700-52
00800	Supplementary Conditions	00800-1 to 00800-2

CALL FOR BIDS

CITY OF PHOENIX
LIFT STATION 76 PHASE II EXPANSION
DESIGN-BID-BUILD

PROJECT NO. WS90400067

PROCUREPHX PRODUCT CATEGORY CODE 912000000
RFx 6000001511

BIDS WILL BE DUE: TUESDAY, APRIL 16, 2024 AT 2:00 P.M.
SUBMITTED INTO THE DESIGN AND CONSTRUCTION PROCUREMENT BID BOX LOCATED ON THE 1ST FLOOR LOBBY OF THE PHOENIX CITY HALL BUILDING, 200 W. WASHINGTON STREET, PHOENIX, ARIZONA, 85003

BIDS WILL BE READ: TUESDAY, APRIL 16, 2024 AT 2:00 P.M.
ON 5TH FLOOR, ROOM 5 WEST
PHOENIX CITY HALL
200 W. WASHINGTON STREET
PHOENIX, AZ 85003-1611

***All times are local Phoenix time**

SCOPE OF WORK

The City of Phoenix is seeking a qualified contractor to provide construction services for the project listed below.

This project includes construction for Lift Station 76 expansion to 2.2MGD, including new larger wet well, submersible pumps, above ground force main header piping and appurtenances, odor control system, chemical facility and 18-inch gravity sewer extension.

A Small Business Enterprise goal of 6.5% has been established for this project.

PRE-BID MEETING

A pre-bid meeting will be held on Tuesday, April 2, 2024, at 11:00 a.m., at 200 W. Washington Street, City Hall Conference Room 5 West. At this meeting, staff will discuss the scope of work, general contract issues and respond to questions from the attendees. As City staff will not be available to respond to individual inquiries regarding the project scope outside of this pre-bid meeting, it is strongly recommended that interested firms send a representative to the pre-bid meeting.

REQUEST FOR BID PACKET

On Thursday, March 21, 2024, the bid packet may be downloaded from the City of Phoenix's eProcurement site at:

https://eprocurement.phoenix.gov/irj/portal

(OR)

the City of Phoenix's "Solicitations" web page as. The web address is:

https://solicitations.phoenix.gov

Firms receiving a copy of the bid packet through any other means are strongly encouraged to download the bid packet from the City webpage.

Firms must be registered in eProcurement https://www.phoenix.gov/finance/vendorsreg as a vendor.

GENERAL INFORMATION

The City reserves the right to award the contract to the lowest responsible responsive bidder or all bids will be rejected, as soon as practicable after the date of opening bids.

The City of Phoenix will provide reasonable accommodations for alternate formats of the bid packet by calling Julie B. Smith at (602) 534-2418 or calling TTY 711. Requests will only be honored if made within the first week of the advertising period. Please allow a minimum of seven calendar days for production.

Questions pertaining to process or contract issues should be directed to Julie B. Smith at (602) 534-2418 or julie.b.smith@phoenix.gov (preferred).

Jeffrey Barton
City Manager

Eric J. Froberg, PE

Published: Arizona Business Gazette
Date: March 21, 2024
Date: March 28, 2024
District: 1

SECTION 00100 – INSTRUCTIONS TO BIDDERS

1. Defined Terms

1.1. Terms used in these Instructions to Bidders which are defined in the General Conditions of the Construction Contract Section 00700 have the meanings assigned to them in the General Conditions. Certain additional terms used in these Instructions to Bidders have the meanings indicated below which are applicable to both the singular and plural thereof.

1.1.1. Owner - the City of Phoenix, Water Services Department.

1.1.2. Bidder - one who submits a proposal directly to Owner, as distinct from a sub-bidder who submits a Proposal directly to a Bidder.

1.1.3. Successful Bidder - the lowest, qualified, responsible and responsive Bidder to whom Owner (on the basis of Owner's evaluation as hereinafter provided) makes an award.

1.1.4. Bid Documents - the proposed Contract Documents as advertised, and all Addenda issued before Bid opening.

2. Copies of Bid Documents

2.1. Project information is available online at:

https://solicitations.phoenix.gov

2.2. Complete sets of Bid Documents shall be used in preparing Bids; neither Owner nor Design Professional assume any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bid Documents.

2.3. Owner and Design Professional, in making copies of Bid Documents available on the above terms, do so only for the purpose of obtaining Bids for the Work and do not confer a license or privilege for any other use.

3. Qualifications of Bidders

3.1. The Bidder awarded the Contract shall comply with ARS Title 34 and all licensing requirements imposed by Owner and any other Political Subdivision with jurisdiction. Failure to provide this information with the Bidders Questionnaire may be just cause for Owner declaring the Bidder's Bid nonresponsive.

3.2. Bidders shall have the necessary equipment therefore and shall possess sufficient capital to properly execute the Work within the time allowed.

3.3. All Bidders wishing to remain in contention for award of the contract must submit completed contract documents listed below. The documents must be submitted to Design and Construction Procurement Section, 5th Floor, or can be sent by email to julie.b.smith@phoenix.gov .

4. Examination of Bid Documents and Site

4.1. It is the responsibility of each Bidder before submitting a Bid:

4.1.1. To examine thoroughly the Bid Documents and other related data identified in the Bid Documents (including "technical data" referred to below);

4.1.2. To visit the site to become familiar with and satisfy Bidder as to the general, local and site conditions that may affect cost, progress, performance or furnishings of the Work;

4.1.3. To consider federal, state and local Laws and Regulations that may affect cost, progress, performance or furnishings of the Work;

4.1.4. To study and carefully correlate Bidder's knowledge and observations with the Bid Documents and such other related data; and

4.1.5. To promptly notify Julie B. Smith, Contracts Specialist II, 200 W. Washington Street, 5th Floor, Phoenix, AZ 85003-1611; Phone 602-534-2418; email julie.b.smith@phoenix.gov of all conflicts, errors, ambiguities or discrepancies which the Bidder has discovered in or between the Bid Documents and such other related documents. **All questions regarding the plans and specifications must be received in writing at a minimum seven calendar days prior to bid opening. Questions received after that time may not be given any consideration**.

4.2. Reference is made to the Supplementary Conditions for identification of:

4.2.1. Those reports of explorations and tests of subsurface conditions at or contiguous to the site which have been utilized by Design Professional in preparation of the Bid Documents. Bidder may rely upon the general accuracy of the "technical data" contained in such reports but not upon other data, interpretations, opinions or information contained in such reports or otherwise relating to the subsurface conditions at the site, nor upon the completeness thereof for the purpose of bidding or construction.

4.2.2. Those drawings of physical conditions in or relating to existing surface and subsurface structures (except underground facilities) which are at or contiguous to the site that have been utilized by Design Professional in preparation of the Bid Documents. Bidder may rely upon the general accuracy of the "technical data" contained in such drawings but not upon other data, interpretations, opinions or information shown or indicated in such drawings or otherwise relating to such structures, nor upon the completeness thereof for the purposes of bidding or construction.

4.2.3. Copies of such reports and drawings will be made available by Owner to any Bidder on request. Those reports and drawings are not part of the Bid Documents, but the "technical data" contained therein upon which Bidder is entitled to rely as provided in Paragraph 4.02 of the General Conditions has been identified and established in the Supplementary Conditions. Bidder is responsible for any interpretation or conclusion drawn from any "technical data" or any such data, interpretations, opinions or information.

4.3. Information and data shown or indicated in the Bid Documents with respect to existing underground facilities at or contiguous to the site is based upon information and data furnished to Owner and Design Professional by owners of such underground facilities or others, and Owner and Design Professional do not assume responsibility for the accuracy or completeness thereof unless it is expressly provided otherwise in the Supplementary Conditions.

4.4. Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders with respect to subsurface conditions, other physical conditions and underground facilities, and possible changes in the Bid Documents due to differing or unanticipated conditions appear in Paragraphs 4.02 and 4.03 of the General Conditions.

4.5. Before submitting a Bid each Bidder will be responsible to obtain such additional or supplementary examinations, investigations, explorations, tests, studies and data concerning conditions (surface, subsurface and underground facilities) at or contiguous to the site or otherwise, which may affect cost, progress, performance or furnishing of the Work or which relate to any aspect of the means, methods, techniques, sequences or procedures of construction to be employed by Bidder and safety precautions and programs incident thereto or which Bidder deems necessary to determine its Bid for performing and furnishing the Work in accordance with the time, price and other terms and conditions of the Bid Documents.

4.6. Reference is made to the General Requirements for the identification of the general nature of Work that is to be performed at the site by Owner or others (such as utilities and other prime contractors) that relates to the Work for which a Bid is to be submitted. On request, Owner will provide to each Bidder for examination access to Contract Documents (other than portions thereof related to price) for such Work.

4.7. The submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with each and every requirement of this Paragraph 4, that without exception the Bid is premised upon performing and furnishing the Work required by the Bid Documents and applying the specific means, methods, techniques, sequences or procedures of construction (if any) shown or

indicated or expressly required by the Bid Documents; that Bidder has given Design Professional written notice of all conflicts, errors, ambiguities and discrepancies that Bidder has discovered in the Bid Documents and the written resolutions thereof by Design Professional is acceptable to Bidder, and that the Bid Documents are sufficient to indicate and convey understanding of all terms and conditions for performing and furnishing the Work.

4.8. The provisions of the above Paragraphs 4.1 through 4.8, inclusive, do not apply to Asbestos, Polychlorinated biphenyls (PCBs), Petroleum, Hazardous Waste or Radioactive Material covered by Paragraph 4.08 of the General Conditions.

5. Interpretations and Addenda

5.1. **Acknowledge all addenda; a bid will be deemed non-responsive if all issued addenda for this project are not acknowledged in writing on Page 1 of Section 300 - Bid Form**. The City of Phoenix shall not be responsible for any oral responses or instructions made by any employees or officers of the City of Phoenix in regard to the bidding instructions, plans, drawings, specifications, or contract documents. A verbal reply to an inquiry does not constitute a modification of the Invitation for Bids. Any changes to the plans, drawings and specifications will be in the form of an addendum.

5.2. It shall be the responsibility of the prospective bidder to determine, prior to the submittal of its bid, if any addenda to the project have been issued by The City of Phoenix, Design and Construction Procurement Section. Any changes to the plans and specifications will be in the form of an addendum. All addenda will be posted online within the bid folder at the following website:

https://solicitations.phoenix.gov

Prospective bidders are responsible for ensuring they have all addenda for all projects they are submitting on. Prospective bidders are strongly encouraged to check the Solicitations website in order to ascertain if any addenda have been issued for this project.

5.3. All technical questions relating to this Work should be directed to the City representative identified in Paragraph 4.1.5.

5.4. For additional information prior to bid submission please contact:

NAME: Julie B. Smith, Design and Construction Procurement
ADDRESS: 200 W. Washington St., 8th Floor, Phoenix AZ 85003-1611
PHONE: 602-534-2418 EMAIL: julie.b.smith@phoenix.gov (preferred)

SBE Utilization
Equal Opportunity Department: 602-262-6790

6. Bid Security

6.1. No Bid will be read unless accompanied by a proposal guarantee certified check, cashier's check, or surety bond using the form in Section 00310 of the Bid Documents, for an amount not less than ten percent (10%) of the total bid amount included in the proposal as a guarantee that the Bidder will enter into a contract to perform the proposal in accordance with the Bid Documents. Surety bonds submitted for this project shall be provided by a company which has been rated "A- or better for the prior four quarters" by the A.M. Best Company. **A bid will be deemed non-responsive if not accompanied by this guarantee**.

6.2. The surety bond shall be executed solely by a surety company or companies holding a certificate of authority to transact surety business in the State of Arizona issued by the Director of the Department of Insurance pursuant to Title 20, Chapter 2, Article 1. The surety bond shall not be executed by an individual surety or sureties even if the requirements of Section 7-101 are satisfied. The Owner will return the certified check, cashier check, or surety bond to Bidders which are not the apparent low Bidder and do not want to remain in contention for the award, and to the Bidder awarded the contract upon execution of the contract.

6.3. Bids without adequate Bid security, including compliance with Paragraph 6.1 above, shall be considered as nonconforming in a material respect with the requirements of the Bid Documents and justifies Owner's refusal to read the Bid.

6.4. The Bid security of the apparent Successful Bidder and the security of any other Bidder remaining in contention for award of contract will be retained by Owner until the end of the period specified in Paragraph 14 below, during which Bids will remain open, or seven (7) days after Owner executes the Agreement, whichever occurs last.

6.5. **When providing a surety bond, failure to provide an "A- or Better for the prior four quarters" bond will result in bid rejection**.

7. Construction Time

7.1. The number of calendar days within which, or the dates by which, the Work is to be Substantially Completed and also Completed and ready for final payment are set forth in the Agreement and may be supplemented as set forth in the agreement.

7.2. If a Bidder believes that any of the Construction Times specified are insufficient or excessive, that Bidder shall advise Owner in accordance with the requirements of Paragraph 5 above.

7.3. Liquidated Damages are specified in the Agreement and may be supplemented as provided in the Agreement.

8. Pre-Approved Equal and Or-Equal Items

8.1. The Contract, if awarded, will be on the basis of materials and equipment described in the Drawings or specified in the Specifications unless Bidder requests consideration of a proposed material and/or equipment as a "pre-approved equal" as defined in General Conditions Paragraph 6.05.B. Design Professional will only consider application for acceptance as a "pre-approved equal" during the bidding phase. Such application must be received by Design Professional at least twelve **(12) calendar days** prior to the established bid date. The Bidder, at his own expense, shall complete the Pre-Approved Equal Application Form labeled as Attachment A at the end of this Section, and provide the additional information requested on the form. The completed form with required attachments shall be submitted to Design and Construction Procurement, Attn: Julie B. Smith, Contracts Specialist II, Phoenix City Hall 5th Floor, 200 W. Washington St., Phoenix AZ 85003 or send via email to julie.b.smith@phoenix.gov. It is the Bidder's responsibility to provide the necessary data to validate that the physical and operational performance and qualities of the proposed material and/or equipment is equivalent to the material and/or equipment named in the Drawings or Specifications. If, in the opinion of the Design Professional, the proposed material and/or equipment is equivalent, a "pre-approved equal" status will be granted by Design Professional through a written Addendum to the Contract Documents no fewer than seven calendar days prior to the established bid date (A.R.S. 34-104).

If in the opinion of the Design Professional the pre-approved equal application is incomplete and lacks sufficient information to judge the quality and conformance of the proposed pre-approved equal, the Bidder will be notified in writing and the application will be returned without further consideration.

8.2. The Contract, if awarded, will be on the basis of materials and equipment described in the Drawings or specified in the Specifications, without consideration of "or equal" items as defined in General Conditions Paragraph 6.05.A. Whenever it is indicated in the Drawings or specified in the Specifications that an "or equal" item of material or equipment may be furnished or used by Contractor if acceptable to Design Professional, application for such acceptance will be considered by Design Professional only after the Notice to Proceed Date. General Conditions 6.05, describe the procedures for the approval of "or equal" items.

9. Subcontractors, Manufacturers, Suppliers, Persons, Firms and Corporations

9.1. Bidder shall submit to Owner the forms found in Sections 00330, 00331 and 00340 of the Bid Documents, listing all Subcontractors, Manufacturers, Suppliers, persons, firms and corporations proposed for those portions of the Work for which such identification is required. Such list shall be accompanied by an experience statement with pertinent information regarding similar projects and

other evidence of qualification for each such Subcontractor, Manufacturer, Supplier, person, firm or corporation if requested by Owner. An Owner or Design Professional who after due investigation has reasonable objection to any proposed Subcontractor, Manufacturer, Supplier, person, firm or corporation, may before the Notice of Award is given request apparent Successful Bidder to submit an acceptable substitute, without an increase in Bid price.

9.2. If apparent Successful Bidder declines to make any such substitution, Owner may award the contract to the next lowest responsive and responsible Bidder that proposes to use acceptable Subcontractors, Manufacturers, Suppliers, persons, firms and corporations. The declining to make requested substitutions will not constitute grounds for sacrificing the Bid security of any Bidder. Any Subcontractor, Manufacturer, Supplier, person, firm or corporation listed to whom Owner or Design Professional does not make written objection prior to the giving of the Notice of Award will be deemed acceptable to Owner and Design Professional subject to revocation of such acceptance after the Effective Date of the Agreement as provided in Paragraph 6.06.B of the General Conditions.

10. SBE Utilization

SEE SECTION 350 - SMALL BUSINESS ENTERPRISE GOAL MEMO, CLAUSE AND FORMS

11. Bid Form and Bid Form Attachments

11.1. The Bid Documents due at time of bid include:

- Bid Form (Section 00300)
- Acknowledge all addenda (Section 00300, Paragraph 1.3.1)
- Bid Bond (Section 00310), including evidence of Power of Attorney (rated A- or better for the prior four quarters)
- List of Major Subcontractors and Suppliers (Section 00330)
- Statement of Proposed SBE Utilization Form (Section 00350-1) or a fully documented waiver packet
- Letters of Intent to Perform as a Subcontractor/Supplier (Section 351)

The Bid Documents due post-bid include:

- Completed Bidder's Questionnaire – Section 00320
- Completed List of All Subcontractors and Suppliers Form – Section 00331
- Schedule of Manufacturers and Suppliers – Section 00340
- Completed Bidder's Disclosure Statement – Section 00360
- Affidavit of Identity if Sole Proprietor – Section 00370

PRIOR TO CONTRACT EXECUTION

- Verification of Experience Modifications Rate (EMR) – the awarded company will be required to provide an EMR verification letter from the insurance company prior to contract execution – Section 00320

These checklists are included solely to aid the Bidder in submitting a Bid. They shall not be relied on to include all items necessary to ensure a complete Bid. The Bidder is solely responsible for including all items as required by the Bid Documents, including any items required by Addenda, which may not be listed in the checklist.

If the Bid Form or any of the Bid Form Attachments are modified by Addendum, revised forms will be reissued in which case Bids shall be submitted on the latest revision of the form issued.

11.2. All blanks on the Bid Form and Bid Form Attachments must be completed by printing in ink or typewriter.

11.3. Bids by corporations must be executed in the corporate name by the president or a vice-president (or other corporate officer accompanied by evidence of authority to sign) and attested by the secretary or an assistant secretary. The corporate address and state of incorporation must be shown below the signature.

11.4. Bids by partnerships must be executed in the partnership name and signed by a partner, whose title must appear under the signature and the official address of the partnership must be shown below the signature.

11.5. Bids by Joint Ventures must be executed in the manner of each individual, partnership and corporation that is a party of the Joint Venture indicated herein.

11.6. All names must be typed or printed in ink below the signature.

11.7. The address and telephone number for communications regarding the Bid must be shown.

11.8. Evidence of authority to conduct business as an out-of-state corporation in Arizona shall be provided in accordance with Paragraph 3 above. State contractor license number must also be shown.

12. Submission of Bids

12.1. Prior to bidding on this Project the Bidder must possess the correct license to perform the Work described in the plans and specifications, as deemed appropriate by the Arizona Registrar of Contractors.

12.2. The properly completed bid documents along with the ten (10) percent bid guarantee shall be submitted in a sealed envelope. The outside of the envelope shall be marked as follows:

Bid of:	**[Firm's Name, Address, and Phone Number]**
For:	**Lift Station 76 Phase II Expansion**
City of Phoenix Project Number:	**WS90400067**

12.3. Sealed bids shall be submitted to the Design and Construction Procurement bid box located on the 1st floor lobby of the Phoenix City Hall building, 200 W. Washington St., Phoenix AZ 85003 prior to the time and date specified for the bid opening.

13. Withdrawal of Bids

13.1. No bidder may withdraw or revise a proposal after it has been deposited with the City, except as provided in Phoenix City Code Chapter 2, Section 190.2. Proposals, read or unread, will not be returned to the bidders until after determination of award has been made.

14. Protest Procedures

A bidder wishing to file a protest for the subject project shall comply with Phoenix City Code Chapter 2, Section 188.

15. Opening of Bids, Objection to Award

15.1. Bids will be opened and (unless obviously non-responsive) read aloud publicly. An abstract of the amounts of the Base Bids will be made available to Bidders after the opening of Bids. Any Bid received after the closing time will not be considered. Any uncertainties on whether a Bid was submitted in time will be resolved against that Bidder, in Owner's sole discretion.

15.2. Only Bids submitted with the following forms will be read aloud publicly: Bid Form (Section 00300), Acknowledgment of Addenda (Section 00300, Paragraph 1.3.1), Bid Bond (Section 00310), Statement of Proposed SBE Utilization Form (Section 00350-1) and associated Letters of Intent to Perform as a Subcontractor/Supplier (Section 00351-1) or a fully documented waiver packet, and List of Major Subcontractors and Suppliers (Section 00330).

16. Other Bid Items

16.1. List of Major Subcontractors and Suppliers

16.1.1. **A bid will be deemed non-responsive if not accompanied by a properly completed and signed "List of Major Subcontractors and Suppliers" form**.

16.1.2. To assist in eliminating the practice of bid shopping on City construction projects, the Bidder shall list all Major Subcontractors and Suppliers (including SBE) to whom the Bidder intends to contract with that are equal to or greater than 5% of the base bid. The list of major subcontractors and suppliers shall be provided on the "List of Major Subcontractors and Suppliers" form. ***Failure to properly complete and sign this form will result in bid rejection***. This form is due with the bid.

16.1.3. If substantial evidence exists that bid shopping occurred on this Project, the Bidder will be ineligible to bid on City construction projects for a period of one year.

16.1.4. The list of All Subcontractors and Suppliers shall be provided on the "List of All Subcontractors and Suppliers" form. This form is due three calendar days after bid opening by 5:00 p.m. All bidders will be required to submit the List of Major Subcontractors and Suppliers form. The three lowest bidders will be required to submit the List of All Subcontractors and Suppliers form. If the List of All Subcontractors and Suppliers form is not submitted by the post-bid deadline, the Bidder will still be required to submit the document prior to award. If the Bidder fails to submit the required List of All Subcontractors and Suppliers form by the post-bid deadline, the Bidder's bid bond may be placed in jeopardy because the City may make a claim against the Bidder's bid bond for the cost difference between the lowest responsive and responsible Bidder's bid and the next lowest bid (and any additional costs involved in awarding the contract to the next lowest responsive and responsible bidder).

16.1.5. Verification of the Bidders Experience Modifications Rate (EMR) from their respective insurer on the insurance company's letterhead must be submitted.

17. Bids to Remain Subject to Acceptance

17.1. All Bids will remain subject to acceptance for 50 calendar days after the day of the Bid opening, but Owner may, in its sole discretion, release any Bid and return the Bid security prior to that date.

17.2. Extensions of the period during which Bids shall remain open may only be made by agreement between Owner, the apparent Successful Bidder and any other Bidder wishing to remain in contention for the award. Any such agreement shall be based on no increase in the Base Bid of the Bidders involved or any Construction Time stated in days. If the apparent Successful Bidder or any other Bidder wishing to remain in contention for the award fails to agree to any such extension, as conditioned in this paragraph, that Bidder shall be disqualified from further consideration for the award. However, that Bidder's failure to agree to any such extension will not constitute grounds for forfeiting that Bidder's Bid security.

17.3. Cancellation of Contract for Conflict of Interest

17.3.1. All parties hereto acknowledge that this Agreement is subject to cancellation by the City of Phoenix pursuant to the provisions of Section 38-511, Arizona Revised Statute.

18. Award of Contract

18.1. It shall be the Bidder's responsibility, liability and risk to verify and confirm with the Arizona Registrar of Contracts that the Bidder possesses the correct license for this Project. Prior to the submission of a Bid on this Project, the Bidder shall possess the correct license to perform the Work described in the Plans and Specifications. Consistent with Arizona Revised Statute Section 32-1123 (West Supp. 2002), as amended from time to time, and enforced by the Arizona Registrar of Contractors; the license requirement set forth above may not apply if this Project is: (i) funded in whole or in part by the United States Department of Transportation, (ii) a Department of Transportation Project, or (iii) a Project subject to Federal Acquisition Regulations, Title 48 Code of Federal Regulations, including Department of Defense Federal Acquisition Regulations.

Prior to Award of the Contract, the successful Bidder shall provide to the City of Phoenix the successful Bidder's Contractor License Classification and number, City of Phoenix Privilege License Number, and Federal Tax Identification Number.

18.2. Owner reserves the right to reject any and all Bids, including without limitation the rights to reject any or all nonconforming, nonresponsive, unbalanced or conditional Bids and to reject the Bid of any Bidder if Owner believes that it would not be in the best interest of the Project to make an award to that Bidder, whether the Bid is not responsive or the Bidder is unqualified or of doubtful financial ability or fails to meet any other pertinent standard or criterion established by Owner. Owner also reserves the right to reject any or all Bids, to waive any non-conformance, to readvertise for Bids, to withhold the award for any reason the Owner determines.

18.2.1. The proposal total will be obtained by adding the extension amount or lump sum indicated for the individual pay items. If there is a conflict between words and figures, the words shall apply. If there is a conflict between the unit bid price and the extension for a particular pay item, the unit bid price shall govern. In either case, the Contracting Agency shall correct the discrepancy in accordance with the above procedure and the corrected proposal total will apply.

18.3. In evaluating Bids, Owner will consider the qualification of the Bidders, whether or not the Bids comply with the prescribed requirements, unit prices and other data, as may be requested in the Bid Form or prior to the Notice of Award.

18.4. Owner will consider the qualifications and experience of Subcontractors, Manufacturers, Suppliers, persons, firms and corporations proposed for those portions of the Work as to which the identity of Subcontractors, Manufacturers, Suppliers, persons, firms and corporations must be submitted as provided herein. Owner also may consider the operating costs, maintenance requirements, performance data, and guarantees or major items of materials and equipment proposed for incorporation in the Work when such data is required to be submitted prior to the Notice of Award.

18.5. Owner may conduct such investigations as Owner deems necessary to assist in the evaluation of any Bid and to establish the responsibility, qualifications and financial ability of Bidders, proposed Subcontractors, Manufacturers, Suppliers, persons, firms and corporations to perform and furnish the Work in accordance with the Bid Documents to Owner's satisfaction within the prescribed time.

18.6. If the Contract is to be awarded, it will be awarded to a responsive and responsible Bidder based on the low total base bid (Items 1 through 36 on the BID FORM). If unit pricing is required in the proposal, the extensions and additions will be verified to assure correctness. Award will be based on the revised total if any errors are found. Additionally, the Contractor shall meet the minimum SBE subcontracting goal set for this Project or have been granted a full or partial waiver of the goal.

Any bidder that currently contracts with the City must be in good standing for its proposal to be considered responsive. For the purpose of this Invitation to Bid, good standing means compliance with all contractual provisions, including payment of financial obligations.

18.7. If the contract is to be awarded, Owner will give the Successful Bidder a Notice to Proceed within sixty (60) days after the date of the Bid opening.

18.8. The Owner expressly reserves the right to cancel this award without recourse or prejudice to contractor until all parties have executed the agreement in full.

19. Contract Security

19.1. Article 5 of the General Conditions set forth the Owner's requirements as to Performance and Payment Bonds. When the Successful Bidder delivers the executed Agreement to Owner, it must be accompanied by the required Performance and Payment Bonds issued by surety company or companies holding a certificate of authority to transact surety business in the State of Arizona issued by the Director of the Department of Insurance pursuant to Title 20, Chapter 2, Article 1. The bonds shall not be executed by an individual surety or sureties even if the requirements of Section 7-101 are satisfied. Failure to comply with these provisions will be cause for rejection of the Bidders Bid.

20. Insurance Requirements

20.1. Article 5 of the General Conditions and set forth the Owner's requirements as to insurance requirements. When the Successful Bidder delivers the executed Agreement to the Owner, it must be accompanied by the Certificate of Insurance on a standard insurance industry ACORD form. The ACORD form shall be issued by an insurance company authorized to transact business in the State of Arizona, or one that is named to the List of Qualified Unauthorized Insurers maintained by the Arizona Department of Insurance.

21. Signing Agreement

21.1. When Owner gives a Notice of Award to the Successful Bidder, it will be accompanied by the required number of unsigned counterparts of the Agreement with all other written Contract Documents attached. Within ten days thereafter Contractor shall sign and deliver the required number of counterparts of the Agreement and attached documents to Owner with the required Bonds and insurance policy(ies). Within a reasonable time thereafter Owner shall deliver one fully signed counterpart to Contractor. Each counterpart is to be accompanied by a complete set of Drawings with appropriate identification.

21.2. The Agreement is subject to cancellation by the City of Phoenix for prohibited conflicts of interest, if any exist, pursuant to the provisions of ARS Title 38, Section 511.

22. Sequence of Work

22.1. The Work under this Contract must be accomplished while the existing facility is in operation, unless otherwise allowed in the General Requirements. Work must be performed so that operation of the facility will not be jeopardized or reduced in efficiency. Bidders are referred to the General Requirements for requirements concerning sequencing of the Work.

23. Compliance with Other Regulations

23.1. ADA and ANSI Access of Premises During Construction

23.1.1. Contractor shall maintain ADA and ANSI accessibility requirements during construction activities in an occupied building or facility. ADA and ANSI accessibility requirements shall include, but not be limited to, parking, building access, entrances, exits, restrooms, areas of refuge, and emergency exit paths of travel. Contractor shall be responsible for the coordination of all Work to minimize disruption to building occupants and facilities.

23.2. Immigration Reform and Control Act

23.2.1. Compliance with Federal Laws Required. Contractor understands and acknowledges the applicability of the Immigration Reform and Control Act of 1986 and the Drug Free Workplace Act. Contractor agrees to comply with these Federal Laws in performing under this Agreement and to permit City inspection of personnel records to verify such compliance.

24. Confidentiality of Plans and Specifications

24.1. Any plans generated for this project must include the following statement in the Title Block on every page: "Per City of Phoenix City Code Chapter 2, Article 2-28, these plans are for official use only and may not be shared with others except as required to fulfill the obligations of the Design Professional's contract with the City of Phoenix."

25. Leadership in Energy and Environmental Design (LEED)

25.1. The contractor shall provide an easily accessible area to serve the construction site that is dedicated to the separation, collection and storage of materials for recycling including (at a minimum) paper, glass, plastics, metals and designate an area specifically for construction and demolition waste recycling. The Contractor must provide documentation that the materials have been taken to a Maricopa County approved recycling facility.

26. Legal Worker Requirements

26.1. The City of Phoenix is prohibited by A.R.S. § 41-4401 from awarding a contract to any Consultant/Architect/Engineer/Contractor who fails, or whose Subconsultants/subcontractors fail, to comply with A.R.S. § 23-214(A). Therefore, Contractor agrees that:

26.1.1. Contractor and each subcontractor it uses warrants their compliance with all federal immigration laws and regulations that relate to their employees and their compliance with § 23-214, subsection A.

26.1.2. A breach of a warranty under paragraph 1 shall be deemed a material breach of the contract that is subject to penalties up to and including termination of the contract.

26.1.3. The City of Phoenix retains the legal right to inspect the papers of any Contractor or subcontractor employee who works on the contract to ensure that the Contractor or subcontractor is complying with the warranty under paragraph 1.

27. Contractor and Subcontractor Worker Background Screening

Contractor agrees that all Contractor's and subcontractors' workers (collectively "Contract Worker(s))" pursuant to this Agreement will be subject to background and security checks and screening (collectively "Background Screening") at Contractor's sole cost and expense, unless otherwise provided for in the scope of work. Contractor's background screening will comply with all applicable laws, rules and regulations. Contractor further agrees that the background screening is necessary to preserve and protect the public health, safety and welfare. The City requires a completed Contract Worker Badge/Key/Intrusion Detection Responsibilities Agreement for each Contract Worker who requires a badge or key.

Background Screening Risk Level: The City has established two levels of risk: Standard and Maximum risk. The current risk level and background screening required is **MAXIMUM LEVEL**. If the scope of work changes, the City may amend the level of risk, which could require the Contractor to incur additional contract costs to obtain background screens or badges.

Terms of This Section Applicable to all Contractor's Contracts and Subcontracts: Contractor will include Contract Worker background screening in all contracts and subcontracts for services furnished under this agreement.

Materiality of Background Screening Requirements; Indemnity: The background screening requirements are material to City's entry into this agreement and any breach of these provisions will be deemed a material breach of this contract. In addition to the indemnity provisions set forth in this agreement, Contractor will defend, indemnify and hold harmless the City for all claims arising out of this background screening section including, but not limited to, the disqualifications of a Contract Worker by Contractor. The background screening requirements are the minimum requirements for the Agreement. The City in no way warrants that these minimum requirements are sufficient to protect Contractor from any liabilities that may arise out of the Contractor's services under this Agreement or Contractor's failure to comply with this section. Therefore, Contractor and its Contract Workers will take any reasonable, prudent and necessary measures to preserve and protect public health, safety and welfare when providing services under this Agreement.

Continuing Duty; Audit: Contractor's obligations and requirements will continue throughout the entire term of this Agreement. Contractor will maintain all records and documents related to all background screenings and the City reserves the right to audit Contractor's records.

BACKGROUND SCREENING – MAXIMUM RISK:
The current risk level and background screening required is **MAXIMUM RISK**.
A maximum risk background screening will be performed every five years when the Contract Worker's work assignment will:

- work directly with vulnerable adults or children, (under age 18); or

- any responsibility for the receipt of payment of City funds or control of inventories, assets, or records that are at risk of misappropriation; or
- unescorted access to:
    - City data centers, money rooms, high-value equipment rooms; or
    - unescorted access to private residences; or
    - access to critical infrastructure sites/facilities; or
- direct or remote access to Criminal Justice Information Systems (CJIS) infrastructure.

Requirements: The background screening for maximum risk level will include a background check for real identity/legal name and will include felony and misdemeanor records from any county in the United States, the State of Arizona, plus any other jurisdiction where the Contractor worker has lived at any time in the preceding seven years from the Contract Worker's proposed date of hire. In addition, Maximum screening levels may require additional checks as included herein, depending on the scope of work, and may be amended if the scope of work changes.

Contractor Certification; City Approval of Maximum Risk Background Screening: Unless otherwise provided for in the Scope of Work, Contractor will be responsible for:

- determining whether Contract Worker(s) are disqualified from performing work for the City for maximum risk level background checks; and,
- submitting pass/fail results to the City for approval; and,
- reviewing the results of the background check every three to five years, dependent on scope; and,
- to engage in whatever due diligence is necessary to make the decision on whether to disqualify a Contract Worker; and,
- Submitting the list of qualified Contract Workers to the contracting department; and,
- If, upon review of the background information, the City will advise the Contractor if it believes a Contract Worker should be disqualified. The Contractor will evaluate the Contract Worker and if the Contractor believes that there are extenuating circumstances that suggest that the person should not be disqualified, the Contractor will discuss those circumstances with the contracting department. The contracting department decision on disqualification of a Contract Worker is final.
- For sole proprietors, the Contractor must comply with the background check for himself and any business partners, or members or employees who will assist on the contract and for whom the requirements of the Agreement apply.
- By executing this agreement, Contractor certifies and warrants that Contractor has read the background screening requirements and criteria in this section, and that all background screening information furnished to the City is accurate and current.
- The City final documented decision will be an "approve" or "deny" for identified Contract Workers.
- The City will not keep records related to background checks once they are confirmed. Information to verify the results will be returned to the Contractor, or any contracted agency that assists with review, after the City's completed review.
- By executing this agreement, Contractor further certifies and warrants that Contractor has satisfied all such background screening requirements for the maximum risk background screening, and verified legal worker status, as required.
- Contract Workers will not apply for the appropriate City of Phoenix identification and access badge or keys until Contractor has received the City's written acceptance of Contract Worker's maximum risk background screening. The City may, in its sole discretion, accept or reject any or all the Contract Workers proposed by Contractor for performing work under this Agreement. A Contract Worker rejected for work at a maximum risk level under this agreement will not be proposed to perform work under other city contracts or engagements without city's prior written approval.

The background checks will be conducted prior to any employee entering to work and will be based upon information provided to the Police Department including, but not limited to: name, address, date

and place of birth, social security number, INS number if applicable, and a copy of a valid photo identification. The information will be provided to the Water Services Department at least five business days (excluding weekends and holidays) in advance of the need for access. The form will be provided by Water Services Department. A designated Water Services Department representative will conduct the security check.

The City may, at any time, in its sole discretion, refuse to allow an employee access to an area for any of the following reasons, but not limited to:

- Conviction of a felony.
- Conviction of a misdemeanor (not including traffic or parking violation).
- Any outstanding warrants (including traffic and parking violations).
- A person currently on parole or probation.
- A person currently involved in an investigation.

CONFIDENTIALITY AND DATA SECURITY: All data, regardless of form, including originals, images and reproductions, prepared by, obtained by, or transmitted to Contractor in connection with this Agreement is confidential, proprietary information owned by the City, unless otherwise agreed upon within this Agreement. Except as specifically provided in this Agreement, the Contractor shall not disclose data generated in the performance of the service to any third person without the prior written consent of the City Manager or his/her designee.

Contractor agrees to abide by all current applicable legal and industry data security and privacy requirements and to notify the City immediately if the scope of work changes or personal identifying information or information subject to Payment Card Industry Standards becomes part of the Agreement.

Contractor agrees to comply with all City information security and technology policies, standards, and procedures when accessing City networks and computerized systems whether onsite or remotely.

A violation of this Section may result in immediate termination of this Agreement without notice. The obligations of Contractor under this Section shall survive the termination of this Agreement.

SECURITY INQUIRIES: Contractor acknowledges that all of the employees that it provides pursuant to this Contract shall, at Contractor's expense, be subject to background and security checks and screening at the request of the City. Contractor shall perform all such security inquiries and shall make the results available to the City for all employees considered for performing work (including supervision and oversight) under this Contract. City may make further security inquiries. Whether or not further security inquiries are made by the City, City may, at its sole, absolute and unfettered discretion, accept or reject any or all the employees proposed by the Contractor for performing work under this Contract. Employees rejected by the City for performing services under this Contract may still be engaged by Contractor for other work not involving the City. An employee rejected for work under this Contract shall not be proposed to perform work under other City contracts or engagements without the City's prior approval.

The City, in its sole discretion, reserves the right, but not the obligation to:

- require an employee/prospective employee of the Contractor to provide fingerprints and execute such other documentation as may be necessary to obtain criminal justice information pursuant to A.R.S. 41-1750 (G) (4);
- act on newly acquired information whether or not such information should have been previously discovered;
- unilaterally change its standards and criteria relative to the acceptability of Contractor's employees and/or prospective employees; and

- object, at any time and for any reason, to an employee of Contractor performing work (including supervision and oversight) under this Agreement. Contractor will bear the costs of all inquiries requested by the City.

28. Business and Operation Licenses, Permits and Certifications Required

28.1. On or before the submission of a bid for this project, bidder must possess all federal, state, county and City licenses, permits, certifications and any other legal authorizations required by law to transact business and to perform the services set forth in this Agreement (collectively "Business Licenses"). Bidder shall submit a completed Bidder's Disclosure Statement as set forth in Section 00360, and provide the following Business License information with its bid:

28.1.1. proper State of Arizona contractors license classification and number;
28.1.2. City of Phoenix transaction privilege license number;
28.1.3. federal tax identification number; and
28.1.4. any special use or other zoning permits required for Bidder's operation and performance of the services under this Agreement.

Unless provided otherwise in this solicitation, **Bidder will be deemed non-responsive, and the bid rejected if Bidder fails to possess the proper Business Licenses at the time of bid or fails to submit a substantially completed Bidder's Disclosure Statement** as specified in this paragraph.

29. Tax Liabilities; Disclosure of Convictions and Breach(s) of Contract

On or before the award of the contract for this project, the successful bidder will: (i) file all applicable tax returns and will make payment for all applicable State of Arizona and Maricopa County Transaction Taxes (ARS Sec. 41-1305) and City of Phoenix Privilege License Taxes (Phoenix City Code Sec.14-415); (ii) disclose any civil fines, penalties or any criminal convictions, other than for traffic related offenses, for violation of federal, state, county or city laws, rules or regulations including, but not limited to, environmental, OSHA, or labor compliance laws (collectively "Laws") by Bidder, Bidder's directors, managing members, responsible corporate officers or party who will be responsible for overseeing and administering this project (collectively "Bidder"); and (iii) disclose any material breach(s) of an agreement with the City of Phoenix, any termination for cause or any litigation involving the City of Phoenix occurring within the past three calendar years. Unless provided otherwise in this solicitation, the successful bidder will be deemed non-responsible and the bid rejected for any of the following: (i) Bidder's civil or criminal conviction, other than for traffic related offenses, for a violation of Laws within the past three calendar years; (ii) liability or culpability resulting in payment of fines or penalties in the cumulative total amount of $100,000 or greater for a violation of "Laws" within the past three calendar years; (iii) material breach of a City of Phoenix agreement, termination for cause or litigation with the City of Phoenix within the past three calendar years; and (iv) Bidder's failure to disclose the information as required by this provision. Further, after award of contract, in addition to any other remedy, Bidder's failure to remit proper taxes to the City of Phoenix may result in the City withholding payment pursuant to Phoenix City Charter Chapter XVIII, Section 14 until all delinquent taxes, interest, and penalties have been paid.

State and Local Transaction Privilege Taxes:

In accordance with applicable state and local law, transaction privilege taxes may be applicable to this transaction. The state and local transaction privilege (sales) tax burden is on the person who is conducting business in Arizona and the City of Phoenix. The legal liability to remit the tax is on the person conducting business in Arizona. Any failure by the Contractor to collect applicable taxes from the City will not relieve the Contractor from its obligation to remit taxes.

It is the responsibility of the Contractor to determine any applicable taxes. The City will review the price or offer submitted and will not deduct, add or alter pricing based on taxes.

If you have questions regarding tax liability, seek advice from a tax professional prior to submitting a bid. Once the bid is submitted, the Offer is valid for the time specified in this Solicitation, regardless of mistake or omission of tax liability.

If the City finds over payment of a project due to tax consideration that was not due, the Contractor will be liable to the City for that amount, and by contracting with the City agrees to remit any overpayments back to the City for miscalculations on taxes included in a bid price.

For purposes of A.R.S. 42-5075(P), this contract is subject to A.R.S. Title 34.

Tax Indemnification:
Contractor will, and require the same of all subcontractors, pay all federal, state and local taxes applicable to its operation and any persons employed by the Contractor. Contractor will, and require the same of all subcontractors, hold the City harmless from any responsibility for taxes, damages and interest, if applicable, contributions required under federal, and/or state and local laws and regulations and any other costs including transaction privilege taxes, unemployment compensation insurance, Social Security and Worker's Compensation.

Tax Responsibility Qualification:
Contractor may be required to establish, to the satisfaction of City, that all fees and taxes due to the City or the State of Arizona for any License or Transaction Privilege taxes, Use Taxes or similar excise taxes, are currently paid (except for matters under legal protest).

Contractor agrees to a waiver of the confidentiality provisions contained in the City Finance Code and any similar confidentiality provisions contained in Arizona statutes relative to State.
Transaction Privilege Taxes or Use Taxes.

Contractor agrees to provide written authorization to the City Finance Department and to the Arizona State Department of Revenue to release tax information relative to Arizona Transaction Privilege Taxes or Arizona Use Taxes to assist the Department in evaluating Contractor's qualifications for and compliance with contract for duration of the term of contract.

30. Lawful Presence Requirement

30.1. Pursuant to A.R.S. §§ 1-501 and 1-502, the City of Phoenix is prohibited from awarding a contract to any natural person who cannot establish that such person is lawfully present in the United States. To establish lawful presence, a person must produce qualifying identification and sign a City-provided affidavit affirming that the identification provided is genuine. This requirement will be imposed at the time of contract award. This requirement does not apply to business organizations such as corporations, partnerships or limited liability companies.

31. City of Phoenix Equal Employment Opportunity Requirement

1. In order to do business with the City, Contractor must comply with Phoenix City Code, 1969, Chapter 18, Article V, as amended, Equal Employment Opportunity Requirements. Contractor will direct any questions in regard to these requirements to the Equal Opportunity Department, (602) 262-6790.

2. Any Contractor in performing under this contract shall not discriminate against any worker, employee or applicant, or any member of the public, because of race, color, religion, sex, national origin, age, or disability nor otherwise commit an unfair employment practice. The Contractor will ensure that applicants are employed, and employees are dealt with during employment without regard to their race, color, religion, sex, national origin, age, or disability, and will adhere to a policy to pay equal compensation to men and women who perform jobs that require substantially equal skill, effort, and responsibility, and that are performed within the same establishment under similar working conditions. Such action shall include but not be limited to the following: Employment, promotion, demotion or transfer, recruitment or recruitment advertising, layoff or termination; rates of pay or other forms of

compensation; and selection for training; including apprenticeship. The Contractor further agrees that this clause will be incorporated in all subcontracts with all labor organizations furnishing skilled, unskilled and union labor, or who may perform any such labor or services in connection with this contract.

If the Contractor employs more than thirty-five employees, the following language shall apply as the last paragraph to the clause above:

The Contractor further agrees not to discriminate against any worker, employee or applicant, or any member of the public, because of sexual orientation or gender identity or expression and shall ensure that applicants are employed, and employees are dealt with during employment without regard to their sexual orientation or gender identity or expression.

3. *Documentation*. Contractor may be required to provide additional documentation to the Equal Opportunity Department affirming that a nondiscriminatory policy is being utilized.

4. *Monitoring*. The Equal Opportunity Department shall monitor the employment policies and practices of suppliers and lessees subject to this article as deemed necessary. The Equal Opportunity Department is authorized to conduct on-site compliance reviews of selected firms, which may include an audit of personnel and payroll records, if necessary.

32. Fair Treatment of Workers

32.1. The Contractor shall keep fully informed of all Federal and State laws, County and City ordinances, regulations, codes and all orders and decrees of bodies or tribunals having any jurisdiction or authority, which in any way affect the conduct of the work. He shall at all times observe and comply with all such laws, ordinances, regulations, codes, orders and decrees; this includes, but is not limited to laws and regulations ensuring fair and equal treatment for all employees and against unfair employment practices, including OSHA and the Fair Labor Standards Act (FLSA). The contractor shall protect and indemnify the Contracting Agency and its representatives against any claim or liability arising from or based on the violation of such, whether by himself or his employees.

33. Record Drawings

33.1. The Contractor shall maintain a record set of plans at the job site. These shall be kept legible and current and shall show all changes or work added in a contrasting, reproducible color. When the project is substantially complete, the Contractor shall submit these plans to the Engineer for approval. When landscaping is included, the Contractor shall submit, prior to final inspection, corrected landscape drawings showing the location of all utility services, controller, pipe, valves, and wiring. The Engineer shall be the sole judge as to the acceptability of the record plans and receipt of an acceptable set is a pre-requisite for final payment.

34. Compliance with Laws

34.1 Contractor must comply with all existing and subsequently enacted federal, state and local laws, ordinances and codes, all applicable ADA requirements, and regulations that are, or become applicable to this Agreement. If a subsequently enacted law imposes substantial additional costs on Contractor, a request for an amendment may be submitted pursuant to this Agreement. Contractor is also required to certify its compliance with all applicable laws and Contractor must pass along these requirements to its Subcontractors. If any of Contractor's certifications is found to be false, the City may terminate this Agreement or impose other remedies due to the false certification.

Attachment A: Pre-Approved Equal Application Form

Project Name:

Project Number:

The Bidder, _____, requests "**pre-approved equal**" status be granted to the following material and/or equipment:

This item(s) is proposed as an "equal" to the similar item specified (or named): _____ in Section _____, Page ____, Paragraph/Line _____, of the Specifications.

Attach the following documentation to verify compliance with the Contract Documents:

1. Complete product description consisting of detailed dimensioned shop drawings, photographs, performance and test data, model number(s), materials of construction finishes, options, etcetera.

2. A copy of the referenced specification section, and all other applicable specification sections, with each paragraph check marked to indicate material and/or equipment compliance. Check marks (□) shall denote full compliance with a paragraph as a whole. Deviations from the specifications shall be underlined and shall be listed and identified below.

3. A list of existing installations including the names and phone numbers of references at those installations.

The Bidder will submit dimensioned drawings necessary to prove to Design Professional that the proposed equipment will fit the installation shown on the Drawings without any modification to the building or structure housing the equipment, piping system, and electrical/control system; without modification to or compromising the process the equipment is a part of; and without modification of other associated equipment and components.

If the Bidder knows that modifications are required to the building or structure housing the equipment, the process, or other associated equipment and components, the submittal must list all such modifications required, and the Bidder must submit a signed statement agreeing to pay for the design changes, engineering costs, and drawing changes, which will be made by Design Professional.

The Bidder will identify all deviations from the Contract Documents. If there are differences between proposed substitution and specified item, please list them below.

Specified	Proposed Substitution

What effect does the substitution, or pre-approved equal have on other trades?

_____

_____

_____

Does manufacturer's warranty of proposed substitution, or pre-approved equal, differ from that specified?

Yes ☐ No ☐ If YES, explain:

Will substitution, or pre-approved equal, affect progress schedule?

Yes ☐ No ☐ If YES, explain:

Will substitution, or pre-approved equal, require more license fees or royalties than specified product?

Yes ☐ No ☐ If YES, explain:

Will maintenance and service parts be locally available for substitution or pre-approved equal? The Bidder will give the address of the nearest source of factory certified maintenance parts.

Yes ☐ No ☐ If YES, explain:

Submitted By:

Signature: _____ Title:_____ Date:_____

Firm: _____

Address: _____

_____

Phone: _____ Fax:_____

For Design Professional's Use Only:

Pre-approved Equal status is:

☐ Granted

☐ Denied

☐ Granted with special requirements attached

☐ Denied because of late submittal

☐ Not Reviewed because of incomplete submittal

By: _____ Date:_____

Remarks: _____

_____

_____

END OF ATTACHMENT "B" TO SECTION 00100

SECTION 00300 – BID FORM AND BID FORM ATTACHMENTS

TABLE OF CONTENTS

Subject	Page
BID FORM	00300-1 to 00300-6
BID BOND	00310-1
BIDDER'S QUESTIONNAIRE	00320-1 to 00320-7
LIST OF MAJOR SUBCONTRACTORS AND SUPPLIERS	00330-1
LIST OF ALL SUBCONTRACTORS AND SUPPLIERS	00331-1
SCHEDULE OF MANUFACTURERS AND SUPPLIERS OF MAJOR EQUIPMENT AND MATERIAL ITEMS	00340-1
SBE GOAL MEMO, CLAUSE AND FORMS	00350-1 to 00350-14
BIDDER'S DISCLOSURE STATEMENT	00360-1 to 00360-4
AFFIDAVIT OF IDENTITY	00370-1

SECTION 00300 - BID FORM

PROPOSAL to the City Engineer of the City of Phoenix. In compliance with the Advertisement for Bids, by the City Engineer, the undersigned bidder:

_____
(Print or type contractor name)

1. Bid Submission

1.1 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an agreement with Owner in the form included in the Bid Documents to perform and furnish all Work as specified or indicated in the Bid Documents for the Bid Price and within the Bid Times indicated in this Bid and in accordance with the other terms and conditions of the Bid Documents.

1.2 Bidder accepts all of the terms and conditions of the Call for Bids and Instructions to Bidders, including without limitation those dealing with the disposition of Bid security. This Bid will remain subject to acceptance for 50 calendar days after the day of Bid opening. Bidder will sign and deliver the required number of counterparts of the Agreement with the bonds and other documents required by the Bid Requirements within ten (10) days after the date of Owner's Notice of Award.

1.3 In submitting this Bid, Bidder represents, as more fully set forth in the Agreement, that:

1.3.1 Bidder has examined and carefully studied the Bidding Documents and the following Addenda receipt of all which hereby is acknowledged: (List Addenda by Addendum Number)

Addenda #	Date of Addenda	Addenda #	Date of Addenda

1.3.2 Bidder has visited the site and become familiar with and is satisfied as to the general, local and site conditions that may affect cost, progress, performance and furnishing of the Work.

1.3.3 Bidder is familiar with and is satisfied as to all federal, state and local Laws and Regulations that may affect cost, progress, performance and furnishing of the Work.

1.3.4 Bidder has carefully studied all reports of explorations and tests of subsurface conditions at or contiguous to the site and all drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the site (except Underground Facilities) which have been identified in the Supplementary Conditions as provided in Article 4 of the General Conditions. Bidder accepts the determination set forth in Article 4 of the General Conditions of the extent of the "technical data" contained in such reports and drawings upon which Bidder is entitled to rely. Bidder acknowledges that such reports and drawings are not Bid Documents and may not be complete for Bidder's purposes. Bidder acknowledges that Owner and Design Professional do not assume responsibility for the accuracy or completeness of information and data shown or indicated in the Bid Documents with respect to Underground Facilities at or contiguous to the site. Bidder has obtained and carefully studied (or assumes responsibility for having done so) all such additional or supplementary examinations, investigations, explorations, tests, studies and data concerning conditions (surface, subsurface and Underground Facilities) at or contiguous to the site or otherwise

which may affect cost, progress, performance or furnishing of the Work or which relate to any aspect of the means, methods, techniques, sequences and procedures of construction to be employed by Bidder and safety precautions and programs incident thereto. Bidder does not consider that any additional examinations, investigations, explorations, tests, studies or data are necessary for the determination of this Bid for performance and furnishing of the Work in accordance with the times, price and other terms and conditions of the Bid Documents.

1.3.5 Bidder is aware of the general nature of Work to be performed by Owner and others at the site that relates to Work for which this Bid is submitted as indicated in the Bid Documents.

1.3.6 Bidder has correlated the information known to Bidder, information and observations obtained from visits to the site, reports and drawings identified in the Bid Documents and all additional examinations, investigations, explorations, tests, studies and data with the Bid Documents.

1.3.7 Bidder has given Design Professional written notice of all conflicts, errors, ambiguities or discrepancies that Bidder has discovered in the Bid Documents and the written resolution thereof by Design Professional is acceptable to Bidder, and the Bid Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performing and furnishing the Work for which this Bid is submitted.

1.3.8 This Bid is genuine and not made in the interest of or on behalf of any undisclosed person, firm or corporation and is not submitted in conformity with any agreement or rules of any group, association, organization or corporation; Bidder has not directly or indirectly induced or solicited any person, firm or corporation to refrain from bidding; and Bidder has not sought collusion to obtain for itself any advantage over any other Bidder or over Owner.

(THE REMAINDER OF THIS PAGE IS INTENTIONALLY LEFT BLANK)

1.4 **Bid Schedule**

1.4.1 Bidder will complete the Work in accordance with the Bid Documents and accept in full payment for the Work items listed below, the following Unit Prices and/or Bid Prices, as applicable:

Bid Item No.	Bid Quantity	Unit	Description	Unit Price	Bid Price
1	1	LS	Mobilization and Demobilization	$	$
2	1	LS	Site Work including but not limited to earthwork, materials, excavation, backfill, etc.	$	$
3	2	EA	Furnish and Install 5-foot Diameter Manhole	$	$
4	1	EA	Furnish and Install 16’ x 8’ Precast Polymer Wet Well	$	$
5	37	CY	Furnish and Install New Reinforced Concrete	$	$
6	1	EA	Furnish and Install Wet Well Access Hatch	$	$
7	1	LS	Furnish and Install Protective Finishes	$	$
8	2	EA	Furnish Submersible Pump Units	$	$
9	1	LS	Submersible Pump Unit Installation, Startup, and Testing	$	$
10	1	LS	Furnish and Install Yard Piping	$	$
11	2	EA	Furnish and Install 14-inch Check Valves	$	$
12	3	EA	Furnish and Install 14-inch Plug Valves	$	$
13	2	EA	Furnish and Install 6-inch Plug Valves	$	$
14	2	EA	Furnish and Install 2-inch Combination air/Vacuum Release Valves	$	$
15	45	LF	Furnish and Install 14-inch Double Barrel Force Main	$	$
16	60	LF	Furnish and Install 8-inch Single Barrel Force Main	$	$
17	2	EA	Furnish and Install New Magnetic Flow Meter	$	$
18	1	LS	Furnish and Install new Biofilter Odor Control Facilities	$	$

Bid Item No.	Bid Quantity	Unit	Description	Unit Price	Bid Price
19	1	LS	Furnish and Install New Bioxide Odor Control Facilities	$	$
20	25	LF	Furnish and Install 2” Drain Piping	$	$
21	14	EA	Furnish and Install Pipe Supports	$	$
22	1	LS	Furnish and Install Removable Handrail	$	$
23	11	EA	Furnish and Install Removable Guard Posts	$	$
24	2	EA	Furnish and Install 2” Ball Valves	$	$
25	2	EA	Furnish and Install 1” Ball Valves	$	$
26	166	SY	Concrete Pavement Removal and Replacement	$	$
27	1	LS	Furnish and Install Electrical	$	$
28	1	LS	Furnish and Install Instrumentation and Control	$	$
29	1	LS	Temporary Bypass Pumping	$	$
30	1	LS	Startup and Testing	$	$
31	2	TON	Rock Removal	$	$
32	1	LS	Demolition of Existing Lift Station Site and Facilities	$	$
33	1	EA	Allowance for All Other Work Not Previously Listed	$150,000	$150,000
34	1	EA	Allowance for Additional Electrical Items	$150,000	$150,000
35	1	EA	Allowance for Additional Programming	$75,000	$75,000
36	1	EA	Contingency for Unforeseen Conditions	$515,000	$515,000

Base Bid (The sum of the computed totals for Bid Items 1 through 36 only):

_____ Dollars and _____ Cents
(Written words)

$ _____
(Figures)

THE BIDDER ACKNOWLEDGES AND AGREES THAT DETERMINATION OF THE LOWEST BIDDER SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF PARAGRAPH 17.6 OF THE INSTRUCTIONS TO BIDDERS.

THE BASE BID DOLLAR VALUE WILL BE ANNOUNCED AT THE BID OPENING.

2. Time of Completion

2.1 Bidder agrees that the Work will be substantially complete within five hundred and forty eight (548) calendar days after the date when the Construction Times commence to run as provided in Article 2 of the General Conditions and completed and ready for final payment in accordance with Article 14 of the General Conditions within forty-five (45) calendar days after the actual date when pursuant to paragraph 14.04 of Section 00700, General Conditions, Substantial Completion of the Work has been achieved.

2.2 Bidder accepts the provisions of the Agreement as to liquidated damages in the event of failure to complete the Work within the times specified in the Agreement.

2.3 In addition, Bidder agrees to meet the specified interim Milestones as defined in the General Requirements.

3. Bid Terms

3.1 Terms used in this Bid which are defined in the General Conditions or Instructions to Bidders will have the meanings indicated in the General Conditions or Instructions to Bidders.

Submitted on _____ ____ , 20____.

3.2 **If Bidder is an Individual:**

Name of Individual: _____

Name & Title of Person
Authorized to sign: _____

Signature: _____

Doing business as: _____

Business Address: _____

_____

Phone Number: _____ FAX Number: _____

3.3 **If Bidder is a Corporation**:

By: _____
(CORPORATION NAME)

Signature: _____

Name and Title: _____

Attest: _____

Name and Title: _____

Business Address: _____

_____

Phone Number: _____ FAX Number: _____

State of Incorporation: _____

3.4 **If Bidder is a Joint Venture (Partnership):**

By: _____ (NAME OF PARTNERSHIP)

Signature: _____

Name & Title: _____

_____

Business Address: _____

_____

Phone Number: _____

FAX Number: _____

By: _____ (NAME OF PARTNERSHIP)

Signature: _____

Name & Title: _____

_____

Business Address: _____

_____

Phone Number: _____

FAX Number: _____

3.5 **If Bidder is a Joint Venture (Corporation):**

By: _____ (CORPORATION NAME)

Signature: _____

Name and Title: _____

_____

Attest: _____

Name and Title: _____

_____

By: _____ (CORPORATION NAME)

Signature: _____

Name and Title: _____

_____

Attest: _____

Name and Title: _____

_____

Business Address: _____ Business Address: _____

_____ _____

Phone Number: _____ Phone Number: _____

FAX Number: _____ FAX Number: _____

State of Incorporation: _____ State of Incorporation: _____

3.6 **Phone and Address for receipt of official communications**: _____

_____

That we, _____,
as Principal, (hereinafter called the Principal) and the _____, a corporation duly organized under the laws of the State of _____, as Surety, (hereinafter called the Surety) are held and firmly bound unto the City of Phoenix as Obligee, in the sum of ten (10) percent of the total amount of the bid of Principal, submitted by him to the City of Phoenix for the work described below, for the payment of which sum, well and truly to be made, the said Principal and the said Surety, bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents and in conformance with A.R.S. #34-201.

WHEREAS, the said Principal is herewith submitting its proposal for **Lift Station 76 Phase II Expansion Project, Project NumberWS90400067**.

NOW, THEREFORE, if the City of Phoenix shall accept the proposal of the Principal and the Principal shall enter into a contract with the City of Phoenix in accordance with the terms of such proposal and give such Bonds and Certificates of Insurance as specified in the Standard Specifications with good and sufficient Surety for the faithful performance of such contract and for the prompt payment of labor and material furnished in the prosecution thereof, or in the event of the failure of the Principal to enter into such contract and give such Bonds and Certificates of Insurance, if the Principal shall pay to the City of Phoenix the difference not to exceed the penalty of the bond between the amount specified in the proposal and such larger amount for which the Obligee may in good faith contract with another party to perform the work covered by the proposal, then this obligation shall be null and void, otherwise to remain in full force and effect.

Signed and sealed this _____ day of _____ A.D., 2023

_____
Principal

_____
Title

_____
Mailing Address

_____

_____
Surety

_____
WITNESS:

_____

A.M. BEST RATING:

SECTION 00320 - BIDDER'S QUESTIONNAIRE

The undersigned Bidder warrants that all statements and answers made to the interrogatories that follow are current, accurate and complete as of the date stated below.

This form is due no later than 5:00pm on the 3rd day after the Bid.

1. Organization

1.1 How many years has your organization been in business under your present name? _____

1.2 Date and state of organization/incorporation: _____ (IRS) EIN: _____

1.3 Title and name of Principals (President, Vice-President, Secretary and Treasurer, if a corporation; partners, if a partnership).

_____ _____

_____ _____

1.4 If your organization, any business entity related to or affiliated with your organization, or any present of former executive employee, officer, director, shareholder (owning 20% or more of the outstanding shares), partner, or owner of your organization or of any such related or affiliated entity has ever been convicted of a felony, or has felony charges pending, in any state within the last three years from the date of Bid opening, including but not limited to a felony conviction under ARS Title 34, Section 252, furnish with this Bidder's Questionnaire all materials facts relating to any such felony conviction or any such pending felony charges against (1) your organization, (2) any such business entity related to or affiliated with your organization, or (3) any such present or former executive employee, officer, director, shareholder (owning 20% or more of the outstanding shares), partner, or owner of your organization or of any such related or affiliated entity.

Attachment _____ , consisting of _____ pages.

2. Licensing

2.1 For each Arizona Contractor's license required to perform the Work identified in the Bid Documents, attach a copy of the "identification card" issued by the Registrar of Contractors. Also attach a copy of any privilege license issued to your organization by the City of Phoenix, the State, and any other Political Subdivision with jurisdiction over the Work. Information concerning the City of Phoenix Privilege License may be obtained from the City of Phoenix Finance Department, Tax and License Division, 251 West Washington Street, 3rd Floor, Phoenix, Arizona, 85003, Attention: License Services, telephone (602) 262-6785, FAX (602) 495-5605.

Attachment _____ , consisting of _____ pages.

2.2 Does your organization hold contractor's licenses covering specialty classification of Work that your organization itself intends to perform and for which a specific specialty license is required under ARS Title 32, by Owner, or any other Political Subdivision with jurisdiction over the Work? _____ If so, attach a list with all licenses by number and classification; state the name of the organization holding the license, the renewal date of each license, and whether each license is active. Also, attach a copy of the corresponding identification cards issued by the Registrar of Contractors, the Owner or the particular Political Subdivision with jurisdiction over the Work.

Attachment _____ , consisting of _____ pages.

3. Experience

3.1 What is the general character of the work performed by your organization? _____

_____

3.2 (A) How many years of experience has your organization had as a General Contractor and as a Subcontractor involving work similar in character and scope to the Work described by the Bid Documents? _____

(B) How many years of experience has your subcontractors listed in Section 00330 - List of Subcontractors and Suppliers had as a General Contractor and as a Subcontractor involving Work similar in character and scope to the Work described by the Bid Documents? _____

3.3 (A) Attach a list of all public contracts and subcontracts that your organization has performed within the last five years over **$3 million** involving Work similar in character and scope to the Work described by the Bid Documents (using the forms in the "References Attachment" provided with this Questionnaire). If the contract or subcontract referenced is not substantially completed, furnish the percent complete for that contract or subcontract.

Attachment _____ , consisting of _____ pages.

(B) Attach a list of all public contracts and subcontracts that your major subcontractors listed in Section 00330 - List of Subcontractors and Suppliers have performed within the last five years over **$50,000** involving Work similar in character and scope to the Work described by the Bid Documents (using the forms in the "References Attachment" provided with this Questionnaire). If the contract or subcontract referenced is not substantially completed, furnish the percent complete for that contract or subcontract.

Attachment _____ , consisting of _____ pages.

3.4 Within the last five years, has your organization failed to complete a contract or subcontract awarded to it? _____ If so, for each contract or subcontract, state when, where and why.

_____

3.5 Within the last five years, has any officer or partner of your organization been an officer or partner of another organization that failed to complete a contract or subcontract awarded to it? _____ If so, for each contract or subcontract, state the name of each officer or partner, the name of the organization(s), the name of the owner(s), and the reasons why the contract(s) or subcontract(s) was/were not completed.

_____

_____

3.6 Within the last five years, has any officer or partner of your organization failed to complete a contract or subcontract awarded in that person's own name? _____ If so, for each contract or subcontract, state the name of each officer or partner, the name of the owner(s), and the reasons why the contract(s) or subcontract(s) was/were not completed?

_____

_____

3.7 Within the last five years, have any claims arising from or relating to a contract or subcontract been made against your organization or any officer or partner of your organization that resulted in litigation or arbitration? _____ If so, the Bidder shall attach a description of each claim, the amount of the claim, the parties involved, and the settlement amount or award.

Attachment _____ , consisting of _____ pages.

3.8 Within the last five years, has your organization or an officer or partner of your organization made any claims arising from or relating to a contract or subcontract that resulted in litigation or arbitration?_____ If so, the Bidder shall attach a description of each claim, the amount of the claim, the parties involved, and the settlement amount or award.

Attachment _____ , consisting of _____ pages.

3.9 Bidder shall have an Experience Modifications Rate (EMR) of less than or equal to 1.20 as determined by insurance industry standards. Failure to submit verification of their Experience Modifications Rate (EMR) from their respective insurer on the insurance company's letterhead, within the specified period, justifies the disqualification of the Bidder for consideration for the award.

Attachment _____ , consisting of _____ pages.

4. Additional Eligibility Data Under ARS Section 34-255

4.1 Parts of the Work, besides those disclosed on the List of Subcontractors and Suppliers, Section 00330, that you intend to subcontract: _____

4.2 If any of those Subcontractors nominated in paragraph 4.1 has ever been convicted of a felony, or has felony charges pending, in any state within the last three years from the date of Bid opening, including but not limited to a felony conviction under ARS Title 34, Section 252, furnish with this Questionnaire all materials facts relating to any such felony conviction or any such pending felony charges strictly in accordance with the requirements of paragraph 1.4.

Attachment _____ , consisting of _____ pages.

4.3 If any of the Suppliers (having a direct Sub-agreement with the Bidder or any of the Bidder's Subcontractors) has ever been convicted of a felony charge or has any felony charges pending in any state within the last three years from the date of Bid opening, including but not limited to a felony conviction under ARS Title 34, Section 252, furnish with this Questionnaire all material facts relating to any such felony conviction or any such pending felony charges strictly in accordance with the requirements in paragraph 1.4.

Attachment _____ , consisting of _____ pages.

4.4 State the name, address and telephone number of a representative of your organization who personally visited and inspected the site:

Also, describe subsurface and physical conditions at or contiguous to the site that your representative investigated and how they were accounted for in the preparation of your organization's Bid.

Attachment _____ , consisting of _____ pages.

4.5 Attach a list of construction equipment and machinery your organization intends to use in the execution of the Work, as estimated in the preparation of your organization's Bid.

Attachment _____ , consisting of _____ pages.

4.6 Does your organization rent and/or lease equipment and/or facilities from other affiliate organizations? _____. If so, state the name of the affiliate organization(s): _____

4.7 Credit available? _____ Amount: $

4.8 Will your organization, i.e., the Bidder named in the Authorized Signature Article on the Bid Form, be the only named Principal in the Performance Bond and Payment Bond? _____

If not, please identify the organization who will be named as Principal or Co-Principal on the

Performance Bond and Payment Bond _____.

Also, state how such organization relates to the Bidder _____.

(NOTE: If another organization is identified, the Bidder shall submit to the Owner or Design Professional a separate Questionnaire filled out by that organization as part of the Qualification Submittal required under Paragraph 3 of the Instructions to Bidders.)

(THE REMAINDER OF THIS PAGE IS INTENTIONALLY LEFT BLANK)

5. References

5.1 Trade references of work similar in character and scope to the Work described by the Bid Documents. (Minimum of three):

_____

_____

_____

5.2 Bank references:

_____

_____

_____

5.3 Insurance:

_____

_____

_____

6. Certificate of Submittal

By: _____
(name of individual, partnership, corporation or joint venture)

Signed By: _____

Name and Title: _____

on this _____ day of _____, 20____.

(THE REMAINDER OF THIS PAGE IS INTENTIONALLY LEFT BLANK)

REFERENCES ATTACHMENT TO BIDDER'S QUESTIONNAIRE

REFERENCE

Public Owner: ____________________

Project/Contract Name: ____________________

Location of Project: ____________________

Contract Price: ____________________

Project Started: ____________________ Completed: ____________________

Owner's Representative (Name & Phone): ____________________

Bidder's Representative (Name & Phone): ____________________

Scope of Project: ____________________

REFERENCE

Public Owner: ____________________

Project/Contract Name: ____________________

Location of Project: ____________________

Contract Price: ____________________

Project Started: ____________________ Completed: ____________________

Owner's Representative (Name & Phone): ____________________

Bidder's Representative (Name & Phone): ____________________

Scope of Project: ____________________

REFERENCE

Public Owner: ____________________

Project/Contract Name: ____________________

Location of Project: ____________________

Contract Price: ____________________

Project Started: ____________________ Completed: ____________________

Owner's Representative (Name & Phone): ____________________

Bidder's Representative (Name & Phone): ____________________

Scope of Project: ____________________

REFERENCES ATTACHMENT TO BIDDER'S QUESTIONNAIRE (continued):

REFERENCE

Public Owner: ______________________________

Project/Contract Name: ______________________________

Location of Project: ______________________________

Contract Price: ______________________________

Project Started: ________________ Completed: ________________

Owner's Representative (Name & Phone): ______________________________

Bidder's Representative (Name & Phone): ______________________________

Scope of Project: ______________________________

REFERENCE

Public Owner: ______________________________

Project/Contract Name: ______________________________

Location of Project: ______________________________

Contract Price: ______________________________

Project Started: ________________ Completed: ________________

Owner's Representative (Name & Phone): ______________________________

Bidder's Representative (Name & Phone): ______________________________

Scope of Project: ______________________________

REFERENCE

Public Owner: ______________________________

Project/Contract Name: ______________________________

Location of Project: ______________________________

Contract Price: ______________________________

Project Started: ________________ Completed: ________________

Owner's Representative (Name & Phone): ______________________________

Bidder's Representative (Name & Phone): ______________________________

Scope of Project: ______________________________

DESCRIPTION OF WORK OR MATERIALS (CONTRACTOR TO ENTER TRADE/SUPPLIER AREAS)	SELF-PERFORMED BY PRIME CONTRACTOR	SUBCONTRACTOR/ SUPPLIER COMPANY NAME (IF NOT SELF-PERFORMED)	CONTACT PERSON	PHONE NUMBER	DOLLAR VALUE OF WORK OR MATERIALS IN BID
	☐YES ☐ NO				
	☐YES ☐ NO				
	☐YES ☐ NO				
	☐YES ☐ NO				
	☐YES ☐ NO				
	☐YES ☐ NO				

I hereby certify by signing below that the above listed companies will be utilized to perform work on this project for an amount **equal to or greater than 5% of the base bid**. These companies shall not be removed or replaced without prior written approval by the City of Phoenix Project Manager. The City requires, as in Paragraph D – List of Major Subcontractors and Suppliers in the Information for Bidders that ALL vendors are listed, or you will be disqualified. If you are self-performing the work, you must still list any suppliers for materials, or list any contractors that will assist you in any form.

COMPANY NAME _____ SIGNATURE _____

NAME & TITLE _____ PHONE NUMBER _____ DATE _____

EMAIL ADDRESS _____

DESCRIPTION OF WORK OR MATERIALS (CONTRACTOR TO ENTER TRADE/SUPPLIER AREAS)	SELF-PERFORMED BY PRIME CONTRACTOR	SUBCONTRACTOR/ SUPPLIER COMPANY NAME (IF NOT SELF-PERFORMED)	CONTACT PERSON	PHONE NUMBER	DOLLAR VALUE OF WORK OR MATERIALS IN BID
	☐YES ☐ NO				
	☐YES ☐ NO				
	☐YES ☐ NO				
	☐YES ☐ NO				
	☐YES ☐ NO				
	☐YES ☐ NO				

I hereby certify by signing below that the above listed companies will be utilized to perform work on this project. These companies shall not be removed or replaced on the project without prior written approval by the City of Phoenix Project Manager. The City requires, as in Paragraph D - List of All Subcontractors and Suppliers in the Information for Bidders that ALL vendors are listed, or you will be disqualified. If you are self-performing the work, you must still list any suppliers for materials, or list any contractor's that will assist you in any form.

COMPANY NAME _____ SIGNATURE _____

NAME & TITLE _____ PHONE NUMBER _____ DATE _____

EMAIL ADDRESS _____

As provided in the Instructions to Bidders, the Bidder proposes that the items of major equipment or materials named herein will be supplied by the Manufacturers and Suppliers set forth below as written by the Bidder, unless changes are specifically authorized by the Owner. Preliminary acceptance of equipment or materials listed by the Manufacturer's name shall not in any way constitute a waiver of the specifications; final acceptance will be based on full conformity with the specifications covering the equipment and/or materials. Failure to provide this information will be just cause for Owner declaring the Bidder's Bid nonresponsive. **This form is due no later than 5:00pm on the 3rd day after the Bid.**

LISTING OF MAJOR EQUIPMENT		
SECTION	TITLE/DESCRIPTION	MANUFACTURER
11212	VERTICAL SUBMERSIBLE WELL PUMPS	
13124	ODOR CONTROL BIOFILTER	
15114	CHECK VALVES AND APPURTENANCES	
15119	SPECIALTY VALVES AND ACCESSORIES	
16423	MOTOR CONTROL CENTERS	
17260	CONTROL PANELS	

MATERIAL		
SECTION	TITLE/DESCRIPTION	MANUFACTURER

Submitted By: _____
(name of individual, partnership, corporation or joint venture)

Signed By: _____

Name and Title: _____

City of Phoenix

To: Matthew Bryan
Project Manager
Water Services Department

Date: 8/1/2023

From: Tiana Madrid, Co-Chair TM
SBE Goal Setting Committee

Subject: SBE GOALS FOR WEST ANTHEM LIFT STATION 76 PHASE II EXPANSION: WS90400067 (DBB)

Attendees: Eric Froberg, Tiana Madrid, Stacey L. Kisling, Marcel C. Begay, Matthew Bryan, Silvia Valadez, and Karina Matthiessen

A Small Business Enterprise (SBE) goal of **6.5%** was established for the above referenced project in accordance with Chapter 18 of the City's Ordinance, A.R. 1.89.

The goal was derived from the current availability of certified SBE firm(s) in the following specified scope(s) of work:

- Demolition
- Pipeline
- Landscape
- Manholes
- Control & Systems
- Electrical
- Concrete
- Metals
- Site Preparation

Only SBE subcontractors certified by the City of Phoenix under Chapter 18, Article VII of the Phoenix City Code are eligible to fulfill the participation goals as stated. A firm's certification must be current and in force at the date and time of the bid. The most current electronic listing of all certified firms can be accessed through the Internet at: www.phoenix.diversitycompliance.com/

If you have any questions or concerns regarding the goal for this project, please contact us at Small.Business.Enterprise@Phoenix.Gov.

Thank you for your continued support of the City's SBE Program.

c: Eric J. Froberg, City Engineer
Patty Kennedy, Deputy Water Services Director
Stacey L. Kisling, Supervisor
Equal Opportunity Division Office
Design and Construction Procurement Section Office

City of Phoenix

Small Business Enterprise Program

SBE – DESIGN BID BUILD (DBB) CONTRACT CLAUSE

PROJECT #: WS90400067 **CONTRACT #:** TBD

PROJECT TITLE: West Anthem Lift Station 76 Phase II Expansion

The City of Phoenix Small Business Enterprise Program (SBE) is managed and administered by the Equal Opportunity Department, Contract Compliance Division. Phoenix is one of the fastest growing, multicultural cities in the country and has shown a historical commitment to business diversity. The City strives to advance the economic growth of businesses through its Small Business Enterprise (SBE) Program.

Through a coordinated effort among several city departments, the SBE Program provides SBE certification, procurement opportunities, construction subcontracting utilization, small business management and technical assistance and educational services and networking opportunities.

The Small Business Enterprise (SBE) participation goal for this project is as follows:

SBE Required Goal = 6.5%

An annual SBE subcontracting participation goal has been established under this Contract. The Prime Contractor is required to demonstrate good faith efforts to utilize certified SBE firms to achieve this goal during the life of this contract.

For purposes of determining the Contractor's actual SBE utilization during and at the end of the project, the Contractor shall meet or exceed their **Proposed SBE Goal Percentage (as indicated on the Submitter's received SBE Utilization Form with their bid submittal)** for the contract, for ***ALL*** work performed on the project, including any amount paid for contingencies and allowances, and selected alternates. **The Proposed Goal shall meet/or exceed the Required Goal.**

For purposes of calculating the Contractor's "Proposed SBE Goal Percentage" on the Contractor's Statement of Proposed SBE Utilization form, bidders must not propose SBE subcontractors from areas identified on the bid form as contingencies and allowances or proposed alternates. Any SBE participation proposed from these areas will be not counted towards meeting the SBE goal requirement necessary for contract award.

The "Total Bid" shall be defined as the total of all the unit prices, or the lump sum total, including alternates and contingencies and allowances. The "Base Bid" shall be defined as the "Total Bid" minus "all proposed alternates" as determined by the project manager. Any additional dollars paid under this contract, including any selected alternate(s), shall be subject to the **Proposed SBE Goal Percentage** listed on the Contractor's Statement of Proposed SBE Utilization form.

SBE PROGRAM DEFINITIONS

Broker, Packager, Manufacturers' Representative, or Jobber means a firm that is not a manufacturer or regular dealer as defined herein.

Commercially Useful Function (CUF) means that a SBE firm is responsible for execution of the work of the contract and is carrying out its responsibilities by actually performing, managing, and supervising the work involved. A SBE must perform at least 75% of the total cost of its contract with its own work force in order to be determined to be performing a CUF on the contract.

Contract is a written agreement obligating the seller or business enterprise to furnish goods or services as submitted and the Purchaser or Buyer to pay for such goods or services.

Contractor is an individual, partnership, joint venture, corporation or firm that executes a contract with the City to perform services requested by a solicitation or procurement. The Contractor may be direct or through an authorized representative.

Joint Venture (JV) is an association between two or more persons, partnerships, corporations, or any combination thereof, formed to carry on a single business activity. The JV is limited in scope and duration to this contract. The resources, assets and labor of the participants must be combined in an effort to accrue profit.

Manufacturer means a firm that operates or maintains a factory or establishment that produces, on the premises, the materials, supplies, articles, or equipment required under the contract.

Purchaser for purposes of this contract means the City.

Regular Dealer or Supplier means a business that owns, operates, or maintains a store, warehouse, or other establishment in which the materials, supplies, articles or equipment of the general character described by the specifications are bought, kept in stock, and regularly sold or leased to the public in the usual course of business. The firm must be an established, regular business that engages, as its principal business and under its own name, in the purchase and sale or lease of the products in question.

Small Business Enterprise (SBE) means a small business that has been determined to meet the requirements for SBE certification with the City of Phoenix and whose certification is in force at the time of the award of business by the City. A directory of currently certified SBE firm is located at https://phoenix.diversitycompliance.com.

Subcontract a contract at any tier below the prime contract, including purchase orders.

Subcontractor is an individual, partnership, joint venture, corporation or firm that holds a contract at any tier below the prime contract, including purchase orders.

Successful Submitter is a Submitter who has been selected to perform services requested by a solicitation or procurement.

SECTION I. SBE CERTIFIED FIRMS

Only firms certified by the City of Phoenix under Chapter 18, Article VIII of the Phoenix city code are eligible to fulfill the participation goal stated above. A firm's ***certification must be in the trade areas listed on the proposed utilization form and current and in force at the date and time of the bid opening deadline***.

The most current electronic directory of all certified **SBE** firms can be accessed at:
https://phoenix.diversitycompliance.com

If you need to verify certification status, please contact the Equal Opportunity Department at (602) 262-6790 and identify yourself as a prime contractor bidding on this project. Prime contractors should verify that the certifications of the SBE firms are current prior to bid opening. ***If a firm's certification expires and is not renewed prior to the bid-opening deadline, that firm will be ineligible to satisfy the goal.***

SECTION II. SBE BID PROCEDURES

The bid envelope shall contain all information and documents related to the SBE requirements of this section. ***Failure to properly complete the "Contractor's Statement of Proposed SBE Utilization" and "Letter of Intent to Perform as a Subcontractor/Supplier" forms, or submit a fully documented waiver request as described below, will result in bid rejection.*** The required documentation includes:

1. **A Contractor's Statement of Proposed SBE Utilization** - The form shall document the name of each SBE firm that will be awarded a subcontract; services to be performed by each subcontractor; dollar amount to be paid for those services; and the total dollar amount that is being proposed in SBE participation.

2. **A Letter of Intent to Perform as a SBE Subcontractor/Supplier** (required for each SBE subcontractor/supplier proposed) The form shall be completed by the SBE firm that will be awarded the subcontract. The form documents services to be performed by the subcontractor/suppler and the total dollar amount of the subcontract that will be awarded to the SBE. Only the services performed in the area(s) described by the SBE's certification description can be counted towards the SBE goal requirement.

The bidder's proposed utilization of SBE firms to fulfill the participation goal must be submitted on the "Contractor's Statement of Proposed SBE Utilization" form included in the specification packet. Additionally, each of the **SBE** subcontractors/suppliers the bidder is proposing to use to meet the goal requirement on this contract must complete the "Letter of Intent to Perform as an SBE Subcontractor/Supplier" (LOI) form. Both forms must be completed and submitted as part of the bid packet by the bid-opening deadline.

Failure to submit a completed "Contractor's Statement of Proposed SBE Utilization" and signed "Letter of Intent to Perform as an SBE Subcontractor/Supplier" form for each of the proposed SBE firms will result in a bidder being declared non-responsive to the requirements of these specifications and the bid will not be considered. The forms must contain the following:

1. The Certified SBE firm name and the certified trade or services to be performed.
2. The dollar amount of the proposed subcontract to be awarded to each SBE firm.
3. The total dollar amount of all SBE proposed subcontracts.

In instances where an exact dollar amount to be subcontracted with a SBE firm cannot be determined, the bidder shall indicate on Columns 3 and 4 of Part B Section 1 of the "Letter of Intent To Perform as a SBE Subcontractor/Supplier" form the minimum guaranteed hours/units and dollar amount that will be paid to the SBE firm. This situation applies only when a Contractor proposes to utilize a SBE firm that engages in work

related to a broker, supplier or; a bid that is based on a per hour charge as in hauling/trucking or construction site security. Please note that this exception does not permit the Prime contractor to complete or modify any other part of the LOI document. Both, the SBE and the bidder must sign the LOI document prior to bid submittal. By signing the document, the bidder affirms that it has not altered or modified the document in any way other than, if applicable, entering the Unit/Hours and Total Quote Amount in Part B SECTION 1.

If a bidder proposes to utilize a firm not certified by the City of Phoenix and/or not certified in the proposed scope of work at the time of bid, the proposed utilization amount for that firm will be deducted from the total proposed SBE utilization amount used for determining if the bidder is responsive to the requirements of this section. Bidder shall not include any amount the SBE firm has indicated in the LOI document as work it will sublet or is not covered in their certification description in the Contractor's Statement of Proposed SBE Utilization form. Only amounts associated with the work to be performed by the SBE, and indicated in the SBE's certification description, may be counted towards the SBE participation goal requirement of this section.

If the reduced proposed SBE utilization is insufficient to meet the established participation goal required for this contract, and no waiver documentation has been submitted, the bidder shall be determined to be **non-responsive** to the requirements of this section and the bid will not be considered.

A certified SBE firm bidding as a Prime Contractor cannot count the work it will self-perform towards meeting the required SBE subcontracting goal.

A "Letter of Intent to Perform as a Subcontractor/Supplier" will be used in determining compliance with the requirements of this section. **The proposed subcontract dollar amount listed for each SBE firm on the "Contractor's Statement of Proposed SBE Utilization" must match the SBE dollar amount indicated in the boxed areas in Parts C, D or E of the signed "Letter of Intent to Perform as a Subcontractor/Supplier."** Failure to submit a completed LOI document with the SBE's and bidder's signatures shall be determined to be **non-responsive** to the requirements of this section and the bid will not be considered.

SECTION III. IF THE BIDDER IS UNABLE TO MEET THE GOAL

A fully documented waiver request detailing why the bidder has been unable to meet the SBE utilization goal in whole, or in part, and the "good faith" effort of the bidder to obtain SBE participation. In order to be viewed as good faith efforts, a bidder's activities must be consistent with all activities that could reasonably be expected from a bidder who was actively and aggressively seeking to meet the SBE goal. To show proof of having exercised good faith efforts in trying to obtain bids from SBE firms to meet the utilization goals. The following factors are illustrative of those matters that shall be considered when judging whether the bidder made "good faith efforts".

1. A cover letter addressed to the Street Transportation Procurement Section clearly indicating whether a full or partial waiver is being requested, the percentage to be waived, and the reasons the waiver is being sought.
2. If a partial waiver is being requested, a Bidder's Statement of Proposed Utilization listing firms that will satisfy the portion of the goal that will be met must be included with the bid proposal. Additionally, a Letter of Intent to Perform as a Subcontractor/Supplier from each SBE firm that is proposed to be utilized must be included with the bid proposal.
3. Proof of contact with SBE firms, including but not limited to, fax logs, telephone logs, mail receipts, etc, including documentation of the number of times that firms were contacted, the dates of contact, and the name, phone number, fax number, and address of the contact person associated with each SBE firm. Solicitation of SBE subcontractors must be consistent with the solicitation of all subcontractors and must clearly demonstrate that SBE firms had sufficient time to submit an effective response.
4. Copies of the documents submitted to all subcontractors requesting their bid. This should include the scope of work to be bid and performed on the project.

5. Copies of bid responses/quotes from all subcontractors who bid to perform work on the project in the areas that SBE firms were also bidding on, including information as to why SBE bids were not considered.
6. Documentation that shows efforts made to provide assistance to SBE firms in the areas of bonding, insurance, or other contracting requirements.
7. Documentation of attendance at the pre-bid conference held for the project.
8. Documentation of contact made with City personnel seeking assistance in identifying eligible SBE firms for contracting opportunities on the project.

SECTION IV. SBE WAIVER PROCEDURES

Requests for a partial or full waiver of the SBE goal for the project including all Good Faith Documentation shall be submitted as part of the bid packet. The request will be reviewed to ensure compliance with the requirements of this section. If the request is determined to meet the requirements, a waiver hearing will be scheduled and the bidder notified of the date, time, and place of the hearing. All waiver hearings are open to the public. However, only the designated representative for the contractor and City staff may participate in the proceedings.

The contractor requesting the waiver may appear at the hearing to present their request and answer questions from the Waiver Review Committee regarding their submittal. The Committee will consider the information and documentation that was submitted at the time of bid. The bidder may not present additional or new information at the hearing. At the conclusion of the hearing process the Committee will make independent recommendations on the request for waiver. The presiding officer, on behalf of the Committee, will provide a written summary of the Committee's recommendations to the City Manager's designee, the City Engineer. The City Engineer will make the final decision to grant or deny the waiver request. The City Engineer's decisions shall be final. The City will notify the contractor regarding the final decision of the City Engineer.

If a partial or full waiver of the SBE goal is granted to a bidder, the bidder shall be considered to have met the project goals and their bid will be considered responsive to the requirements of this section. If a waiver is denied, the bidder is deemed non-compliant and non-responsive to the requirements of this section and their bid will not be considered.

Failure to submit the Contractor's Statement of Proposed SBE Utilization form and a LOI from each SBE firm proposed OR a fully documented waiver request at the time of bid will be cause to determine the bidder non-responsive to the requirements of this section.

SECTION V. LIMITATION OF THE USE OF SUPPLIERS AND BROKERS TO FULFILL THE SBE GOAL

Proposed expenditures to brokers and suppliers can be used to meet the utilization goal, provided that the combined applicable expenditures do not exceed 25 percent (25%) of the total SBE goal requirement. Contractors may count one hundred percent (100%) of the dollars proposed to be paid to a SBE supplier, and all costs associated with fees and commission to be paid to a SBE broker, up to the 25% limitation.

Supplier (or Wholesaler) is defined as firm that does not directly manufacture the product being supplied and has an established, regular business that engages, as its principal business and under its own name, in the purchase and sale or lease of the products in question. A supplier is a firm that owns, operates, or maintains a store, warehouse, or other establishment in which the materials, supplies, articles or equipment of the general character described by the specifications and required under the contract are bought, kept in stock, and regularly sold or leased to the public in the usual course of business.

EXAMPLE: *An SBE goal of 5% has been established on a project where the contractor has submitted a base bid of $1,000,000. This results in a dollar goal of $50,000 to be subcontracted to SBE's. The contractor proposes to contract with a SBE supplier for $100,000. Only $12,500, or 25 percent (25%), may be counted*

towards achievement of the SBE goal for this project. The remaining $37,500 must be achieved through the use of firms that are not suppliers or brokers.

Broker is defined as firm that arranges or expedites services or transactions through the use of individuals not directly employed by the company. Brokers are not regular suppliers. Only costs associated with the fees and commission paid to the certified firm for providing such services may be applied towards the SBE contract goal.

The following defines the expenditures to SBE firms that are NOT subject to the 25% limitation. The following expenditures may be counted in their entirety towards fulfilling 100% of the utilization goal:

1. Expenditures to certified SBE firms that operate and maintain an establishment or factory to produce, on the premises, the materials or supplies purchased for the contract.
2. Expenditures to a certified SBE fabricator that operates and maintains a factory to substantially alter materials or supplies before resale.
3. Expenditures, including fees and commissions, charged to provide bona fide technical and professional personnel recruitment for the contract. The total cost paid that shall be comparable to the industry standards customarily charged for the same or similar services.
4. Expenditures, including fees and commissions, charged for providing bonds and insurance specifically required for the performance of the contract. The total cost shall be comparable to the industry standards charged for the same or similar services.

All SBE firms proposed to participate on this contract opportunity must be SBE certified by the City of Phoenix prior to the date and time of the bid.

Participation on the contract will be calculated based on that portion (dollar value) of the contract that the SBE actually performs with its own forces. This includes the cost of supplies and materials obtained by the SBE for the work on the contract, ***except*** in cases when; it has been determined by the City *not* to be part of the firm's certification description; the SBE is certified as a "placer", "finisher", or "installer" of those materials only, or when the supplies and/or equipment it uses to perform its work is purchased or leased from the Contractor or its affiliate.

Special emphasis and care should be taken to ensure that the following types of participation are handled properly when preparing your bid packet, as failure to correctly calculate the allowable SBE participation in the following areas shall result in your bid being declared non-responsive if the SBE goal requirement is not met:

Fees & Commissions*:* SBE firms that supply a bona fide service for a fee or commission may be counted only to the extent of the fees or commissions charged by the SBE. This includes, but is not limited to, providing professional, technical, consultant, or managerial services, and bonds or insurance specifically required for the performance of a contract. Fees must be reasonable, not excessive, compared to fees customary for similar services.

EXAMPLE: *A* SBE *firm that supplies uniformed officers for security or traffic control may count only the amounts charged as a commission. The hourly amount paid to the officers may not be counted. If the "per hour" bid amount to the prime contractor is $35, and $25 per hour will be paid to the officers, only $10 per hour can be counted towards achieving the* SBE *goal. If the firm or bidder estimates that there will be 200 hours of work bid at a rate of $35 per hour, only $2,000 of the total $7,000 bid could be counted.*

Trucking & Hauling: The amount of a trucking/hauling subcontract that may be counted towards the utilization requirements may be limited. An SBE must itself own and operate at least one fully licensed,

insured, and operational truck that will be used on the contract. In addition, trucks the SBE leases without drivers under a long-term leasing agreement may be considered part of the trucking firm's workforce and

counted in full, provided the leasing agreement(s) is/are for a period of not less than 6 months and; **the leased vehicles have been recorded with the City's Equal Opportunity Department's Certification Office prior to the submittal of the LOI document.**

EXAMPLE: *A* SBE *trucking firm uses seven trucks on a job; two are owned by the* SBE *and five are leased from other firms. If two of the five trucks are leased without drivers and the remaining three are leased with drivers from another firm, then the amount paid to the* SBE *for the services provided by the trucks it owns and the two it leases without drivers and operates with its own employees can be counted in full towards meeting the* SBE *requirements. The Contractor may not count any portion of the amount the SBE receives for the two trucks it leases with drivers towards the* SBE *utilization goal.*

SECTION VI. POST AWARD SBE COMPLIANCE INFORMATION - DBB

Submittal of a bid to the City of Phoenix shall constitute an agreement by the bidder to comply with the SBE utilization requirements of this section should the bidder be awarded a contract. This includes, but is not limited to, the following compliance activities:

1. The contractor shall contract, or attempt to contract, in good faith with all SBE firms listed on the Bidder's Statement of Proposed SBE Utilization form submitted with their bid. The subcontract shall be for an amount that is equal to, or greater than, the total proposed dollar amount listed on the form, with the exception of instances where the City changes a scope of work in the contract that would reduce the available work in the subcontractor's area of performance.
2. The contractor shall not reduce any of the proposed SBE scopes of work or amounts indicated on the Bidder's Statement of Proposed SBE Utilization form without first submitting a Request for Exemption and receiving approval in writing from the City's Equal Opportunity Department (EOD), Contract Compliance Division.
3. The contractor shall notify the City of Phoenix Equal Opportunity Department immediately if any firm listed on the Bidder's Statement of Proposed SBE Utilization form refuses to enter into a subcontract or fails to perform according to the requirements of the subcontract.
4. Any reduction of retention by the City to the contractor shall result in a corresponding reduction to subcontractors or suppliers who have performed satisfactory work. The contractor has 14 days from the date their retention reduction takes effect to reduce retention to the subcontractors.
5. The contractor shall return all retention monies to subcontractors at such time as the work originally proposed by the subcontractor, and expressed in the original subcontract agreement, is complete and the purchaser (City) has accepted the work and paid the prime for the work performed by the subcontractor. Retention shall be paid no later than 30 days after such payment is made by the City.
6. The contractor shall act in good faith to meet the contract SBE utilization goal and provide all necessary documentation to show proof of those efforts as requested by the City.

If for any reason the SBE firm is decertified prior to the execution of a subcontract agreement, the bidder shall find additional SBE participation in the amount equivalent to or greater than that which was originally proposed for the SBE firm. Bidder shall make every good faith effort possible in finding a SBE replacement in the proposed trade area first, before considering SBE participation in other trade areas.

SECTION VII. Subcontract Assurances

Each contract signed by the Agency and the Successful Bidder and each subcontract signed by the Successful Bidder with a Subcontractor, including Subcontractors with lower tier Subcontractors must include the following assurances verbatim:

Prompt Payment of Subcontractors *The Contractor and Subcontractor shall promptly pay its lower tier subcontractors, sub consultants, or suppliers upon receipt of payment from the City of Phoenix (Agency).*

Progress Payments: In accordance with the Arizona Revised Statues (ARS), Section 34-221(G), the Contractor(s) shall promptly pay its subcontractors, sub consultants, or suppliers within seven (7) calendar days of receipt of each progress payment from the Agency. Any diversion by the Contractor(s) of payments received for work performed on the contract, or failure to reasonably account for the application or use of such payments, constitutes grounds for a declaration of breach of the contract with the Agency.

Retention Payments: If the Agency reduces the Contractor's retention, the Contractor shall correspondingly, within 14 days, reduce the retentions held against the Subcontractors and suppliers that have performed satisfactory work.

Release of Retention: The Contractor(s) shall ensure prompt and full payment of retentions to Subcontractors and suppliers when their work is complete, the Agency has accepted the work, and the Agency has paid the Contractor for the work. The Contractor shall pay each Subcontractor's and supplier's retention no later than 30 days after the Agency pays Contractor for the completed scope of work.

Changes to Subcontracts and Values *The City of Phoenix prohibits Contractor(s) from altering the Contractor's Statement of Proposed SBE Utilization form without receiving prior, written consent from the City. The Equal Opportunity Department must be informed, in writing, and in advance of the following:*

- *Reduction to the scope of work performed by subcontractors working on the contract*
- *Changes in any of the subcontract values resulting in a reduced dollar amount*
- *Replacement and/or release of any subcontractor after contract award*

Contractor(s) and Subcontractor(s) are required to complete a Request for Exemption Form and have the written approval of the Contract Compliance Office prior to taking action on any of the above listed matters related to SBE subcontractors.

In the event that any provision of this subcontract varies from the provisions of the contract or subcontract, the provisions for SBE contract compliance as contained in Administrative Regulation 1.89, Section IX, shall provide definitive guidance.

Disclaimer: *Nothing in this section prevents the Contractor or Subcontractor from enforcing its subcontract with a lower tier Subcontractor or supplier for defective work, late performance, and other claims arising under the Subcontract.*

SECTION VIII. RECORDS and REPORTING REQUIREMENTS

1. **Records**

During performance of the Contract, the Successful Submitter shall keep all records necessary to document the participation of all subcontractors and suppliers. The Successful Submitter shall provide the records to the Agency within 72 hours of the Agency's request and at final completion of the Contract. The Agency will prescribe the form, manner, and content of reports. The required records may include but not limited to:

a) A complete listing of all Subcontractors and suppliers on the project;
b) Each Subcontractor's and supplier's scope performed;
c) The dollar value of all subcontracting work, services, and procurement;
d) Copies of all executed Subcontracts, purchase orders, and invoices: and
e) Copies of all payment documentation.

2. **Reports**

a. The contractor shall participate in all compliance reviews determined necessary by the City. This includes, but is not limited to participating in on-site reviews, providing monthly utilization reports of SBE activity, providing signed copies of subcontracts and/or purchase orders with each SBE listed on the Bidder's Statement of Proposed SBE Utilization form, and complying with any and all requests for information the City deems appropriate for effectively monitoring this contract for compliance with the SBE Program requirements.
b. The contractor shall provide regular, monthly report/audit information that will assist us in effectively monitoring your compliance with the SBE Program requirements. This shall include listing all subcontractors working on the contract and reporting payments into the Certification and Compliance System https://phoenix.diversitycompliance.com. Reporting audits shall include all payments received from the City and payments you have issued to all subcontractors and suppliers. **Copies of the first 2 pages of the Pay Request submittal are required with each report. All Monthly audit reports are to be completed online by the 15th of every month.** (https://phoenix.diversitycompliance.com).
    i. The total of all payments received from the City during the previous month.
    ii. The first two pages of each payment application submitted for those payments.
    iii. All payments made to Subcontractors during the previous month.

Before the Agency processes the Successful Submitter's final payment and/or outstanding retention held against the Successful Submitter, the Successful Submitter shall submit to the Agency a final certification of full and final payment to each Subcontractor in the form prescribed by the Agency. The form must be completed and certified by the Successful Submitter's and each Subcontractor's duly authorized agents.

SECTION IX. PERFORMANCE OF A COMMERCIALLY USEFUL FUNCTION

The prime contractor may count only expenditures to SBE subcontractors that perform a commercially useful function in the work of the contract, as defined in Chapter 18 Article VI of the City Code. A "commercially useful function" constitutes performing real and actual services related to the contract.

SBE subcontractors may enter into second-tier subcontracts consistent with normal industry practices. If an SBE subcontracts greater than twenty-five **(25)** percent of the work of their contract, the SBE subcontractor shall be presumed not to be performing a commercially useful function. In this event, the prime contractor will not be allowed to claim any expenditure to the SBE subcontractor.

SECTION X. FAILURE TO COMPLY WITH THE SBE PROGRAM REQUIREMENTS

If the Equal Opportunity Department determines that the contractor will fail, or has failed, to meet the SBE subcontracting goals, and/or has failed to act in good faith to ensure compliance with the SBE conditions of its contract; it shall deem the contractor "noncompliant" and not in good standing. A noncompliant status shall result in the rejection of all future contract bids or offers for all projects or other procurements with the City until such time that the contractor has cured its breaches and demonstrates that it has faithfully performed its approved SBE utilization plan and all other provisions of this article required to be deemed in good standing. In addition to this action, the City may also exercise its option to impose any or all of the following remedies:

1. Withholding from the contractor ten percent (10%) of all future payments on the involved eligible project until it is determined that the contractor is in compliance;

2. Withholding from the contractor all future payments on the involved project until it is determined that the contractor is in compliance

Failure to cure a non-compliance status within the time frame provided by the City may result in further action, including but not limited to imposing any or all of the following sanctions:

1. Rejection of all future bids or offers from the contractor for any eligible project with the City or any of its departments or divisions for a period of (1) year after substantial completion of the contract.

2. Cancellation of the contract.

City of Phoenix

Small Business Enterprise Program

CONTRACTOR'S STATEMENT OF PROPOSED SBE UTILIZATION (DBB)

PROJECT NUMBER/TITLE: WS90400067/ West Anthem Lift Station 76 Phase II Expansion **Required SBE Goal: 6.5%**

SBE FIRMS	COMPANY NAME	SERVICES TO BE PROVIDED	SUPPLIER- (YES or NO) May not satisfy more than 25% of the Goal	SBE $ AMOUNT from LOI Tables - Sections C, D, or E	Countable SBE $ Amount (towards proposed goal)

($_____) - **($_____)** - ($_____) = ($_____)
Total Bid - **Allowances & Contingencies** - **Alternates** = **Base Bid**

Total Proposed SBE Dollars

$_____

($_____) ÷ $_____) **X 100 =** _____**% (NO ROUNDING)**
Total Proposed SBE Dollars ÷ Base Bid X 100 = Proposed SBE %

Proposed SBE Percentage must equal or exceed the Required SBE Goal Percentage.

Do **NOT** propose SBE dollars in scopes related to Alternates, Allowances, or Contingencies as part of meeting the required SBE %.

All additional contract dollars, including selected alternates, contingencies, and allowances paid after award of contract, will be subject to the SBE contract goal %.

I hereby certify by signing below the foregoing SBE firms shall be contracted to work on the trades identified above and/or supply material/equipment for this project.

*The information shown above is a **true reflection of the proposed subcontracts**.*

COMPANY NAME: _____ EMAIL: _____ PHONE: _____

NAME : _____ TITLE: _____

SIGNATURE: _____ DATE: _____

City of Phoenix

Small Business Enterprise Program

Letter of Intent (LOI) To Perform as an SBE Subcontractor

(THIS FORM ***MUST*** BE COMPLETED BY THE SBE SUBCONTRACTOR – BOTH SBE SUBCONTRACTOR & PRIME SIGNATURE ARE REQUIRED)

Project Number: WS90400067 **Contract #:** TBD	**Project Description:** West Anthem Lift Station 76 Phase II Expansion

TO: _____ (Insert Name of Prime Contractor)

FROM: _____ (Insert Name of SBE Firm)

A. The undersigned declares that the firm bidding to perform the work described herein, has been granted certification by the City of Phoenix (COP) as a Small Business Enterprise (SBE) in the area(s) of:

(COP) Certification Description:

B. The undersigned is bidding to perform the following scope(s) of work on the above referenced project:

SECTION 1 - COMPLETE THIS PORTION IF THE SCOPE OF WORK IS BEING BID BY UNIT PRICE OR HOURLY RATE SUPPLIER, BROKER, TRUCKING, HAULING, UNIFORMED OFFICERS MUST USE THIS SECTION			
Scope of Work	**Unit/Hourly Rate**	**# of Units/Hours**	**Total Quote Amount**
			$

SECTION 2 - GENERAL OR SPECIALTY CONSTRUCTION TRADE AREAS MUST USE THIS SECTION	
Scope of Work	**Total Quote Amount**
	$

C. Of the Total Quote Amount reflected in Part B-SECTION 2, the following scope(s) of work with the given amount **will not** be performed by the SBE or **is/are not** covered under the SBE's certification description:

Scope(s) of Work _____ **Amount $**_____

Subtract Amount in Part C above from the Total Quote Amount in Part B-Section 2 =* $_____

* ***Only this amount shall be reflected on the Bidder's Statement of Proposed Utilization.***

D. If trucking services are included in Part B - SECTION 1 above, SBE **MUST** complete the following:

Of the Total Quote Amount noted in part B-Section 1, the SBE affirms that the amount of * $_____ shall be performed by drivers the firm employs, and trucks the SBE owns and leases without drivers.

(*The amount referenced above is transferred from Step 9 of the Worksheet (L.O.I.W.-1). *Only this amount shall be on the Statement of Proposed Utilization)*

E. All subcontractors providing Broker or Traffic Control/Security Services indicated in Part B-SECTION 1 above **MUST Complete the Following:**

Rate of the SBE's fees/commissions _____%; for a Total Amount in fees/commissions of: $_____

The Percentage and Total Amount referenced above is transferred from Steps 2 and 3 of the Worksheet (page L.O.I. W.-1).
Only the Total Amt in fee/commissions shall be reflected on the Bidders Statement of Proposed Utilization.

Should the prime contractor receiving this form be selected for award of the contract, the undersigned affirms that he/she will enter into an agreement to perform the work bid herein.

_____ _____

(SBE Subcontractor Authorized Signature) (Date)

_____ _____

(Print Name and Title) (Phone Number)

By signing this LOI document, the Prime Contractor affirms that it has not altered or modified this document in any way other than, if applicable, entering the Unit/Hours and Total Quote Amount in Part B SECTION 1.

_____ _____

(Prime Contractor Authorized Signature) (Date)

_____ _____

(Print Name and Title) (Phone Number)

City of Phoenix
Small Business Enterprise Program

LETTER OF INTENT TO PERFORM AS A SUBCONTRACTOR/SUPPLIER INSTRUCTIONS AND WORKSHEET - *L.O.I. W.-1*

A Letter of Intent to Perform as a SBE Subcontractor/Supplier (required for each SBE subcontractor/supplier proposed). The form documents services to be performed by the subcontractor/suppler and the total dollar amount of the subcontract that will be awarded to the SBE. Only the services performed in the area(s) described by the SBE's certification description can be counted towards the SBE goal requirement.

Part I. Trucking and Hauling: SBEs should indicate on Part B-Section 1 and Part D, of the LOI form, the information regarding trucks to be used in executing the contract. The City allows the counting of all payments for services provided by trucks which the SBE owns. Trucks which the SBE leases on a long-term basis and are operated with drivers the SBE employs may also be counted in full. The payments for short-term leased trucks, with or without SBE employed drivers cannot be counted.

Only trucks for which leasing agreements have been submitted and approved by EOD as part of the SBE firm's current certification file shall be considered eligible for counting towards the goal.

STEP ONE	STEP TWO	STEP THREE
Value of work expected to be performed by trucks owned by the SBE (2 Trucks)	Value of work expected to be performed by trucks leased (**with drivers**) by the SBE on a long-term basis (2 Trucks)	Combined value of work expected to be performed by other trucking firms and/or trucks leased (**without drivers**) by the SBE (3 Trucks)
$20,000	**$20,000**	**$33,000**

STEP FOUR	STEP FIVE	STEP SIX
Estimated value for services provided by all trucks the SBE will use on the contract. **(Add Steps One, Two, and Three)**	Expected value of work performed by trucks not eligible for counting as SBE participation **(Value in Step Three)**	Total estimated value that can be counted for SBE participation **(Subtract Step Five from Step Four)** **$73,000 - $33,000**
$73,000	**$33,000**	**=$40,000**

Part II. Fees and Commissions: Insert the information from below under Step Three-Commission/Fees Percentage and the Countable Amount for SBE Participation into Part E of the LOI form. This part is applicable for the use of uniformed officers to provide traffic control and security and other services provided at an hourly rate by non-employees of the SBE contractor.

(The following information is provided as a sample only)

STEP ONE		
Total Number of Hours	Per Hour Bid Amount	Calculation Formula: Total Gross Bid Amount
200	**$35**	**200 × $35 = $7,000**

STEP TWO			
Per Hour Bid Amount	Officers Hourly Rate	SBE Firm Commission/Fee	Calculation Formula: Fees/Commissions Percentage
$35	**$25**	**$10**	**(10 / 35) * 100 = 28.57%**

STEP THREE		
Gross Bid Amount (from Step One)	Commission/Fee % (from Step Two)	Calculation Formula: Amount Countable for SBE Participation
$7,000	**28.57%**	**$7,000 × .2857 = $2,000**

Part III. Construction Trade Areas: SBE must indicate in the Scope of Work of Part B-Section 2 of the LOI form, ***all*** scope(s) of work associated with the Total Quote Amount. The SBE must complete Part C of the LOI form by entering the Scope of Work and amount not expected to be performed by the SBE or which is not covered under the SBE's certification description. Subtracting this amount from the Total Quote Amount in Part B-Sect. 2 will result in the portion of work that can be counted as SBE participation.

Authorized Contact for this Disclosure Statement

Name: _____
Title: _____
E-mail: _____
Phone number: _____
FAX number: _____

List any other DBA, trade name, other identity, or EIN used in the last five (5) years, the state or country where filed, and the status (active or inactive): (if applicable):

_____

_____

Business Characteristics:

Business entity type – Please check appropriate box and provide additional information:

☐	Corporation	Date of incorporation:	_____
☐	Limited Liability Company	Date organized:	_____
☐	Limited Liability Partnership	Date of registration:	_____
☐	Limited Partnership	Date established:	_____
☐	General Partnership	Date established:	_____
☐	Sole Proprietor	How many years in business:	_____
☐	Other (explain)	Date established:	_____

Was the business entity formed in the State of Arizona? ☐ Yes ☐ No

If no, indicate jurisdiction where Business Entity was formed: _____

Is the Business Entity currently registered to do business in Arizona with the Arizona Corporation Commission? ☐ Yes ☐ No ☐ Not required _____ (if sole proprietor or general partnership)

Does the Business Entity have a City of Phoenix business privilege license? ☐ Yes ☐ N If “no” explain and provide detail such as “not required” or “application in progress” or other reason.

_____

Is the Business Entity publicly traded? ☐ Yes ☐ No

Is the responding Business Entity a Joint Venture? ☐ Yes ☐ No Note: If the Submitting Business entity is a Joint Venture, also submit a questionnaire for each Business Entity comprising the Joint Venture.

Is the Business Entity's Principal Place of Business/Executive office in Phoenix? ☐ Yes ☐ No

If "no" does the Business Entity maintain an office in Phoenix? ☐ Yes ☐ No

Provide the address and phone number for the Phoenix office.

_____

Is the business certified by Phoenix as a Small Business Enterprise? ☐ Yes ☐ No

Identify Business Entity Officials and principal Owners:

Name(s) _____Title_____
Percentage ownership ___%(Enter 0% if not applicable).

Name(s) _____Title_____
Percentage ownership ___%(Enter 0% if not applicable).

Name(s) _____Title_____
Percentage ownership ___%(Enter 0% if not applicable).

Name(s) _____Title_____
Percentage ownership ___%(Enter 0% if not applicable).

Affiliates and Joint Venture Relationships

Does the Business entity have any Affiliates? ☐ Yes ☐ No Attach additional pages if necessary.

Affiliate name: _____
Affiliate EIN (if available):_____.
Affiliate's primary Business Activity:_____
Explain relationship with Affiliate and indicate percent ownership, if applicable. _____

Are there any Business Entity Officials or Principal Owners that the Business Entity has uncommon with this Affiliate? ☐ Yes ☐ No

Individual's Name:_____
Position/Title with Affiliate:_____

Has the Business Entity participated in any joint Ventures within the past three years? ☐ Yes ☐ No

(Attach additional pages if necessary)

Joint Venture Name:_____

Joint venture EIN (if applicable):_____

Identify parties to the Joint Venture:

_____

Contract History

Has the Business Entity held any contracts with the City of Phoenix in the last three (3) years?

☐ Yes ☐ No If "yes" attach a list.

Integrity – Contract Bidding

Within the past three (3) years:

Has the Business Entity or any Affiliate been suspended or debarred from any government contracting process or been disqualified on any government procurement? ☐ Yes ☐ No

Been subject to a denial or revocation of a government prequalification? ☐ Yes ☐ No

Been denied a contract award or had a bid rejected based upon a finding of a non-responsibility by a government entity? ☐ Yes ☐ No

Agreed to a voluntary exclusion from bidding/contracting with a government entity? ☐ Yes ☐ No

Initiated a request to withdraw a bid submitted to a government entity or made any claim of an error on a bid submitted to a government entity? ☐ Yes ☐ No

Initiated a request to withdraw a bid submitted to a government entity or made any claim of an error on a bid submitted to a government entity? ☐ Yes ☐ No

For each "Yes" answer above, provide an explanation of the issues.

Integrity – Contract Award

Within the past three (3) years has the Business Entity or any Affiliate been suspended, cancelled, or terminated for cause on any government contract? ☐ Yes ☐ No

Been subject to an administrative proceeding or civil action seeking specific performance or restitution in connection with any government contract? ☐ Yes ☐ No

For each "yes" answer, provide an explanation. (Attach explanation on a separate sheet of paper).

Certifications/Licenses

Within the past three (3) years, has the Business Entity or Affiliate had a revocation, suspension, or disbarment of any business or professional permit and/or license? ☐ Yes ☐ No

If "yes" provide an explanation of the issue(s), the Business Entity involved, the relationship to the submitting Business Entity, relevant dates, the government entity involved, and any remedial or corrective action(s) taken and the current status of the issues.

Legal Proceedings

Within the past three (3) years, has the Business Entity of any Affiliate:

Been the subject of an investigation, whether open or closed, by any government entity for a civil or criminal violation? ☐ Yes ☐ No

Been the subject of an indictment, grant of immunity, judgment or conviction, (including entering into a plea bargain for conduct constituting a crime)? ☐ Yes ☐ No

Received any OSHA citation and Notification of Penalty containing a violation classified as serious or willful? ☐ Yes ☐ No

Had a government entity find a willful prevailing wage or supplemental payment violation? ☐ Yes ☐ No

Been involved in litigation as either a plaintiff or a defendant involving a copyright or patent infringement violation or an anti-trust violation? ☐ Yes ☐ No

Other than previously disclosed, for the past three (3) years:

Been subject to the imposition of a fine or penalty in excess of $1000 imposed by any government as a result of the issuance of citation, summons or notice of violation, or pursuant to any administrative, regulatory, or judicial determination? ☐ Yes ☐ No

Been charged or convicted of a criminal offense pursuant to any administrative and/or regulatory action taken by any government entity? ☐ Yes ☐ No

If "yes" provide an explanation of the issue(s), the Business Entity involved, the relationship to the submitting Business Entity, relevant dates, the government entity involved, and any remedial or corrective action(s) taken and the current status of the issues.

Leadership Integrity

If the Business Entity is a joint Venture Entity, answer "N/A – Not Applicable" to questions below:

Within the past three (3) years has any individual previously identified, or any other Business Entity Leader not previously identified, or any individual having the authority to sign, execute, or approve bids, proposals, contracts or supporting documentation with the city of Phoenix been subject to:

A sanction imposed relative to any business or professional permit and/or license? ☐ Yes ☐ No

☐ N/A

An investigation, whether open or closed, by any government entity for a civil or criminal violation for any business-related conduct? ☐ Yes ☐ No ☐ N/A

CITY OF PHOENIX: Water Services Department
PROJECT NAME: Lift Station 76 Phase II Expansion
PROJECT NUMBER: WS90400067

City of Phoenix

AFFIDAVIT OF IDENTITY

Your completion of this form is required by Arizona state law. A.R.S. §§ 1-501 and -50 only if you are a sole proprietor.

I, _____(print full name exactly as on document), hereby affirm, upon penalty of perjury, that I presented the document marked below to the City of Phoenix, that I am lawfully present in the United States, and that I am the person stated on the document. (*select one category only*)

☐ Arizona driver license issued after 1996.
Print first four numbers/letters from license: | | | | |

☐ Arizona non-operating identification license.
Print first four numbers/letters from license: | | | | |

☐ Birth certificate or delayed birth certificate issued in any state, territory or possession of the U.S.
Year of birth: _____ Place of birth: _____

☐ United States Certificate of birth abroad
Year of birth: _____ Place of birth: _____

☐ United States Passport
Print first four number/letters on Passport: | | | | |

☐ Foreign Passport with United States Visa
Print first four number/letters on Passport: | | | | |
Print first four number/letters on Visa: | | | | |

☐ I-94 Form with a photograph
Print first four numbers on I-94 | | | | |

☐ USCIS Employment Authorization Document (EAD)
Print first four numbers on EAD | | | | |
or Perm. Resident Card (acceptable alternative): | | | | |

☐ Refugee Travel Document
Date of issuance: _____ Refugee Country: _____

☐ U.S. Certificate of Naturalization
Print first four digits of CIS Reg. No. | | | | |

☐ U.S. Certificate of Citizenship
Date of issuance: _____ Place of issuance: _____

☐ Tribal Certificate of Indian Blood
Date of issuance: _____ Name of Tribe: _____

☐ Tribal or Bureau of Indian Affairs Affidavit of Birth
Year of birth: _____ Place of birth: _____

Signed: _____ Dated: _____

SECTION 00500 - AGREEMENT

TABLE OF CONTENTS

Subject		Page
ARTICLE 1 -	WORK	1
ARTICLE 2 -	DESIGN PROFESSIONAL	1
ARTICLE 3 -	CONTRACT TIMES	1
ARTICLE 4 -	CONTRACT PRICE	1
ARTICLE 5 -	PAYMENT PROCEDURES	2
ARTICLE 6 -	INTEREST	2
ARTICLE 7 -	CONTRACTOR'S REPRESENTATIONS	2
ARTICLE 8 -	CONTRACT DOCUMENTS	3
ARTICLE 9 -	MISCELLANEOUS	4
ARTICLE 10 -	CITY OF PHOENIX EQUAL EMPLOYMENT OPPORTUNITY REQUIREMENT	4
ARTICLE 11 -	SBE UTILIZATION GOALS	4
AGREEMENT FORM		5

SECTION 00500 - AGREEMENT

THIS AGREEMENT made and entered into as of the date of the Clerk's attestation below by and between the City of Phoenix, Arizona, an Arizona municipal corporation organized and existing under and by virtue of the laws of the State of Arizona (hereinafter called Owner) and **«Company»**, **«LegalEntity»** (hereinafter called Contractor). Owner and Contractor, in consideration of the mutual covenants hereinafter set forth, agree as follows:

ARTICLE 1 - WORK

The Lift Station 76 Phase II Expansion Project consists of construction and installation of a new sanitary sewer pipeline, manholes, biofilter and ancillary equipment, lift station wet well, force main, new electrical equipment and instrumentation equipment. In addition, the project includes demolition, site improvements and bypass pumping as required to maintain service at all times as shown per the contract documents.

ARTICLE 2 - DESIGN PROFESSIONAL

The Owner has retained Wilson Engineers, LLC, who is hereinafter called the Design Professional and who is to act as Owner's representative, assume all duties and responsibilities of and have the rights and authority assigned to the Design Professional in the Contract Documents in connection with completion of the Work in accordance with the Contract Documents.

ARTICLE 3 - CONTRACT TIMES

The periods allowed for completion of the Work are as follows:

The entire Work shall be Substantially Complete in accordance with the requirements of the Contract Documents within five hundred and forty eight (548) calendar days from the date when the Contract Times commence to run.

All Work shall be complete and ready for final acceptance as specified in the Contract Documents within forty-five (45) calendar days from the actual date when pursuant to Section 00700, General Conditions, Substantial Completion of the Work has been achieved.

Liquidated Damages. Owner and Contractor recognize that time is of the essence of this Agreement and that Owner will suffer financial loss if the Work is not completed within the times specified above, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions. They also recognize the delays, expense and difficulties involved in proving the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty) Contractor shall pay Owner one thousand seven hundred eighty dollars and no cents ($1,780.00) for each day that expires after the time specified above for Substantial Completion until the Work is substantially complete. After Substantial Completion, if Contractor shall neglect, refuse or fail to complete the remaining Work within the time specified above for completion and readiness for final payment or any proper extension thereof granted by Owner, Contractor shall pay Owner one thousand seven hundred eighty dollars and no cents ($1,780.00) for each day that expires after the time specified above for completion and readiness for final payment.

In addition, Contractor agrees to meet any additional Contract Times set forth in Attachment A to this Agreement. Contractor further agrees to pay Owner the liquidated damage amounts as specified in Attachment A to this Agreement if such work is not completed on time.

All time limits stated in the Contract Documents are of the essence of the Agreement.

ARTICLE 4 - CONTRACT PRICE

Owner shall pay Contractor for completion of the Work in accordance with the Contract Documents an amount in current funds equal to the amount determined pursuant to below:

for all Work, in accordance with the Bid Form, a Sum of:

_____ DOLLARS AND _____ CENTS
(written words)

$ _____
(figures)

All specific cash allowances are included in the above price and have been computed in accordance with paragraph 11.02 of the General Conditions.

ARTICLE 5 - PAYMENT PROCEDURES

Contractor shall submit to Design Professional for review Applications for Payment covering Work performed during the preceding calendar month. Owner and Contractor mutually agree that Owner will make a progress payment based on a duly certified (by Design Professional) and approved (by a duly authorized representative of Owner) estimate of the Work covered by the corresponding Application for Payment, subject to those conditions stipulated below, in the General Conditions and in other parts of the Contract Documents.

Owner may deduct from each progress payment and final payment an amount equal to Owner's estimate of the liquidated damages then due or that would become due based on Owner's estimate of late completion of the Work, provided Contractor fails to submit and implement a written schedule recovery plan describing the cause of schedule slippage or delayed progress and the actions proposed and taken to recover schedule.

ARTICLE 6 - INTEREST

All moneys not paid when due as provided in Article 14 of the General Conditions shall bear interest in accordance with ARS #34-221(G).

ARTICLE 7 - CONTRACTOR'S REPRESENTATIONS

In order to induce Owner to enter into this Agreement, Contractor makes the following representations:

Contractor has examined and carefully studied the Contract Documents (including the Addenda listed in paragraph 8) and the other related data identified in the Bidding Documents including "technical data."

Contractor has visited the site and become familiar with and is satisfied as to the general, local and site conditions that may affect cost, progress, performance or furnishing of the Work.

Contractor is familiar with and is satisfied as to all federal, state, and local Laws and Regulations that may affect cost, progress, performance and furnishing of the Work.

Contractor has carefully studied all reports of explorations and tests of subsurface conditions at or contiguous to the site and all drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the site (except Underground Facilities) which have been identified in the Supplementary Conditions as provided in paragraph 4.02 of the General Conditions. Contractor accepts the determination set forth in Article 4 of the General Conditions of the extent of the "technical data" contained in such reports and drawings upon which Contractor is entitled to rely. Contractor acknowledges that such reports and drawings are not Contract Documents and may not be complete for Contractor's

purposes. Contractor acknowledges that Owner and Design Professional do not assume responsibility for the accuracy or completeness of information and data shown or indicated in the Contract Documents with respect to Underground Facilities at or contiguous to the site. Contractor has obtained and carefully studied (or assumes responsibility for having done so) all such additional supplementary examinations, investigations, explorations, tests, studies and data concerning conditions (surface, subsurface and Underground Facilities) at or contiguous to the site or otherwise which may affect cost, progress, performance or furnishing all the Work or which relate to any aspect of the means, methods, techniques, sequences and procedures of construction to be employed by Contractor and safety precautions an programs incident thereto. Contractor does not consider that any additional examinations, investigations, explorations, tests, studies or data are necessary for the performance and furnishing of the Work at the Contract Price, within the Contract Times and in accordance with the other terms and conditions of the Contract Documents.

Contractor is aware of the general nature of Work to be performed by Owner and others at the site that relates to the Work as indicated in the Contract Documents.

Contractor has correlated the information known to Contractor, information and observations obtained from visits to the site, reports and drawings identified in the Contract Documents and all additional examinations, investigations, explorations, tests, studies and data with the Contract Documents.

Contractor has given Design Professional written notice of all conflicts, errors, ambiguities or discrepancies that Contractor has discovered in the Contract Documents and the written resolution thereof by Design Professional is acceptable to Contractor, and the Contract Documents are sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.

ARTICLE 8 - CONTRACT DOCUMENTS

The Contract Documents are complementary, and anything mentioned or shown in a part of the Contract Documents shall be of like effect as if mentioned or shown in all parts of the Contract Documents. In resolving conflicts, the Contract Documents shall be given the priority determined by Design Professional which results in Work consistent with and reasonably inferable from their intent. Except when in contradiction with this priority rule, the Contract Documents shall be given priority by Design Professional in the following order:

- This Agreement (pages 00500-1 to 00500-5, inclusive), fully executed by Owner and Contractor.
- Addenda numbers ___ to ___, inclusive.
- Performance Bond (page 00610-1) and Payment Bond (page 00620-1).
- Notice to Proceed.
- Change orders.
- Contractor's Bid Package (Sections 00300 thru 00370).
- Supplementary Conditions (pages 00800-1 to 00800-2, inclusive).
- General Conditions (pages 00700-1 to 00700-52, inclusive).
- Specifications bearing the following general title and consisting of Divisions 1 through 17 and pages listed in table of contents therein:

  Lift Station 76 Phase II Expansion, Project No. WS90400067-4, Volume 2 of 3; Technical

Specifications For Construction

- Drawings bearing the following general title and consisting of a cover sheet and sheets listed in the Index of Drawings therein.

  Lift Station 76 Phase II Expansion, Project No. WS90400067-4, Volume 3 of 3; For Construction

- Insurance Policies

The following which may be delivered or issued after the Effective Date of the Agreement and are not attached hereto:

- All Written Amendments and other documents amending, modifying or supplementing the Contract Documents pursuant to paragraphs 3.06 of the General Conditions.

- The documents listed in paragraphs 8.2 et seq. above are attached to this Agreement (except as expressly noted otherwise above).

There are no Contract Documents other than those listed above in this Article 8. The Contract Documents may only be amended, modified or supplemented as provided in paragraphs 3.06 of the General Conditions.

ARTICLE 9 - MISCELLANEOUS

Terms used in this Agreement which are defined in Article 1 of the General Conditions will have the meanings indicated in the General Conditions.

No assignment by a party hereto of any rights under or interests in the Contract Documents will be binding on another party hereto without the written consent of the party sought to be bound; and, specifically but without limitation, moneys that may become due and moneys that are due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract Documents.

Owner and Contractor each binds itself, its partners, successors, assigns and legal representatives to the other party hereto, its partners, successors, assigns and legal representatives in respect to all covenants, agreements and obligations contained in the Contract Documents.

Any provision or part of the Contract Documents held to be void or unenforceable under any Law of Regulation shall be deemed stricken, and all remaining provisions shall continue to be valid and binding upon Owner and Contractor, who agree that the Contract Documents shall be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.

ARTICLE 10 - CITY OF PHOENIX EQUAL EMPLOYMENT OPPORTUNITY REQUIREMENT

1.1 See Section 00100-14 - Instructions to Bidders

ARTICLE 11 - SBE UTILIZATION GOAL

See Section 350-1 – Small Business Enterprise Goal Clause and Forms

IN WITNESS WHEREOF, this Agreement has been duly executed by the parties herein named, on the date and year first above written.

The Contractor agrees that this Contract, as awarded, is for the stated work and understands that payment for the total work will be made on the basis of the indicated amount(s), as bid in the Proposal.

PROJECT NO. WS90400067
LIFT STATION 76 PHASE II EXPANSION

BASE BID	**$«BaseBidAmount»**
ALTERNATE	**$«AlternateAmount»**
TOTAL CONTRACT AMOUNT	**$«ContractAmountInFigures»**

CITY OF PHOENIX,
an Arizona municipal corporation
Jeffrey Barton, City Manager

By:_____
Eric J. Froberg, PE, City Engineer

FIRM NAME,
a/an [enter State] [Enter Business Type]

By:_____
Name of Signatory, Title

ATTEST:

_____
City Clerk

APPROVED AS TO FORM;
JULIE M. KRIEGH, City Attorney

By:_____

BOND NO. _____

PREMIUM: $_____

SECTION 00600 – BOND FORMS

Subject	Page
Performance Bond	00610-1
Payment Bond	00620-1

BOND NO. _____

PREMIUM: $_____

STATUTORY PERFORMANCE BOND
PURSUANT TO TITLE 34, CHAPTER 6
OF THE ARIZONA REVISED STATUTES
(Penalty of this bond must be 100% of the Contract Amount)

KNOW ALL MEN BY THESE PRESENT, that, **«Company»**, (hereinafter called the Principal), as Principal, and _____, a corporation organized and existing under the laws of the State of _____, with its principal office in the City of _____, (hereinafter called the Surety), as Surety, are held and firmly bound unto the City of Phoenix in the County of Maricopa, State of Arizona, (hereinafter called the Obligee), in the amount of **CONTRACT AMOUNT IN WORDS DOLLARS, ($ContractAmountInFigures),** for the payment thereof, the said Principal and Surety bind themselves, and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these present.

WHEREAS, the Principal has entered into a certain written contract with the Obligee, dated the **«City Clerk Date WSuffix»** day of **«CouncilActionDateMonth»**, **«CouncilActionDateYear»**, for **WS90400067 Lift Station 76 Phase II Expansion Design Bid Build**, for which contract is hereby referred to and made a part hereof as fully and to the same extent as if copied at length herein.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that, if the said Principal shall faithfully perform and fulfill all the undertakings, covenants, terms, conditions, and agreements of said Contract during the original term of said Contract any extension thereof, with or without notice to the Surety, and during the life of any guaranty required under the Contract, and shall also perform and fulfill all the undertakings, covenants, terms, conditions, and agreements of any all duly authorized modifications of said Contract that may hereafter be made, notice of which modifications to the Surety being hereby waived; then the above obligation shall be void, otherwise to remain in full force and effect.

PROVIDED, HOWEVER, that this bond is executed pursuant to the provisions of Title 34, Chapter 6, of the Arizona Revised Statutes, and all liabilities on this Bond shall be determined in accordance with the provisions of said Title, Chapter, and Article, to the extent as if it were copied at length herein.

THE prevailing party in a suit on this Bond shall be entitled to such reasonable attorney's fees as may be fixed by a judge of the Court.

WITNESS our hands this _____ day of _____, 20____

«Company»
PRINCIPAL SEAL AGENT OF RECORD

By: _____

_____
AGENT ADDRESS

_____
SURETY SEAL _____
TELEPHONE NUMBER

A.M. BEST RATING:

By: _____ By:_____
ATTORNEY-IN-FACT AGENT

BOND NO. _____

PREMIUM: $_____

LABOR AND MATERIALS BOND
STATUTORY PAYMENT BOND PURSUANT TO
TITLE 34, CHAPTER 6, OF THE ARIZONA REVISED STATUTES
(Penalty of this Bond must be 100% of the Contract Amount)

KNOW ALL MEN BY THESE PRESENT, that, **«Company»**, (hereinafter called the Principal), as Principal, and _____, a corporation organized and existing under the laws of the State of _____, with its principal office in the City of _____, (hereinafter called the Surety), as Surety, are held and firmly bound unto the City of Phoenix in the County of Maricopa, State of Arizona, (hereinafter called the Obligee), in the amount of **CONTRACT AMOUNT IN WORDS DOLLARS, ($ContractAmountInFigures),** for the payment thereof, the said Principal and Surety bind themselves, and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these present.

WHEREAS, the Principal has entered into a certain written contract with the Obligee, dated the **«City Clerk Date WSuffix»** day of **«CouncilActionDateMonth»**, **«CouncilActionDateYear»**, for **WS90400067 Lift Station 76 Phase II Expansion Design Bid Build**, for which contract is hereby referred to and made a part hereof as fully and to the same extent as if copied at length herein.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that, if the said Principal shall promptly pay all moneys due to all persons supplying labor or materials to him or his subcontractors in the prosecution of the work provided for in said contract, then this obligation shall be void, otherwise to remain in full force and effect.

PROVIDED, HOWEVER, that this bond is executed pursuant to the provisions of Title 34, Chapter 6, of the Arizona Revised Statutes, and all liabilities on this Bond shall be determined in accordance with the provisions of said Title, Chapter, and Article, to the extent as if it were copied at length herein.

THE prevailing party in a suit on this Bond shall be entitled to such reasonable attorney's fees as may be fixed by a judge of the Court.

WITNESS our hands this _____ day of _____, 20____

«Company»
PRINCIPAL SEAL

By: _____

_____
SURETY SEAL

A.M. BEST RATING:

By: _____
ATTORNEY-IN-FACT

_____
AGENT OF RECORD

_____
AGENT ADDRESS

_____
TELEPHONE NUMBER

By:_____
AGENT

SECTION 00700 - GENERAL CONDITIONS

Table of Contents

ARTICLE 1 - DEFINITIONS AND TERMINOLOGY 4
1.01 Defined Terms 4
1.02 Terminology 7

ARTICLE 2 - PRELIMINARY MATTERS 8
2.01 Delivery of Bonds and Evidence of Insurance 8
2.02 Copies of Documents 8
2.03 Commencement of Contract Times; Notice to Proceed 8
2.04 Starting the Work 8
2.05 Before Starting Construction 8
2.06 Dust Control and Prevention 8

ARTICLE 3 - CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE 9
3.01 Intent 9
3.02 Reference Standards 9
3.03 Reporting and Resolving Discrepancies 9
3.06 Amending and Supplementing Contract Documents 10
3.07 Reuse of Documents 10
3.08 Electronic Data 11
3.09 Data Confidentiality 11
3.10 Personal Identifying Information - Data Security 12

ARTICLE 4 - AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS; REFERENCE POINTS 12
4.01 Availability of Lands 12
4.02 Subsurface and Physical Conditions 12
4.03 Differing Subsurface or Physical Conditions 13
4.03.C Possible Price and Times Adjustments 13
4.04 Archaeological Deposits: 14
4.05 Underground Facilities 15
4.06 Compliance with A.R.S. 40-360.21 15
4.07 Reference Points 15
4.08 Hazardous Environmental Condition at Site 15
4.09 Materials Containing Asbestos 16

ARTICLE 5 – BONDS AND INSURANCE 17
5.03 Insurance Requirements 17
5.05 Minimum Scope and Limits of Insurance 17

ARTICLE 6 – CONTRACTOR'S RESPONSIBILITIES 19
6.01 Supervision and Superintendence 19
6.02 Labor; Working Hours 19
6.03 Services, Materials, and Equipment 20
6.04 Progress Schedule 20
6.05 Substitutes and "Or-Equals" 20
6.06 Concerning Subcontractors, Suppliers, and Others 22
6.07 Payments to Subcontractors and Suppliers 23
6.08 Patent Fees and Royalties 24
6.09 Permits 24

6.10 Laws and Regulations 25
6.10.G Taxes ..... **Error! Bookmark not defined.**
6.11 Use of Site and Other Areas 25
6.12 Record Documents 26
6.13 Safety and Protection 26
6.16 Emergencies 27
6.17 Shop Drawings and Samples 27
6.18 Continuing the Work 28
6.20 Indemnification 28
6.21 Quality Control 29

ARTICLE 7 - OTHER WORK AT THE SITE 29
7.01 Related Work at Site 29
7.02 Coordination 30
7.03 Legal Relationships 30
7.04 Mutual Duties and Responsibilities 30

ARTICLE 8 - OWNER'S RESPONSIBILITIES 31
8.01 Communications to Contractor 31
8.02 Replacement of Individual or Entity 31
8.03 Furnish Data 31
8.04 Pay When Due 31
8.05 Lands and Easements; Reports and Tests 31
8.06 Change Orders 31
8.07 Inspections, Tests, and Approvals 31
8.08 Limitations on Owner's Responsibilities 31
8.09 Undisclosed Hazardous Environmental Condition 31
8.10 Compliance with Safety Program 31

ARTICLE 9 - DESIGN PROFESSIONAL'S STATUS DURING CONSTRUCTION 32
9.01 Owner's Representative 32
9.02 Visits to Site 32
9.03 Project Representative 32
9.04 Authorized Variations in Work 32
9.05 Rejecting Defective Work 32
9.06 Shop Drawings, Change Orders and Payments 32
9.07 Determinations for Unit Price Work 33
9.09 Limitations on Design Professional's Authority and Responsibilities 33
9.10 Compliance with Safety Program 34

ARTICLE 10 - CHANGES IN THE WORK; CLAIMS 34
10.01 Authorized Changes in the Work 34
10.02 Unauthorized Changes in the Work 34
10.03 Execution of Change Orders 34
10.04 Notification to Surety 35
10.05 Claims 35
10.06 Owner's Right to Audit 35
10.07 Audit Procedure 35

ARTICLE 11 – COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK 36
11.01 Cost of the Work 36
11.02 Allowances 38
11.02.B Cash Allowances 38
11.02.C Contingency Allowance 38
11.03 Unit Price Work 38

ARTICLE 12 - CHANGE OF CONTRACT PRICE; CHANGE OF CONTRACT TIMES 39

12.01 Change of Contract Price 39
12.02 Change of Contract Times 39
12.03 Delays 39

ARTICLE 13 - TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK 40
13.01 Notice of Defects 40
13.02 Access to Work 41
13.03 Tests and Inspections 41
13.04 Uncovering Work 41
13.05 Owner May Stop Work 42
13.06 Correction or Removal of Defective Work 42
13.07 Correction Period 42
13.08 Acceptance of Defective Work 43
13.09 Owner May Correct Defective Work 43

ARTICLE 14 - PAYMENTS TO CONTRACTOR AND COMPLETION 43
14.01 Schedule of Values 43
14.02 Progress Payments 44
14.02.A.4 SBE Goal Compliance 44
14.02.A.5 Stored Materials and Equipment 44
14.02.A.6 Retainage 44
14.02.B Review of Applications 45
14.02.C Reduction in Payment 46
14.03 Contractor's Warranty of Title 47
14.04 Substantial Completion 47
14.05 Partial Utilization 47
14.06 Final Inspection 48
14.07 Final Payment 48
14.08 Waiver of Claims 49

ARTICLE 15 - SUSPENSION OF WORK AND TERMINATION 49
15.01 Owner May Suspend Work 49
15.02 Owner May Terminate for Cause 50
15.03 Owner May Terminate For Convenience 50
15.04 Contractor May Stop Work or Terminate 51

ARTICLE 16 - DISPUTE RESOLUTION 51
16.01 Methods and Procedures 51
16.02 Certification of Contractor Claims 51
16.03 Venue: Service of Process 51

ARTICLE 17 - MISCELLANEOUS 52

ARTICLE 1 - DEFINITIONS AND TERMINOLOGY

1.01 Defined Terms

1.01.A Wherever used in the Bidding Requirements or Contract Documents and printed with initial capital letters, the terms listed below will have the meanings indicated which are applicable to both the singular and plural thereof. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.

1.01.A.1 Addenda - Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.

1.01.A.2 Agreement - The written instrument which is evidence of the agreement between Owner and Contractor covering the Work.

1.01.A.3 Application for Payment - The form acceptable to Design Professional which is to be used by Contractor during the course of the Work in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.

1.01.A.4 Asbestos - Any material that contains more than one percent asbestos and is friable or is releasing asbestos fibers into the air above current action levels established by the United States Occupational Safety and Health Administration.

1.01.A.5 Bid - The offer or proposal of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

1.01.A.6 Bidder - The individual or entity who submits a proposal directly to Owner.

1.01.A.7 Bidding Documents - The Bidding Requirements and the proposed Contract Documents (including all Addenda).

1.01.A.8 Bidding Requirements - The advertisement or invitation to bid, Instructions to Bidders, Bid security of acceptable form, if any, and the Bid Form with any supplements.

1.01.A.9 Bonds - Performance and Payment bonds and other instruments of security.

1.01.A.10 Change Order - A document recommended by Design Professional which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, issued on or after the Effective Date of the Agreement.

1.01.A.11 Claim - An assertion by Owner or Contractor seeking an adjustment of Contract Price or Contract Times, or both, and other relief with respect to the terms of the Contract. A demand for money or services by a third party is not a Claim.

1.01.A.12 Contract - The entire and integrated written agreement between the Owner and Contractor concerning the Work. The Contract supersedes prior negotiations, representations, or agreements, whether written or oral.

1.01.A.13 Contract Documents - Those items so designated in the Agreement. Only printed or hard copies of the items listed in the Agreement are Contract Documents. Approved Shop Drawings, other Contractor submittals, and the reports and drawings of subsurface and physical conditions are not Contract Documents.

1.01.A.14 Contract Price - The moneys payable by Owner to Contractor for completion of the Work in accordance with the Contract Documents as stated in the Agreement (subject to the provisions of Paragraph 11.03 in the case of Unit Price Work).

1.01.A.15 Contract Times - The number of days or the dates stated in the Agreement to: (i) achieve Milestones, if any, (ii) achieve Substantial Completion; and (iii) complete the Work so that it is ready for final payment as evidenced by Design Professional's written recommendation of final payment.

1.01.A.16 Contractor - The individual or entity with whom Owner has entered into the Agreement.

1.01.A.17 Contractor's Contingency - means a fund to cover cost growth during the Project used at the discretion of the Contractor usually for costs that result from Project circumstances. The amount of the Contractor's Contingency is negotiated as a separate line item in each JOA proposal.

1.01.A.18 Cost of the Work - See Paragraph 11.01 for definition. Cost of the Work does not equal Contract Price or adjusted Contract Price.

1.01.A.19 Design Professional – The individual or entity named as such in the Agreement.

1.01.A.20 Design Professional's Consultant - An individual or entity having a contract with Design Professional to furnish services as Design Professional's independent professional associate or consultant with respect to the Project and who is identified as such in the Supplementary Conditions.

1.01.A.21 Drawings - That part of the Contract Documents prepared or approved by Design Professional which graphically shows the scope, extent, and character of the Work to be performed by Contractor. Shop Drawings and other Contractor submittals are not Drawings as so defined.

1.01.A.22 Effective Date of the Agreement - The date indicated in the Agreement on which it becomes effective.

1.01.A.23 Engineer - May be used interchangeably with Design Professional

1.01.A.24 Field Order - A written order issued by Design Professional which requires minor changes in the Work, but which does not involve a change in the Contract Price or the Contract Times.

1.01.A.25 General Conditions Costs – Includes, but not limited to, the following types of costs for the Contractor during the construction phase: payroll costs for project manager or construction manager but not both for Work conducted at the Site, payroll costs for the superintendent and full - time general foremen, payroll costs for management personnel resident and working on the Site, workers not included as direct labor costs engaged in support (e.g. loading/unloading, clean - up, etc.), costs of offices and temporary facilities including office materials, office supplies, office equipment minor expenses, utilities, fuel, sanitary facilities and telephone services at the Site, costs of liability insurance premiums not included in labor burdens for direct labor costs, costs of bond premiums, costs of consultants not in the direct employ of the Contractor or Subcontractors, taxes on the Work and for which the Contractor is liable, fees for permits and licenses. Certain limitations and exclusions related to Changes are described in the General Conditions for the construction phase.

1.01.A.26 General Requirements - Sections of Division 1 of the Specifications.

1.01.A.27 Hazardous Environmental Condition - The presence at the Site of Asbestos, PCBs, Petroleum, Hazardous Substance, or Radioactive Material in such quantities or circumstances that may present a substantial danger to persons or property exposed thereto.

1.01.A.28 Hazardous Substance - any material, whether solid, semi - solid, liquid or gas, which, if not stored and/or used properly, may cause harm or injury to persons through inhalation, ingestion, absorption or injection, or which may negatively impact the environment through the use or discharge of the material on the ground, in the water (including groundwater), or to the air.

1.01.A.29 Hazardous Waste - The term Hazardous Waste shall have the meaning provided in Section 1004 of the Solid Waste Disposal Act (42 USC Section 6903) as amended from time to time.

1.01.A.30 Laws and Regulations; Laws or Regulations - Any and all applicable laws, rules, regulations, ordinances, codes, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.

1.01.A.31 Milestone - A principal event specified in the Contract Documents relating to an intermediate completion date or time prior to Substantial Completion of all the Work.

1.01.A.32 Notice of Award - The written notice by Owner to the Successful Bidder stating that upon timely compliance by the Successful Bidder with the condition’s precedent listed therein, Owner will sign and deliver the Agreement.

1.01.A.33 Notice to Proceed - A written notice given by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work under the Contract Documents.

1.01.A.34 Owner - The individual or entity with whom Contractor has entered into the Agreement and for whom the Work is to be performed.

1.01.A.35 Owner’s Contingency - means a fund to cover cost growth during the Project used at the discretion of the City usually for costs that result from City directed changes or differing/unforeseen site conditions. Owner’s Contingency applies to conditions that are unanticipated and may be referred to as “unknown unknowns". The amount of the Owner’s Contingency is set by the City and is in the Contract Price.

1.01.A.36 PCBs - Polychlorinated biphenyls.

1.01.A.37 Petroleum - Petroleum, including crude oil or any fraction thereof which is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute), such as oil, petroleum, fuel oil, oil sludge, oil refuse, gasoline, kerosene, and oil mixed with other non-Hazardous Waste and crude oils.

1.01.A.38 Progress Schedule - A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising the Contractor's plan to accomplish the Work within the Contract Times.

1.01.A.39 Project - The total construction of which the Work to be performed under the Contract Documents may be the whole, or a part.

1.01.A.40 Radioactive Material - Source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 USC Section 2011 et seq.) as amended from time to time.

1.01.A.41 Related Entity - An officer, director, partner, employee, agent, consultant, or Subcontractor.

1.01.A.42 Resident Project Representative - The authorized representative of Design Professional who may be assigned to the Site or any part thereof.

1.01.A.43 Samples - Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work, and which establish the standards by which such portion of the Work will be judged.

1.01.A.44 Schedule of Submittals - A schedule, prepared and maintained by Contractor, of required submittals and the time requirements to support scheduled performance of related construction activities.

1.01.A.45 Schedule of Values - A schedule, prepared and maintained by Contractor, which divides the Contract Price into pay items, such that the sum of all pay items equals the Contract Price for the Work, or for any portion of the Work having a separate specified Contract Price.

1.01.A.46 Shop Drawings - All drawings, diagrams, illustrations, schedules, and other data or information which are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work.

1.01.A.47 Site - Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights - of - way and easements for access thereto, and such other lands furnished by Owner which are designated for the use of Contractor.

1.01.A.48 Specifications - That part of the Contract Documents consisting of written requirements for materials, equipment, systems, standards and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable thereto.

1.01.A.49 Subcontractor - An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work at the Site.

1.01.A.50 Substantial Completion - The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Design Professional, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion thereof.

1.01.A.51 Successful Bidder - The Bidder submitting a responsive Bid to whom Owner makes an award.

1.01.A.52 Supplementary Conditions - That part of the Contract Documents which amends or supplements these General Conditions.

1.01.A.53 Supplier - A manufacturer, fabricator, supplier, distributor, materialman, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or Subcontractor.

1.01.A.54 Total Float - Number of calendar days by which the Work or any part of the Work may be delayed without necessarily extending a pertinent Contract Time.

1.01.A.55 Underground Facilities - All underground pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or attachments, and any encasements containing such facilities, including those that convey electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, water,

wastewater, storm water, other liquids or chemicals, or traffic or other control systems.

1.01.A.56 Unit Price Work - Work to be paid for on the basis of unit prices.

1.01.A.57 Warranty Period – Period for which Contractor is responsible for correction of defective Work as defined in Paragraph 13.07.

1.01.A.58 Work - The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction, and furnishing, installing, and incorporating all materials and equipment into such construction, all as required by the Contract Documents.

1.01.A.59 Work Change Directive - A written statement to Contractor issued on or after the Effective Date of the Agreement and signed by Owner and recommended by Design Professional ordering an addition, deletion, or revision in the Work, or responding to differing or unforeseen subsurface or physical conditions under which the Work is to be performed or to emergencies. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the change ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Times.

1.01.A.60 Written Amendment - A written amendment of the Contract Documents, signed by Owner and Contractor on or after the Effective Date of the Agreement and normally dealing with the non-engineering or nontechnical rather than strictly construction related aspects of the Contract Documents.

1.02 Terminology

1.02.A The words and terms discussed in Paragraph 1.02B through G are not defined but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.

1.02.B Intent of Certain Terms or Adjectives:

1.02.B.1 The Contract Documents include the terms “as allowed,” “as approved,” “as ordered,” “as directed” or terms of like effect or import to authorize an exercise of professional judgment by Design Professional. In addition, the adjectives “reasonable,” “suitable,” “acceptable,” “proper,” “satisfactory,” or adjectives of like effect or import are used to describe an action or determination of Design Professional as to the Work. It is intended that such exercise of professional judgment, action or determination will be solely to evaluate, in general, the Work for compliance with the information in the Contract Documents and with the design concept of the Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Design Professional any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility contrary to the provisions of Paragraph 9.09 or any other provision of the Contract Documents.

1.02.C Day:

1.02.C.1 The word “day” means a calendar day of 24 hours measured from midnight to the next midnight.

1.02.D Defective:

1.02.D.1 The word “defective,” when modifying the word “Work,” refers to Work that is unsatisfactory, faulty, or deficient in that it:

1.02.D.1.a does not conform to the Contract Documents; or

1.02.D.1.b does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or

1.02.D.1.c has been damaged prior to Design Professional’s recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 14.04 or 14.05).

1.02.E Furnish, Install, Perform, Provide:

1.02.E.1 The word “furnish,” when used in connection with services, materials, or equipment, shall mean to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.

1.02.E.2 The word “install,” when used in connection with services, materials, or equipment, shall mean to put into use or place in final position

said services, materials, or equipment complete and ready for intended use.

1.02.E.3 The words “perform” or “provide,” when used in connection with services, materials, or equipment, shall mean to furnish and install said services, materials, or equipment complete and ready for intended use.

1.02.E.4 When “furnish,” “install,” “perform,” or “provide” is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, “provide” is implied.

1.02.F Unless stated otherwise in the Contract Documents, words or phrases that have a well - known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

1.02.G Shall, Will

1.02.G.1 The words “shall” and “will” are used interchangeably to express what is mandatory.

ARTICLE 2 - PRELIMINARY MATTERS

2.01 Delivery of Bonds and Evidence of Insurance

2.01.A When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner such bonds as Contractor may be required to furnish.

2.01.B Evidence of Insurance: Before any Work at the Site is started, Contractor shall deliver to Owner, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance which Contractor is required to purchase and maintain in accordance with Article 5.

2.02 Copies of Documents

2.02.A Owner shall furnish to Contractor one reproducible copy of the Drawings and Specifications. Additional copies will be furnished upon request at the cost of reproduction.

2.03 Commencement of Contract Times; Notice to Proceed

2.03.A The Contract Times will commence to run on the day indicated in the Notice To Proceed. A Notice To Proceed may be given at any time within ninety (90) days after the Effective Date of the Agreement.

2.04 Starting the Work

2.04.A Contractor shall start to perform the Work on the date when the Contract Times commence to run. No Work shall be done at the Site prior to the date on which the Contract Times commence to run.

2.05 Before Starting Construction

2.05.A Preconstruction Conference: A conference attended by Contractor, Design Professional, Owner and others as appropriate will be held to establish a working understanding among the parties as to the Work and to discuss the schedules referred to in the General Requirements, procedures for handling Shop Drawings and other submittals, processing Applications for Payment and maintaining required records.

2.05.B Designation of Authorized Representatives: At this conference Owner and Contractor each shall designate, in writing, a specific individual to act as its authorized representative with respect to the services and responsibilities under the Contract. Such individuals shall have the authority to transmit instructions, receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.

2.06 Dust Control and Prevention

2.06.A To facilitate and encourage strict compliance with the Maricopa County Air Pollution Control Regulations pertaining to fugitive dust control, Contractor shall submit the following documentation to the Project Manager at the pre-construction conference prior to conducting any earth moving or dust generating activities under the Contract.

2.06.A.1 Copy of a valid Maricopa County Earth Moving (Dust Control) Permit applicable to the Work or services under the Contract.

2.06.A.2 Copy of the Dust Control Plan applicable to the Work or services under the Contract.

2.06.A.3 Documentation that all of Contractor’s on-site project managers have received the Comprehensive or Basic dust control training as required by Maricopa County Rule 310 based on project disturbed acres.

2.06.B For construction sites where:

2.06.B.1 5-acres or more are disturbed, Contractor shall designate and identify to the City

an individual who has completed the dust control training set forth in Section 2 above as the site Dust Control Coordinator. The Dust Control Coordinator shall be present on-site all times that earth moving or dust generating activities are occurring and until all ground surfaces at the site have been stabilized.

2.06.B.2 less than 1-acre is disturbed, the Contractor shall designate an individual who has completed Basic Training to be on site at all times that earth moving or dust generating activities are occurring.

2.06.C Contractor shall notify the Project manager within twenty-four (24) hours of any inspection, Notice of Violation, or other contact by the Maricopa County Air Quality Department with it or any of its subcontractors regarding the Work or services under the Contract. A copy of any written communications, notices or citations issued to Contractor or any of its subcontractors regarding the work or services under the Contract shall likewise be transmitted to the Project Manger within twenty-four (24) hours.

2.06.D The Contractor shall prevent any dust nuisance due to construction operations in accordance with MAG Specifications, Section 104.1.3, Cleanup and Dust Control. The Contractor shall use a power pick-up broom as part of the dust control effort. No separate measurement or payment will be made for cleanup or dust control, or for providing a power pick-up broom on the job.

2.06.E The Contractor may be instructed by the Design Professional to provide additional pavement cleaning (in parking lots, or other locations) above and beyond the normal expected cleanup and dust control required by MAG Section 104.1.3 If requested by the Design Professional, Contractor shall clean the requested areas with a power pick-up broom.

2.06.F Use of the power pick-up broom in the special requested areas only, shall be measured and paid for on an hourly basis under the bid item, “Power Broom”. The number of hours listed in the bid proposal is only an estimate. Actual hours requested for this project may vary.

2.06.G Contractor agrees to indemnify and reimburse Owner for any fine, penalty, fee or monetary sanction imposed on Owner by Maricopa County arising out of or caused by the performance of Work or services under the Contract. Contractor shall remit payment of the reimbursable sum to the City within thirty (30) days of being presented with a demand for Payment from Owner.

ARTICLE 3 - CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

3.01 Intent

3.01.A The Contract Documents are complementary; what is required by one is as binding as if required by all.

3.01.B It is the intent of the Contract Documents to describe a functionally complete project (or part thereof) to be constructed in accordance with the Contract Documents. Any labor, documentation, services, materials, or equipment that reasonably may be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the indicated result will be provided whether or not specifically called for at no additional cost to Owner.

3.01.C Clarifications and interpretations of the Contract Documents shall be issued by Design Professional as provided in Article 9.

3.02 Reference Standards

3.02.A Standards, Specifications, Codes, Laws, and Regulations

3.02.A.1 Reference to standards, specifications, manuals, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, shall mean the standard, specification, manual, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Agreement if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.

3.02.A.2 No provision of any such standard, specification, manual or code, or any instruction of a Supplier shall be effective to change the duties or responsibilities of Owner, Contractor, or Design Professional, or any of their subcontractors, consultants, agents, or employees from those set forth in the Contract Documents. No such provision or instruction shall be effective to assign to Owner, or Design Professional, or any of their Related Entities, any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract Documents.

3.03 Reporting and Resolving Discrepancies

3.03.A Reporting Discrepancies

3.03.A.1 Contractor’s Review of Contract Documents Before Starting Work: Before

undertaking each part of the Work, Contractor shall carefully study and compare the Contract Documents and check and verify pertinent figures therein and all applicable field measurements. Contractor shall promptly report in writing to Design Professional any conflict, error, ambiguity, or discrepancy which Contractor may discover and shall obtain a written interpretation or clarification from Design Professional before proceeding with any Work affected thereby.

3.03.A.2 Contractor's Review of Contract Documents During Performance of Work: If, during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents, or between the Contract Documents and (a) any applicable Law or Regulation, (b) any standard, specification, manual, or code, or (c) any instruction of any Supplier, then Contractor shall promptly report it to Design Professional in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 6.16.A) until an amendment or supplement to the Contract Documents has been issued by one of the methods indicated in Paragraph 3.06.

3.03.A.3 Contractor shall not be liable to Owner or Design Professional for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor knew or reasonably should have known thereof.

3.03.B Resolving Discrepancies

3.03.B.1 Except as may be otherwise specifically stated in the Contract Documents, the provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity, or discrepancy between the provisions of the Contract Documents and:

3.03.B.1.a the provisions of any standard, specification, manual, or code, or instruction (whether or not specifically incorporated by reference in the Contract Documents); or

3.03.B.1.b the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

3.04 If the issue of priority involves the Specifications and Drawings, figured dimensions shall govern over scaled dimensions. Work not dimensioned shall be subject to interpretation by Design Professional. Work not expressly shown, identified, sized or located shall be the same as similar Work shown or specified. Detail drawings shall govern over general Drawings, larger scale Drawings take precedence over smaller scale Drawings and Contract Drawings govern over Shop Drawings. Whenever notes, specifications, dimensions, details or schedules in the Specifications or Drawings, or between the Specifications and Drawings conflict, Contractor shall furnish the higher performance requirement.

3.05 References made on the Plans and in the Specifications to Maricopa Association of Governments (MAG) Standards Details and Specifications are for information only. Any references made to the MAG General Provisions by these details and specifications are not applicable to this Project. The General Conditions and Supplementary Conditions as described in the Contract Documents are applicable.

3.06 Amending and Supplementing Contract Documents

3.06.A The Contract Documents may be amended to provide for additions, deletions, and revisions in the Work or to modify the terms and conditions thereof by:

3.06.A.1 a formal Written Amendment,

3.06.A.2 a Change Order, or

3.06.A.3 a Work Change Directive.

3.06.B The requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Work may be authorized, by one or more of the following ways:

3.06.B.1 A Field Order;

3.06.B.2 Design Professional's approval of a Shop Drawing or Sample (subject to the provisions of Paragraph 6.17); or

3.06.B.3 Design Professional's written interpretation or clarification.

3.07 Reuse of Documents

3.07.A Contractor and any Subcontractor or Supplier or other individual or entity performing or furnishing all of the Work under a direct or indirect contract with Contractor, shall not:

3.07.A.1 have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of

Design Professional or its consultants, including electronic media editions; or

3.07.A.2 reuse any such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Design Professional and specific written verification or adaptation by Design Professional.

3.07.B The prohibitions of this Paragraph 3.07 will survive final payment, or termination of the Contract. Nothing herein shall preclude Contractor from retaining copies of the Contract Documents for record purposes.

3.08 Electronic Data

3.08.A Unless otherwise stated in the Supplementary Conditions, the data furnished by Owner or Design Professional to Contractor or by Contractor to Owner or Design Professional, that may be relied upon are limited to the printed copies (also known as hard copies). Files in electronic media format of text, data, graphics, or other types are furnished only for the convenience of the receiving party. Any conclusion or information obtained or derived from such electronic files will be at the user's sole risk. If there is a discrepancy between the electronic files and the hard copies, the hard copies govern.

3.08.B Because data stored in electronic media format can deteriorate or be modified inadvertently or otherwise without authorization of the data's creator, the party receiving electronic files agrees that it will perform acceptance tests or procedures within 60 days, after which the receiving party shall be deemed to have accepted the data thus transferred. Any errors detected within the 60 - day acceptance period will be corrected by the transferring party.

3.08.C When transferring documents in electronic media format, the transferring party makes no representations as to long term compatibility, usability, or readability of documents resulting from the use of software application packages, operating systems, or computer hardware differing from those used by the data's creator.

3.09 Data Confidentiality

3.09.A "Data" means all information, whether written or verbal, including plans, photographs, studies, investigations, audits, analyses, samples, reports, calculations, internal memos, meeting minutes, data field notes, work product, proposals, correspondence and any other similar documents or information prepared by, obtained by, or transmitted to the Contractor or its subcontractors in the performance of this Contract.

3.09.B The parties agree that all data, regardless of form, including originals, images, and reproductions, prepared by, obtained by, or transmitted to the Contractor or its subcontractors in connection with the Contractor's or its subcontractor's performance of this Contract is confidential and proprietary information belonging to the City.

3.09.C Except as specifically provided in this Contract, the Contractor or its subcontractors shall not divulge data to any third party without prior written consent of the City. The Contractor or its subcontractors shall not use the data for any purposes except to perform the services required under this Contract. These prohibitions shall not apply to the following data provided the Contractor or its subcontractors have first given the required notice to the City:

3.09.C.1 Data which was known to the Contractor or its subcontractors prior to its performance under this Contract unless such data was acquired in connection with work performed for the City;

3.09.C.2 Data which was acquired by the Contractor or its subcontractors in its performance under this Contract and which was disclosed to the Contractor or its subcontractors by a third party, who to the best of the Contractor's or its subcontractor's knowledge and belief, had the legal right to make such disclosure and the Contractor or its subcontractors are not otherwise required to hold such data in confidence; or

3.09.C.3 Data which is required to be disclosed by virtue of law, regulation, or court order, to which the Contractor or its subcontractors are subject.

3.09.D In the event the Contractor or its subcontractors are required or requested to disclose data to a third party, or any other information to which the Contractor or its subcontractors became privy as a result of any other contract with the City, the Contractor shall first notify the City as set forth in this section of the request or demand for the data. The Contractor or its subcontractors shall give the City sufficient facts so that the City can be given an opportunity to first give its consent or take such action that the City may deem appropriate to protect such data or other information from disclosure.

3.09.E The Contractor, unless prohibited by law, within ten calendar days after completion of services for a third party on real or personal property owned or leased by the City, the Contractor or its subcontractors shall promptly deliver, as set forth in this section, a copy of all data to the City. All data shall continue to be subject to the confidentiality agreements of this Contract.

3.09.F The Contractor or its subcontractors assume all liability for maintaining the confidentiality of the data in its possession and agrees to compensate the City if any of the provisions of this section are violated by the Contractor, its employees, agents or subcontractors. Solely for the purposes of seeking injunctive relief, it is agreed that a breach of this section shall be deemed to cause irreparable harm that justifies injunctive relief in court. Contractor agrees that the requirements of this Section shall be incorporated into all subcontracts entered into by Contractor. A violation of this Section may result in immediate termination of this Contract without notice.

3.10 Personal Identifying Information - Data Security

3.10.A Personal identifying information, financial account information, or restricted City information, whether electronic format or hard copy, must be secured and protected at all times. At a minimum, Contractor must encrypt and/or password protect electronic files. This includes data saved to laptop computers, computerized devices or removable storage devices.

3.10.B When personal identifying information, financial account information, or restricted City information, regardless of its format, is no longer necessary, the information must be redacted or destroyed through appropriate and secure methods that ensure the information cannot be viewed, accessed, or reconstructed.

3.10.C In the event that data collected or obtained by Contractor or its subcontractors in connection with this Contract is believed to have been compromised, Contractor or its subcontractors shall immediately notify the Project Manager and City Engineer. Contractor agrees to reimburse the City for any costs incurred by the City to investigate potential breaches of this data and, where applicable, the cost of notifying individuals who may be impacted by the breach.

3.10.D Contractor agrees that the requirements of these Paragraphs 3.09 and 3.10 shall be incorporated into all subcontracts entered into by Contractor. It is further agreed that a violation of this Section shall be deemed to cause irreparable harm that justifies injunctive relief in court. A violation of this Section may result in immediate termination of this Contract without notice.

3.10.E Contractor shall indemnify, defend, save and hold harmless the City and its officers, officials, agents, and employees from and against any and all claims, actions, liabilities, damages, losses, or expenses (including court costs, attorneys' fees, and cost of claims processing, investigation and litigation) for any loss caused, or alleged to be caused, in whole or in part, by Contractor or any of its owners', officers', directors', agents' or employees' failure to comply with the requirements of this Section. This indemnity includes any claim arising out of the failure of Contractor to conform to any federal, state or local law, statute, ordinance, rule, regulation or court decree.

3.10.F The obligations of Contractor or its subcontractors under these Paragraphs 3.09 and 3.10 shall survive the termination of this Contract.

ARTICLE 4 - AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS; REFERENCE POINTS

4.01 Availability of Lands

4.01.A The Contract Documents indicate the lands upon which the Work is to be performed and those rights - of - way and access easements furnished by Owner. Easements for permanent structures or for permanent changes in existing facilities will be obtained by Owner, unless otherwise stated.

4.01.B Contractor shall obtain, at no increase in Contract Price or Contract Time, any additional lands, rights - of - way and easements that Contractor, in its sole discretion, requires for temporary facilities, ingress and egress, storage, disposal of spoil or waste material or any other purpose. Contractor shall obtain

4.01.B.1 all required permits from the U.S. Government, the State and any Political Subdivision or public utility with jurisdiction, and

4.01.B.2 permission by written agreement if private property. Contractor shall submit copies of all permits and written agreements to Owner.

4.02 Subsurface and Physical Conditions

4.02.A Reports and Drawings: The Supplementary Conditions identify:

4.02.A.1 those reports known to Owner of explorations and tests of subsurface conditions at or contiguous to the Site; and

4.02.A.2 those drawings known to Owner of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities).

4.02.B Limited Reliance by Contractor on Technical Data Authorized: Contractor may rely upon the accuracy of the "technical data" contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such "technical data" is identified in the Supplementary Conditions. Except for such reliance on such "technical data," Contractor may not rely upon or make any claim against Owner or Design Professional, or any of their Related Entities with respect to:

4.02.B.1 the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto; or

4.02.B.2 other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or

4.02.B.3 any Contractor interpretation of or conclusion drawn from any "technical data" or any such other data, interpretations, opinions, or information.

4.03 Differing Subsurface or Physical Conditions

4.03.A Notice: If Contractor believes that any subsurface or physical condition that is uncovered or revealed either:

4.03.A.1 is of such a nature as to establish that any "technical data" on which Contractor is entitled to rely as provided in Paragraph 4.02 is materially inaccurate; or

4.03.A.2 is of such a nature as to require a change in the Contract Documents; or

4.03.A.3 differs materially from that shown or indicated in the Contract Documents; or

4.03.A.4 is of an unusual nature and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents; then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), notify Owner and Design Professional in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except as aforesaid) until receipt of written order to do so.

4.03.B Design Professional's Review: After receipt of written notice as required by Paragraph 4.03.A, Design Professional will promptly review the pertinent condition, determine the necessity of Owner's obtaining additional exploration or tests with respect thereto, and advise Owner in writing (with a copy to Contractor) of Design Professional's findings and conclusions.

4.03.C **Possible Price and Times Adjustments**

4.03.C.1 In accordance with Articles 11 and 12 of the General Conditions, an adjustment in the Contract Price or in the Contract Times, or both, will be allowed to the extent that the existence of such differing subsurface or physical condition causes an increase or decrease in Contractor's cost of, or time required for performance of, the Work subject, however, to the following:

4.03.C.1.a such condition must meet any one or more of the categories described in Paragraph 4.03.A; and

4.03.C.1.b with respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraphs 9.07 and 11.03.

4.03.C.2 Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times if:

4.03.C.2.a Contractor knew of the existence of such conditions at the time Contractor made a final commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract; or

4.03.C.2.b the existence of such condition could reasonably have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous

areas required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's making such final commitment; or

4.03.C.2.c Contractor failed to give the written notice as required by Paragraph 4.03.A.

4.03.C.3 If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, a Claim may be made therefor as provided in Paragraph 10.05. However, neither Owner nor Design Professional, nor and any of their Related Entities shall not be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.

4.04 Archaeological Deposits:

4.04.A Archaeological monitoring may be required within the limits of the project during construction. The Contractor must coordinate all ground disturbing work with the archaeologist(s) and provide a current work schedule to facilitate the archaeologist's investigation and monitoring of all ground disturbing work within the area(s) of interest. When archaeological materials are discovered, the Contractor must stop work immediately within a 10-meter zone of the discovery, secure the area, and immediately notify the on-site archaeologist(s) who must then contact the City Archaeology Office (602-495-0901) or the Street Transportation Environmental Section at 602-534-3747, who will coordinate with the City Archaeology Office. The Contractor must not recommence work in the area of discovery until directed in writing by the City Archaeology Office.

4.04.B If suspected archaeological materials are discovered during construction without an archaeologist present, the Contractor must stop work immediately within a 10-meter zone of the discovery, secure the area, and immediately notify the City Archaeology Office (602-495-0901). The Contractor must not recommence work in the area of discovery until directed in writing by the City Archaeology Office.

4.04.C In 1990, the Arizona legislature amended two state laws (Arizona Antiquities Act & State Historic Preservation Act) that protect human burials and associated artifacts on both private and state land. As specified in these laws and rephrased below:

4.04.C.1 A person shall not knowingly excavate in or upon any historic or prehistoric archaeological site, except when acting as a duly authorized agent of an institution or corporation organized for scientific, research or land use planning purposes. [Arizona Revised Statute §41-841(A) - Archaeological Discoveries] Any person, institution or corporation violating any provision of this article is guilty of a class 2 misdemeanor. [A.R.S. §41-846 - Violation].

4.04.C.2 A person who knowingly excavates in violation of A.R.S. §41-841 is guilty of a class 5 felony pursuant to Arizona Criminal Code- Title 13. A second or subsequent violation under this subsection is a class 3 felony. [A.R.S. I 7 .OJ - Excavating Certain Sites].

4.04.D A class 5 felony carries potential penalties of up to two years in prison. If a City of Phoenix (City) project may impact historic or pre-historic archaeological resources, the guidelines described above must be adhered to. Therefore, no subsurface disturbance activities related to this without having an archaeological consultant on-site prior to and during this project's ground disturbance activities.

4.04.E The City of Phoenix Office of the City Engineer is requesting that the Project Archaeological Requirements Acknowledgment Form is completed for all City sponsored or managed projects involving ground subsurface disturbance activities in areas that may include archaeological resources, as determined by the City of Phoenix Archaeology Office (CAO). If archaeological monitoring is required on a project, a City Archaeological Monitoring Acknowledgment form will be provided for your review and signature. The guidelines and the provisions in the Terms and Conditions of the Archaeological Monitoring Form must be followed as prescribed on the form and referenced above in this section. Penalties for non-compliance are detailed on the Archaeological Monitoring Form. Failure to comply with the requirements of this acknowledgment form and the City contract may constitute a breach of contract.

4.04.F If Contractor discovers archaeological sites or objects, Contractor may be allowed an adjustment of Contract Time(s) pursuant to Article 12. If Owner, with the advice of Design Professional, concludes that the Contract Documents require changes due to archaeological

features, Owner shall, pursuant to Article 10 of the General Conditions, order any changes in the Work and corresponding adjustments in Contract Price required solely because of the archaeological features encountered.

4.05 Underground Facilities

4.05.A Shown or Indicated: The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or contiguous to the Site is based on information and data furnished to Owner or Design Professional by the owners of such Underground Facilities, including Owner, or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:

4.05.A.1 Owner and Design Professional shall not be responsible for the accuracy or completeness of any such information or data provided by others; and

4.05.A.2 the cost of all of the following will be included in the Contract Price, and Contractor shall have full responsibility for:

4.05.A.2.a reviewing and checking all such information and data;

4.05.A.2.b locating all Underground Facilities shown or indicated in the Contract Documents;

4.05.A.2.c coordination of the Work with the owners of such Underground Facilities, including Owner, during construction; and

4.05.A.2.d the safety and protection of all such Underground Facilities and repairing any damage thereto resulting from the Work.

4.05.B Not Shown or Indicated:

4.05.B.1 If an Underground Facility is uncovered or revealed at or contiguous to the Site which was not shown or indicated, or not shown or indicated with reasonable accuracy in the Contract Documents, Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), identify the owner of such Underground Facility and give written notice to that owner and to Owner and Design Professional. Design Professional will promptly review the Underground Facility and determine the extent, if any, to which a change is required in the Contract Documents to reflect and document the consequences of the existence or location of the Underground Facility. During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.

4.05.B.2 If Design Professional concludes that a change in the Contract Documents is required, a Work Change Directive or a Change Order will be issued to reflect and document such consequences. An adjustment shall be made in the Contract Price or Contract Times, or both, to the extent that they are attributable to the existence or location of any Underground Facility that was not shown or indicated or not shown or indicated with reasonable accuracy in the Contract Documents and that Contractor did not know of and could not reasonably have been expected to be aware of or to have anticipated. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment in Contract Price or Contract Times, Owner or Contractor may make a Claim therefor as provided in Paragraph 10.05.

4.06 Compliance with A.R.S. 40-360.21

4.06.A Owner shall comply in all respects with A.R.S. 40 - 360.21 et seq. as amended.

4.07 Reference Points

4.07.A Owner shall provide engineering surveys to establish reference points for construction which in Design Professional's judgment are necessary to enable Contractor to proceed with the Work. Contractor shall be responsible for laying out the Work, shall protect and preserve the established reference points and property monuments, and shall make no changes or relocations without the prior written approval of Owner. Contractor shall report to Design Professional whenever any reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations and shall be responsible for the accurate replacement or relocation of such reference points or property monuments by professionally qualified personnel.

4.08 Hazardous Environmental Condition at Site

4.08.A Reports and Drawings: The Supplementary Conditions identify those reports and drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at the Site.

4.08.B Limited Reliance by Contractor on Technical Data Authorized: Contractor may rely upon the accuracy of the "technical data" contained

in such reports and drawings, but such reports and drawings are not Contract Documents. Such "technical data" is identified in the Supplementary Conditions. Except for such reliance on such "technical data," Contractor may not rely upon or make any claim against Owner or Design Professional, or any of their Related Entities with respect to:

4.08.B.1 the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by Contractor and safety precautions and programs incident thereto; or

4.08.B.2 other data, interpretations, opinions and information contained in such reports or shown or indicated in such drawings; or

4.08.B.3 any Contractor interpretation of or conclusion drawn from any "technical data" or any such other data, interpretations, opinions or information.

4.08.C Contractor, Subcontractors, Manufacturers and Suppliers shall use, store, process, transfer, transport, dispose of and otherwise handle Hazardous Substances in accordance with applicable Rules and Regulations.

4.08.D Except as otherwise provided in the Technical Specifications, if Contractor encounters Hazardous Substances on-site (including, but not limited to Asbestos, polychlorinated biphenyls (PCBs), Petroleum products, radioactive products or materials used in the normal course of construction as paint thinners, solvents, gasoline, oil, etc.) which were neither shown in nor inferable from Contract Documents (or otherwise identified as part of the Work) and which may present substantial danger, Contractor shall immediately (a) stop all affected Work, (b) give verbal and written notice to Owner of the conditions, and (c) take appropriate health and safety precautions. Upon receipt of the notice, Owner will investigate the conditions. If the material is a Hazardous Substance which may present substantial danger, Owner shall stop the affected Work in writing. Except as otherwise provided in Paragraph 4.08.F, Owner shall arrange for removal or other appropriate handling of the Hazardous Substance by negotiating a change in the Work with Contractor, by separate contract with other contractors, or as Owner may otherwise deem expedient; in the alternative, Owner may terminate the Agreement or affected Work with Contractor for Owner's convenience.

4.08.E Once the Hazardous Substance has been removed or rendered harmless in accordance with Paragraph 4.08.D, the affected Work may be resumed as directed by Owner. Pursuant to A.R.S. Section 32.1129.03, and subject to Contractor's compliance with that Section and Paragraph 12.03.A, Contractor may be entitled to damages and time for delay attributable to the discovery of Hazardous Substances which interrupt the Work.

4.08.F Requirements for the Contractor's management of Hazardous Substances (materials) brought onto the construction site by Contractor are addressed in the General Requirements. If contamination occurs on-site due to (a) Contractor's violation(s) of Rules, Regulations or Contract Documents covering the use, storage, processing, transfer, transport, disposal or otherwise handling of any Hazardous Substances, or (b) any other cause within the control attributable to the fault or negligence of the Contractor, such as the spillage of chemicals, Contractor shall be responsible for all costs and time required to clean up the Site and render harmless the Hazardous Substances to the satisfaction of Owner, the State and any political subdivision with jurisdiction. Immediately upon contamination of the Site, Contractor shall notify Owner's representative or designee. If Contractor fails to proceed with due diligence or act appropriately, Owner, in its sole discretion, shall have the right to act, and if it does so, Contractor shall defend, indemnify and hold Owner harmless from and against all claims, as provided in Paragraph 6.20.A arising out of or in any way resulting from Owner's action under this provision. If the Owner is cited and fined by any political subdivision with jurisdiction for the herein described actions of the Contractor, Contractor shall immediately reimburse Owner for the cost of such fines.

4.09 Materials Containing Asbestos

4.09.A Materials containing asbestos and/or lead in any form are unacceptable to incorporate into the Project unless formally accepted in writing by the Owner. This written approval shall take place prior to the material being incorporated into the project and/or brought to the site.

4.09.B Repair kits or touch-up materials, materials that include asbestos and/or lead introduced into the product at the factory or applied at the assembly plant are all unacceptable. Any and all field-applied

products that are comprised of asbestos and/or lead containing materials are also unacceptable.

4.09.C If asbestos and/or lead are installed without written approval by Owner, Contractor will remove these materials at his expense and dispose of these materials in accordance with all State and Federal laws and pay for the supervision and reporting costs in addition to the cost to properly remove them.

ARTICLE 5 – BONDS AND INSURANCE

5.01 Performance and Payment Bonds: Contractor shall furnish Performance and Payment Bonds, each in an amount at least equal to the Contract Price as security for the faithful performance and payment of all Contractor's obligations under the Contract Documents. The Payment Bond shall remain in effect at least until one year after the date when final payment becomes due, except as provided otherwise by Laws and Regulations or by the Contract Documents. The Performance Bond shall remain in effect as long as Contractor is liable for (a) defective Work appearing after final inspection, (b) failure to comply with the Contract Documents or the terms or any special guaranties specified therein, or (c) Contractor's continuing obligations under the Contract Documents. Failure to comply with these provisions will be cause for rejection of the bidder's proposal.

5.01.A Bonds shall be executed by surety company or companies holding a Certificate of Authority to transact surety business in the State of Arizona, issued by the Director of the Department of Insurance. A copy of the Certificate of Authority shall accompany the bonds. The certificate shall be made payable and acceptable to the City of Phoenix. The bonds shall be written or countersigned by an authorized representative of the surety who is either a resident of the state of Arizona or whose principal office is maintained in this state, as by law required, and the bonds shall have attached thereto a certified copy of Power of Attorney of the signing official. Personal or individual bonds are not acceptable.

5.01.B All bonds submitted for this project shall be provided by a company which has been rated "A- or better for the prior four quarters" by the A.M. Best Company.

5.02 If the surety on any Bond furnished by Contractor is declared a bankrupt or becomes insolvent or its right to do business is terminated in the State of Arizona or it ceases to meet the requirements of paragraph 5.01, Contractor shall within ten days thereafter substitute another Bond and surety, both of which must be acceptable to Owner.

5.03 Contractor's Insurance

5.03.A Contractor and subcontractors must procure insurance against claims that may arise from or relate to performance of the work hereunder by Contractor and its agents, representatives, employees and subconsultants. Contractor and subcontractors must maintain that insurance until all their obligations have been discharged, including any warranty periods under this Contract.

5.04 The Owner in no way warrants that the limits stated in this section are sufficient to protect the Contractor from liabilities that might arise out of the performance of the work under this Contract by the Contractor, its agents, representatives, employees, or subcontractors and Contractor may purchase additional insurance as they determine necessary.

5.05 Scope and Limits of Insurance

5.05.A Contractor must provide coverage with limits of liability not less than those stated below. An excess liability policy or umbrella liability policy may be used to meet the liability limits provided that (1) the coverage is written on a "following form" basis, and (2) all terms under each line of coverage below are met.

5.05.A.1 **Commercial General Liability** -

General Aggregate	$2,000,000
Products - Completed Operations Aggregate	$1,000,000
Personal & Advertising Injury	$1,000,000
Each Occurrence	$1,000,000

5.05.A.1.a The policy must name the City of Phoenix as an additional insured with respect to liability for bodily injury, property damage and personal and advertising injury with respect to premises, ongoing operations, products and completed operations, and liability assumed under an insured contract arising out of the activities performed by, or on behalf of the Contractor, related to this Contract.

5.05.A.1.b Coverage must include XCU coverage.

5.05.A.1.c There shall be no endorsement or modification which limits the scope of coverage or

the policy limits available to the City of Phoenix as an additional insured.

5.05.A.1.d City of Phoenix is an additional insured to the full limits of liability purchased by the Contractor.

5.05.A.1.e The Contractor's insurance coverage must be primary and non-contributory with respect to any insurance or self-insurance carried by the City.

5.05.A.1.f Contractor's policies must be endorsed to provide an extension of the completed operations coverage for a period of nine years.

5.05.A.2 **Automobile Liability** - Bodily injury and property damage for any owned, hired, and non-owned vehicles used in the performance of this Contract.

Combined Single Limit (CSL)	$1,000,000

5.05.A.2.a The policy must be endorsed to include The City of Phoenix as an additional insured with respect to liability arising out of the activities performed by, or on behalf of the Contractor, related to this Contract

5.05.A.2.b City of Phoenix is an additional insured to the full limits of liability purchased by the Contractor

5.05.A.2.c The Contractor's insurance coverage must be primary and non-contributory with respect to any insurance or self-insurance carried by the City.

5.05.A.3 Workers' Compensation and Employers' Liability -

Workers' Compensation	Statutory
Employers' Liability	
Each Accident	$100,000
Disease – Each Employee	$100,000
Disease – Policy Limit	$500,000

5.05.A.3.a Policy must contain a waiver of subrogation against the City of Phoenix.

5.05.A.3.b This requirement does not apply when a Contractor or Subcontractor is exempt under A.R.S. §23-902(E), **AND** when such contractor or subcontractor executes the appropriate sole proprietor waiver form.

5.05.A.4 Builders' Risk Insurance - Policy must be in an amount equal to the initial Contract Amount plus additional coverage equal to Contract amount for all subsequent Change Orders.

5.05.A.4.a The City of Phoenix, the Contractor and Subcontractors, must be named Insureds on the policy.

5.05.A.4.b Special Causes of Loss coverage must be written on a replacement cost basis and must include coverage for soft costs, flood and earth movement.

5.05.A.4.c Coverage must be written on an all risk,

5.05.A.4.d Policy must be maintained until whichever of the following must first occur: (1) final payment has been made; or, (2) until no person or entity, other than the Owner, has an insurable interest in the property required to be covered.

5.05.A.4.e Policy must be endorsed such that the insurance must not be cancelled or lapse because of any partial use or occupancy by the Owner.

5.05.A.4.f Policy must provide coverage from the time any covered property becomes the responsibility of the Contractor, and continue without interruption during construction, renovation, or installation, including any time during which the covered property is being transported to the construction installation site, or awaiting installation, whether on or off site.

5.05.A.4.g Policy must contain a waiver of subrogation against the Owner.

5.05.A.4.h Contractor is responsible for the payment of all policy deductibles.

5.05.B **Notice of Cancellation**

5.05.B.1 For each insurance policy required by the insurance provisions of this Contract, the Contractor must provide to the City, within five business days of receipt, a notice if a policy is suspended, voided or cancelled for any reason. Such notice must be sent directly to the Owner's Project Manager listed in the Supplementary Conditions.

5.05.C **Acceptability of Insurers**

5.05.C.1 Insurance is to be placed with insurers duly licensed or authorized to do business in the State of Arizona and with an "A.M. Best" rating of not less than B+ VI. The Owner in no way warrants that the required minimum insurer rating is sufficient to protect the Contractor from potential insurer insolvency.

5.05.D **Verification of Coverage**

5.05.D.1 Contractor must furnish the Owner with certificates of insurance (ACORD form or

equivalent approved by the Owner) as required by this Contract. The certificates for each insurance policy are to be signed by a person authorized by that insurer to bind coverage on its behalf.

5.05.D.2 All certificates and any required endorsements are to be received and approved by the Owner before work commences. Each insurance policy required by this Contract must be in effect at or prior to commencement of work under this Contract and remain in effect for the duration of the Project. Failure to maintain the insurance policies as required by this Contract or to provide evidence of renewal is a material breach of the Contract.

5.05.D.3 All certificates required by this Contract must be sent directly to Design and Construction Procurement, 200 W. Washington Street, 5th Floor, Phoenix, AZ 85003. **The Contract Number, Project Number, and Project title must be noted on the certificate of insurance.** The Owner reserves the right to require complete, certified copies of all insurance policies required by this Contract, at any time. **DO NOT SEND CERTIFICATES OF INSURANCE TO THE OWNER'S RISK MANAGEMENT DIVISION.**

5.05.E **Subcontractors**

5.05.E.1 Contractor's certificates shall include all subcontractors as additional insureds under its policies **OR** Contractor shall be responsible for ensuring and verifying that all subcontractors have valid and collectable insurance. At any time throughout the life of the contract, the City of Phoenix reserves the right to require proof from the Contractor that its subcontractors have insurance coverage. All subcontractors providing services included under this Contract's Scope of Services are subject to the insurance coverages identified above and must include the City of Phoenix as an additional insured. In certain circumstances, the Contractor may, on behalf of its subcontractors, waive a specific type of coverage or limit of liability where appropriate to the type of work being performed under the subcontract. Contractor assumes liability for all subcontractors with respect to this Contract.

5.05.F **Approval**

5.05.F.1 Any modification or variation from the insurance requirements and conditions must be documented by an executed contract amendment.

ARTICLE 6 – CONTRACTOR'S RESPONSIBILITIES

6.01 Supervision and Superintendence

6.01.A Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction. Contractor shall not be responsible for the negligence of Owner or Design Professional in the design or specification of a specific means, method, technique, sequence, or procedure of construction which is shown or indicated in and expressly required by the Contract Documents.

6.01.B At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who shall not be replaced without written notice to Owner and Design Professional except under extraordinary circumstances.

6.01.C All communications given to or received from the contractor's representative, designated pursuant to Paragraph 2.05.B, shall be binding on Contractor.

6.02 Labor; Working Hours

6.02.A Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. Contractor shall at all times maintain good discipline and order at the Site.

6.02.B Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site shall be performed during regular working hours. Contractor will not permit the performance of Work on a Saturday, Sunday, or any legal holiday without Owner's written consent (which will not be unreasonably withheld) given after prior written notice to Design Professional.

6.02.B.1 Regular working hours, unless specifically disallowed by Laws or Regulations, shall be between 6:00 a.m. and 7:00 p.m. from May 1st through September 30th and between 7:00 a.m. and 7:00 p.m. from October 1st through April 30th, not exceeding forty-five (45) hours per week. Contractor shall reimburse Owner for all additional costs resulting from Work performed outside regular working hours, which shall include (a) premium time charges of Design Professional and Owner, and (b) added costs assessed against or

incurred by Owner which Contractor could reasonably foresee.

6.02.C The combined premium time charges of Design Professional and Owner shall be as defined in the Supplementary Conditions.

6.03 Services, Materials, and Equipment

6.03.A Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start up, and completion of the Work.

6.03.B All materials and equipment incorporated into the Work shall be as specified or, if not specified, shall be of good quality and new, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications shall expressly run to the benefit of Owner. If required by Design Professional, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.

6.03.C All materials and equipment shall be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

6.04 Progress Schedule

6.04.A Contractor shall adhere to the Progress Schedule developed and maintained by Contractor in accordance with the General Requirements.

6.04.B Proposed adjustments in the Progress Schedule that will change the Contract Times shall be submitted in accordance with the requirements of Article 12. Adjustments in Contract Times may only be made by a Change Order or Written Amendment.

6.05 Substitutes and "Or-Equals"

6.05.A Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the specification or description is intended to establish the type, function, appearance, and quality required. If the specification or description contains or is followed by the words "or-equal", other items of material or equipment or other Suppliers may be accepted by the Design Professional under circumstances stated in Paragraph 6.05.A.1 below. Requests for acceptance of "or-equal" items will be received by the Design Professional after Notice to Proceed has been issued.

6.05.A.1 "Or Equal" Items: If in Design Professional's sole discretion an item of material or equipment proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, it may be considered by Design Professional as an "or equal" item, in which case review and approval of the proposed item may, in Design Professional's sole discretion, be accomplished without compliance with some or all of the requirements for acceptance of proposed substitute items. For the purposes of this Paragraph 6.05.A.1, a proposed item of material or equipment will be considered functionally equal to an item so named if:

6.05.A.1.a in the exercise of reasonable judgment Design Professional determines that:

6.05.A.1.a.1it is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;

6.05.A.1.a.2it will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole; and

6.05.A.1.a.3it has a proven record of performance and availability of responsive service.

6.05.A.1.b Contractor certifies that, if approved and incorporated into the Work:

6.05.A.1.b.1there will be no increase in cost to the Owner or increase in Contract Times; and

6.05.A.1.b.2it will conform substantially to the detailed requirements of the item named in the Contract Documents.

6.05.B If the specification, description, list of acceptable equipment and/or Suppliers is not followed by the words "or-equal", other equivalent equipment or Suppliers proposed by the Contractor will be reviewed as a "pre-approved equal" by the Design Professional only prior to the Bid date. The Instructions to Bidders describes the time schedule, procedure, and other requirements for application for "pre-approved equal" acceptance. Proposed "pre-approved equal" and "or-equal" items must be

determined by the Design Professional to be equivalent as prescribed in Paragraph 6.05.A.1.

6.05.C If the Contractor proposes to use equipment, Supplier(s) or materials not equivalent to what is specified, Contractor must make an application to the Design Professional for approval of a substitute in accordance with Paragraph 6.05.C.3. Requests by the Contractor to use substitute items must be submitted to the Design Professional after the Notice to Proceed has been issued. Generally, a substitute will not be approved without a cost credit to the Owner. A substitute will be approved only through a Change Order.

6.05.C.1 Substitute Items: If in Design Professional's sole discretion an item of material or equipment proposed by Contractor does not qualify as an "or equal" item under Paragraph 6.05.A.1, it will be considered a proposed substitute item.

6.05.C.2 Contractor shall submit sufficient information as provided below to allow Design Professional to determine if the item of material or equipment proposed is essentially equivalent to that named and an acceptable substitute therefor. Requests for review of proposed substitute items of material or equipment will not be accepted by Design Professional from anyone other than Contractor.

6.05.C.3 Contractor shall make written application to Design Professional for review of a proposed substitute item of material or equipment that Contractor seeks to furnish or use. The application:

6.05.C.3.a shall certify that the proposed substitute item will:

6.05.C.3.a.1 perform adequately the functions and achieve the results called for by the general design,

6.05.C.3.a.2 be similar in substance to that specified, and

6.05.C.3.a.3 be suited to the same use as that specified;

6.05.C.3.b will state:

6.05.C.3.b.1 the extent, if any, to which the use of the proposed substitute item will prejudice Contractor's achievement of Substantial Completion on time;

6.05.C.3.b.2 whether use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item; and

6.05.C.3.b.3 whether incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty;

6.05.C.3.c will identify:

6.05.C.3.c.1 all variations of the proposed substitute item from that specified, and

6.05.C.3.c.2 available engineering, sales, maintenance, repair, and replacement services; and

6.05.C.3.d shall contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including costs of redesign and claims of other contractors affected by any resulting change.

6.05.D Substitute Construction Methods or Procedures: If a specific means, method, technique, sequence, or procedure of construction is expressly required by the Contract Documents, Contractor may furnish or utilize a substitute means, method, technique, sequence, or procedure of construction approved by Design Professional. Contractor shall submit sufficient information to allow Design Professional, in Design Professional's sole discretion, to determine that the substitute proposed is equivalent to that expressly called for by the Contract Documents. The requirements for review by Design Professional will be similar to those provided in Paragraph 6.05.C.3.

6.05.E Design Professional's Evaluation: Design Professional will be allowed a reasonable time within which to evaluate each proposal or submittal made pursuant to Paragraphs 6.05.A and 6.05.C. Design Professional may require Contractor to furnish additional data about the proposed substitute item. Design Professional will be the sole judge of acceptability. No "or equal" or substitute will be ordered, installed or utilized until Design Professional's review is complete, which will be evidenced by a Change Order in the case of a substitute and an approved Shop Drawing for an "or equal." Design Professional will advise Contractor in writing of any negative determination.

6.05.E.1 The Design Professional will not accept any substitute item unless it yields a net savings to Owner and does not extend Contract Time(s), and seventy-five percent (75%) of the savings in Contract Price and reduction in Contract

Time(s) are credited to Owner. The remaining twenty five percent (25%) of the net savings in Contract Price and/or reduction in Contract Time will be credited to Contractor. If, in Design Professional's judgment, acceptance of a substitute item will result in increased future costs to Owner for operation, maintenance, or replacement, the portion of the net savings in Contract Price which is to be credited to Contractor will be reduced by an amount equal to twenty five percent (25%) of the estimated present worth of such increased future costs to Owner.

6.05.F Special Guarantee: Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.

6.05.G Design Professional's Cost Reimbursement: Design Professional will record Design Professional's costs in evaluating a substitute proposed or submitted by Contractor pursuant to Paragraphs 6.05.A and 6.05.C Whether or not Design Professional approves a substitute so proposed or submitted by Contractor, Contractor shall reimburse Owner for the charges of Design Professional for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the charges of Design Professional for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.

6.05.H Contractor's Expense: Contractor shall provide all data in support of any proposed substitute or "or equal" at Contractor's expense.

6.06 Concerning Subcontractors, Suppliers, and Others

6.06.A Contractor shall not employ any Subcontractor, Supplier, or other individual or entity (including those acceptable to Owner as indicated in Paragraph 6.06.B), whether initially or as a replacement, against whom Owner may have reasonable objection. Contractor shall not be required to employ any Subcontractor, Supplier, or other individual or entity to furnish or perform any of the Work against whom Contractor has reasonable objection.

6.06.B The identity of certain Subcontractors, Manufacturers, Suppliers, individuals or entities (including those who are to furnish the principal items of materials or equipment) are required to be submitted as specified in the Bid Documents for acceptance by Owner, and if Bidder has submitted a list thereof in accordance with Section 00330 (List of Major Subcontractors and Suppliers), Section 00331 (List of All Subcontractors and Suppliers) and Section 00340 (Schedule of Manufacturers and Suppliers of Major Equipment and Material Items), Owner's acceptance (either in writing or by failing to make written objection thereto by the date indicated for acceptance or objection in the Bid Documents or the Contract Documents) of any Subcontractor, Manufacturer, Supplier, individual or entity so identified may be revoked on the basis of reasonable objection after due investigation, in which case Contractor shall submit an acceptable replacement for the rejected Subcontractor, Supplier, or other individual or entity, and the Contract Price will be adjusted by the difference in the cost occasioned by such replacement, and an appropriate Change Order will be issued. No acceptance by Owner of any such Subcontractor, Supplier, or other individual or entity, whether initially or as a replacement, shall constitute a waiver of any right of Owner or Design Professional to reject work.

6.06.C Contractor shall be fully responsible to Owner for all acts and omissions of the Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work just as Contractor is responsible for Contractor's own acts and omissions. Nothing in the Contract Documents:

6.06.C.1 shall create for the benefit of any such Subcontractor, Supplier, or other individual or entity any contractual relationship between Owner or Design Professional and any such Subcontractor, Supplier or other individual or entity, nor

6.06.C.2 shall create any obligation on the part of Owner or Design Professional to pay or to see to the payment of any moneys due any such Subcontractor, Supplier, or other individual or entity except as may otherwise be required by Laws and Regulations.

6.06.D Contractor shall be solely responsible for scheduling and coordinating the Work of Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work under a direct or indirect contract with Contractor.

6.06.E Contractor shall require all Subcontractors, Suppliers, and such other individuals or entities performing or furnishing any of the Work to communicate with Design Professional through Contractor.

6.06.F The divisions and sections of the Specifications and the identifications of any Drawings shall not control Contractor in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.

6.06.G All Work performed for Contractor by a Subcontractor or Supplier will be pursuant to an appropriate agreement between Contractor and the Subcontractor or Supplier which specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of Owner and Design Professional. Whenever any such agreement is with a Subcontractor or Supplier who is listed as an additional insured on the property insurance provided in Article 5, the agreement between the Contractor and the Subcontractor or Supplier will contain provisions whereby the Subcontractor or Supplier waives all rights against Owner, Contractor, Design Professional, and all other individuals or entities identified in the Supplementary Conditions to be listed as insureds or additional insureds (and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them) for all losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work. If the insurers on any such policies require separate waiver forms to be signed by any Subcontractor or Supplier, Contractor will obtain the same.

6.07 Payments to Subcontractors and Suppliers

6.07.A Contractor Payment to Subcontractor or Supplier. Contractor shall pay its Subcontractors or Suppliers within seven (7) calendar days of receipt of each progress payment from the Owner. The Contractor shall pay for the amount of work performed or materials supplied by each Subcontractor or Supplier as accepted and approved by the Owner with each progress payment. In addition, any reduction of retention by the Owner to the Contractor shall result in a corresponding reduction to Subcontractors or Suppliers who have performed satisfactory work. Contractor shall pay Subcontractors or Suppliers the reduced retention within fourteen (14) calendar days of the payment of the reduction of the retention to the Contractor. No Contract between Contractor and its Subcontractors and Suppliers may materially alter the rights of any Subcontractor or Supplier to receive prompt payment and retention reduction as provided herein.

6.07.B **Prompt Payment:** If the Contractor fails to make payments in accordance with these provisions, the Owner may take any one or more of the following actions and Contractor agrees that the Owner may take such actions:

6.07.B.1 to hold the Contractor in default under this Agreement;

6.07.B.2 withhold future payments including retention until proper payment has been made to Subcontractors or Suppliers in accordance with these provisions;

6.07.B.3 reject all future Bids from the Contractor for a period not to exceed one year from Substantial Completion date of this Project; or

6.07.B.4 terminate Agreement.

6.07.C Alternative Dispute Resolution Between Contractor and Subcontractor or Supplier.

6.07.C.1 If Contractor's payment to a Subcontractor or Supplier is in dispute, Contractor and Subcontractor or Supplier agree to submit the dispute to any of one of the following dispute resolution processes within fourteen (14) calendar days from the date of any party gives notice to the others:

6.07.C.1.a binding arbitration;

6.07.C.1.b a form of alternative dispute resolution (ADR) agreeable to all parties or

6.07.C.1.c a City of Phoenix facilitated mediation.

6.07.C.2 When disputed claim is resolved through ADR or otherwise, the Contractor and Subcontractor or Supplier agrees to implement the resolution within seven (7) calendar days from the resolution date.

6.07.D **Inspection and Audit**. Contractor, its subcontractors and suppliers shall comply with A.R.S. 35-214 and the Owner shall have all rights and remedies to inspect and audit the records and files of Contractor, subcontractor or supplier, as afforded the State of Arizona, in accordance with the provisions of A.R.S. Section 35-214.

6.07.D.1 Records of the Contactor's direct personnel payroll, bond expenses, and reimbursable expenses pertaining to this Project and records of accounts between the City and the Contractor must be kept on the basis of generally

accepted accounting principles and must be made available to the City and its auditors for up to five years following Final Acceptance of the Project.

6.07.D.2 The City, its authorized representative, and/or any federal agency, reserves the right to audit the Contractor's records to verify the accuracy and appropriateness of all cost and pricing data, including data used to negotiate the Contract Documents and any Change Orders.

6.07.D.3 The City reserves the right to decrease the Contract Price and/or payments made on this Agreement and/or request reimbursement from the Contractor following final contract payment on this Agreement if, upon audit of the Contractor's records, the audit discloses the Contractor has provided false, misleading, or inaccurate cost and pricing data.

6.07.D.4 The Contractor shall include a similar provision in all of its contracts with Subcontractors and Suppliers providing services or supplying materials under the Contract Documents to ensure that the City, its authorized representative, and/or the appropriate federal agency has access to the Subcontractors and Suppliers records to verify the accuracy of all cost and pricing data.

6.07.D.5 The City reserves the right to decrease the Contract Price and/or payments made on this Agreement and/or request reimbursement from the Contractor following final contract payment on this Agreement if the above provision is not included in Subcontractors and Suppliers contracts, and one or more Subcontractors or Suppliers refuse to allow the City to audit their records to verify the accuracy and appropriateness of cost and pricing data.

6.07.D.6 If, following an audit of this Agreement, the audit discloses the Contractor has provided false, misleading, or inaccurate cost and pricing data, and the cost discrepancies exceed 1% of the total Agreement billings, the Contractor shall be liable for reimbursement of the reasonable, actual cost of the audit.

6.07.E **Non-Waiver**. Should the Owner fail or delay in exercising or enforcing any right, power, privilege, or remedy under this Section, such failure or delay shall not be deemed a waiver, release, or modification of the requirements of this Section or of any of the terms or provisions thereof.

6.07.F **Inclusion of Provisions in Subcontracts**. Contractor shall include these prompt payment provisions in every subcontract, including procurement of materials and leases of equipment for the Agreement.

6.07.G **No Third-Party Benefits or Rights**. Nothing contained in the Agreement is intended to benefit or confer any rights on any person or entity not a party to the Agreement, and no such person or entity, including but not limited to other Contractors, Subcontractors or Suppliers, may assert any claim, cause of action, or remedy against the Owner hereunder.

6.08 Patent Fees and Royalties

6.08.A Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if to the actual knowledge of Owner or Design Professional its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by Owner in the Contract Documents.

6.08.B To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Design Professional, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents.

6.09 Permits

6.09.A Unless otherwise provided in the Supplementary Conditions, Contractor shall obtain and pay for all construction permits and licenses. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of opening of Bids,

or, if there are no Bids, on the Effective Date of the Agreement. Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.

6.10 Laws and Regulations

6.10.A Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Except where otherwise expressly required by applicable Laws and Regulations, neither Owner nor Design Professional shall be responsible for monitoring Contractor's compliance with any Laws or Regulations.

6.10.B If Contractor performs any Work knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or other dispute resolution costs) arising out of or relating to such Work. However, it shall not be Contractor's responsibility to make certain that the Specifications and Drawings are in accordance with Laws and Regulations, but this shall not relieve Contractor of Contractor's obligations under Paragraph 3.03.

6.10.C Contractor shall (a) comply with all Laws and Regulations governing the use of explosives, (b) obtain and pay for any required permits before their use, and (c) furnish a copy of the permits to Design Professional before using explosives. Contractor shall, under the supervision of competent and suitably trained and qualified personnel, exercise the utmost care not to endanger life or damage property in the transportation, storage, handling, use and disposal of explosives. Contractor shall be responsible for and shall defend, indemnify and hold harmless Owner and Design Professional against all claims for injury, damage and other adverse impacts inside and outside the permit area resulting from the use of explosives, including but not limited to all costs, delay and delay costs.

6.10.D Changes in Laws or Regulations not known at the time of opening of Bids (or, on the Effective Date of the Agreement if there were no Bids) having an effect on the cost or time of performance of the Work shall be the subject of an adjustment in Contract Price or Contract Times. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

6.10.E Fair Treatment of Workers

6.10.E.1 The Contractor shall keep fully informed of all Federal and State laws, County and City ordinances, regulations, codes and all orders and decrees of bodies or tribunals having any jurisdiction or authority, which in any way affect the conduct of the work. He shall at all times observe and comply with all such laws, ordinances, regulations, codes, orders and decrees; this includes, but is not limited to Laws and Regulations ensuring fair and equal treatment for all employees and against unfair employment practices, including OSHA and Fair Labor Standards Act (FSLA). The Contractor shall protect and indemnify the Contracting Agency and its representatives against any claim or liability arising from or based on the violation of such, whether by himself or his employees.

6.10.F No Israel Boycott

6.10.F.1 By entering into this contract, the Engineer/Contractor certifies that they are not currently engaged in and agrees for the duration of the Contract to not engage in, a boycott of Israel.

6.10.G No Forced Labor of Ethnic Uyghurs

6.10.G.1 If this Contract requires Contractor (a company engaging in for-profit activity and having ten or more full-time employees) to acquire or dispose of services, supplies, information technology, goods, or construction, then pursuant to Title 35, Chapter 2, Article 10 of the Arizona Revised Statutes Contractor must certify and agree that it and any contractors, subcontractors, or suppliers it utilizes do not and will not use the forced labor of ethnic Uyghurs in the People's Republic of China or any goods or services produced by such forced labor. Provided these statutory requirements are applicable, Contractor, by entering this Contract, now certifies it is not currently engaged in, and agrees for the duration of the Contract to not engage in, (a) the use of forced labor of ethnic Uyghurs in the People's Republic of China; (b) the use of any goods or services produced by the forced labor of ethnic Uyghurs in the People's Republic of China; or (c) the use of any contractors, subcontractors, or suppliers that use the forced labor or any goods or services produced by the forced labor of ethnic Uyghurs in the People's Republic of China.

6.11 Use of Site and Other Areas

6.11.A Limitation on Use of Site and Other Areas

6.11.A.1 Contractor shall confine construction equipment, the storage of materials and equipment, and the operations of workers to the Site and other areas permitted by Laws and Regulations, and as directed in the General Requirements. Contractor shall assume full responsibility for any damage to any such land or area, or to the owner or occupant thereof, or of any adjacent land or areas resulting from the performance of the Work.

6.11.A.2 Should any claim be made by any such owner or occupant because of the performance of the Work, Contractor shall promptly settle with such other party by negotiation or otherwise resolve the claim by other dispute resolution proceeding or at law.

6.11.A.3 To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Design Professional, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Design Professional, or any other party indemnified hereunder to the extent caused by or based upon Contractor's performance of the Work.

6.11.B Removal of Debris During Performance of the Work: During the progress of the Work Contractor shall keep the Site and other areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris shall conform to applicable Laws and Regulations.

6.11.C Cleaning: Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor shall remove from the Site all tools, appliances, construction equipment and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.

6.11.D Loading Structures: Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent property to stresses or pressures that will endanger it.

6.12 Record Documents

6.12.A Contractor shall maintain record documents as indicated in the General Requirements.

6.13 Safety and Protection

6.13.A Contractor shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. Such responsibility does not relieve Subcontractors of their responsibility for the safety of persons or property in the performance of their work, nor for compliance with applicable safety Laws and Regulations. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:

6.13.A.1 all persons on the Site or who may be affected by the Work;

6.13.A.2 all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and

6.13.A.3 other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.

6.13.B Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection. Contractor shall notify owners of adjacent property and of Underground Facilities and other utility owners when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property.

6.13.C Contractor shall comply with the applicable requirements of Owner’s safety programs, if any. The Supplementary Conditions identify any Owner’s safety programs that are applicable to the Work.

6.13.D Contractor shall inform Owner and Design Professional of the specific requirements of Contractor’s safety program with which Owner’s

and Design Professional's employees and representatives must comply while at the site.

6.13.E All damage, injury, or loss to any property referred to in Paragraph 6.13.A.2 or 6.13.A.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Design Professional, or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).

6.13.F Contractor's duties and responsibilities for safety and for protection of the Work shall continue until such time as all the Work is completed and Design Professional has issued a notice to Owner and Contractor in accordance with Paragraph 14.07.D that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).

6.14 Safety Representative

6.14.A Contractor shall designate a qualified and experienced safety representative at the Site whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs.

6.14.B The safety representative will also be qualified to manage the hazardous materials management requirements described in the General Requirements.

6.15 Hazard Communication Programs

6.15.A Contractor shall be responsible for coordinating any exchange of material safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with Laws or Regulations. This also applies to the hazardous materials management requirements described in the General Requirements.

6.15.B Contractor shall contact the Owner's Environmental Health and Safety (EHS) Specialist at the Site where Work is to be performed to obtain information regarding the EHS policies and participate in any required training. Contractor shall comply with all EHS policies in effect during the performance of its Work.

6.16 Emergencies

6.16.A In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, Contractor is obligated to act to prevent threatened damage, injury, or loss. Contractor shall give Design Professional prompt written notice if Contractor believes that any significant changes in the Work or variations from the Contract Documents have been caused thereby or are required as a result thereof. If Design Professional determines that a change in the Contract Documents is required because of the action taken by Contractor in response to such an emergency, a Work Change Directive or Change Order will be issued.

6.17 Shop Drawings and Samples

6.17.A Unless otherwise indicated in the General Requirements, Contractor shall submit Shop Drawings and Samples to Design Professional, for review and approval. Procedures for submittal, review, approval and resubmittal of Shop Drawings, Samples and other submittals are detailed in the General Requirements.

6.17.B Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Design Professional's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.

6.17.B.1 Technical submittal(s) consisting of drawings and specifications involving architecture, professional engineering, land surveying or landscape architecture, as defined in A.R.S. Title 32, shall be prepared by or under the direct supervision of a registrant within the specific category involved.

6.17.B.2 Submittal(s) are not Contract Documents. Technical submittal(s) are intended to demonstrate how Contractor intends to conform with the design concept of the Project and the information given in the Contract Documents.

6.17.C Design Professional's Review

6.17.C.1 Design Professional's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction (except where a particular means, method, technique, sequence, or procedure of

construction is specifically and expressly called for by the Contract Documents) or to safety precautions or programs incident thereto. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

6.18 Continuing the Work

6.18.A Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as permitted by Paragraph 15.04 or as Owner and Contractor may otherwise agree in writing.

6.19 Contractor's General Warranty and Guarantee

6.19.A Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Design Professional and its Related Entities shall be entitled to rely on representation of Contractor's warranty and guarantee.

6.19.B Contractor's warranty and guarantee hereunder excludes defects or damage caused by:

6.19.B.1 abuse, modification, or improper maintenance or operation by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or

6.19.B.2 normal wear and tear under normal usage.

6.19.C Contractor's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents or a release of Contractor's obligation to perform the Work in accordance with the Contract Documents:

6.19.C.1 observations by Design Professional;

6.19.C.2 recommendation by Design Professional or payment by Owner of any progress or final payment;

6.19.C.3 the issuance of a certificate of Substantial Completion by Design Professional or any payment related thereto by Owner;

6.19.C.4 use or occupancy of the Work or any part thereof by Owner;

6.19.C.5 any review and approval of a Shop Drawing or Sample submittal or the issuance of a notice of acceptability by Design Professional;

6.19.C.6 any inspection, test, or approval by others; or

6.19.C.7 any correction of defective Work by Owner.

6.19.C.8 expiration of the correction period pursuant to Paragraph 13.07.

6.20 Defense and Indemnification

6.20.A To the maximum extent allowed by law, including Title 34 A.R.S., Contractor ("Indemnitor") agrees to defend, indemnify, and hold harmless the City of Phoenix and its officers, officials (elected or appointed), agents and employees (and any jurisdiction or agency issuing permits for any work included in the project, and its officers, agents and employees) ("Indemnitee") from any and all claims, actions, liabilities, damages, losses or expenses, (including but not limited to court costs, attorney fees, expert fees, and costs of claim processing, investigation and litigation) of any nature or kind whatsoever ("Losses") caused or alleged to be caused, in whole or in part, by the wrongful, negligent or willful acts, or errors or omissions of Indemnitor or any of its owners, officers, directors, members, managers, agents, employees, or subcontractors (Indemnitor's Agents") arising out of or in connection with this Contract. This defense and indemnity obligation includes holding Indemnitee harmless for any Losses or other amount arising out of or recovered under any state's workers' compensation law or arising out of the failure of Indemnitor or Indemnitor's Agents to conform to any federal, state or local law, statute, ordinance, rule, regulation, or court decree. Indemnitor's duty to defend Indemnitee accrues immediately at the time a claim is threatened or a claim is made against Indemnitee, whichever is first. Indemnitor's duty to defend exists regardless of whether Indemnitor is ultimately found liable. Indemnitor must indemnify Indemnitee from and against any and all Losses, except where it is proven that those Losses are solely as a result of Indemnitee's own negligent or willful acts or omissions. Indemnitor is responsible for primary loss investigation, defense and judgment costs where this indemnification applies. In consideration of the City's award of this Contract, Indemnitor agrees to waive all rights of subrogation against Indemnitee for losses arising from or related to any work performed by Indemnitor or Indemnitor's

Agents for the City of Phoenix under this Contract. The obligations of Indemnitor under this provision survive the termination or expiration of this Contract.

6.20.B Delegation of Professional Design Services

6.20.C Contractor will not be required to provide professional design services unless such services are specifically required by the Contract Documents for a portion of the Work or unless such services are required to carry out Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. Contractor shall not be required to provide professional services in violation of applicable law.

6.20.D If professional design services or certifications by a design professional related to systems, materials or equipment are specifically required of Contractor by the Contract Documents, Owner and Design Professional will specify all performance and design criteria that such services must satisfy. Contractor shall cause such services or certifications to be provided by a properly licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to Design Professional.

6.20.E Owner and Design Professional shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications or approvals performed by such design professionals, provided Owner and Design Professional have specified to Contractor all performance and design criteria that such services must satisfy.

6.20.F Pursuant to this Paragraph 6.21, Design Professional's review and approval of design calculations and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria given and the design concept expressed in the Contract Documents. Design Professional's review and approval of Shop Drawings and other submittals (except design calculations and design drawings) will be only for the purpose stated in Paragraph 6.17.

6.20.G Contractor shall not be responsible for the adequacy of the performance or design criteria required by the Contract Documents.

6.21 Quality Control

6.21.A Contractor shall establish a quality control program:

6.21.A.1 to insure sufficient supervision, examination, inspection and testing of all items of Work at appropriate intervals, including those of Subcontractors and Suppliers; and

6.21.A.2 to control conformance to the applicable Specifications and Drawings with respect to identified products, workmanship, construction, maintenance while idle, finish and functional performance. At minimum Contractor's quality control program shall include checking, approval and coordination of submittal and oversight of all specified tests; and it shall specifically assign to responsible Contractor personnel the obligation to verify and inspect when complete all items of Work which cannot be later located or inspected without uncovering Work. Contractor shall accurately annotate data on the thus obtained record documents.

6.22. Off Duty Police Office Requirements

6.22.A. Off-duty police officers are required for construction projects as defined in the most recent edition of the City of Phoenix Traffic Barricade Manual and TRACS permit. The Contractor must competitively procure off-duty police with vendors who are Authorized Traffic Coordinators with the City of Phoenix Police Department or Phoenix Police Department off-duty detail. The following requirements must be included in the procurement:

6.22.A.2.a Hourly fees charged
6.22.A.2.b Administrative fees (administrative fees to be charged as a part of the hourly rate, not billed separately)

6.22.A.2.c Pay applications requesting reimbursement for Off Duty Police hours worked will be accompanied with itemized documentation indicating officer name, date worked, hours worked, time of day worked and location.

6.22.A.2.d For audit purposes, contractor's files will contain documentation from the successful off duty vendor that the above items are accounted for in the vendor's price proposal.

ARTICLE 7 - OTHER WORK AT THE SITE

7.01 Related Work at Site

7.01.A Owner may perform other work related to the Project at the Site with Owner's employees, or through other direct contracts therefor, or have

other work performed by utility owners. If such other work is not noted in the Contract Documents, then:

7.01.A.1 written notice thereof will be given to Contractor prior to starting any such other work; and

7.01.A.2 if Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times that should be allowed as a result of such other work, a Claim may be made therefor as provided in Paragraph 10.05.

7.01.B Contractor shall afford each other contractor who is a party to such a direct contract, each utility owner and Owner, if Owner is performing other work with Owner's employees, proper and safe access to the Site, provide a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work, and properly coordinate the Work with theirs. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering such work; provided, however, that Contractor may cut or alter others' Work with the written consent of Design Professional and the others whose work will be affected. The duties and responsibilities of Contractor under this Paragraph are for the benefit of such utility owners and other contractors to the extent that there are comparable provisions for the benefit of Contractor in said direct contracts between Owner and such utility owners and other contractors.

7.01.C If the proper execution or results of any part of Contractor's Work depends upon work performed by others under this Article 7, Contractor shall inspect such other work and promptly report to Design Professional in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. Contractor's failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent defects and deficiencies in such other work.

7.02 Coordination

7.02.A If Owner intends to contract with others for the performance of other work on the Project at the Site, the following will be set forth in Supplementary Conditions:

7.02.A.1 the individual or entity who will have authority and responsibility for coordination of the activities among the various contractors will be identified;

7.02.A.2 the specific matters to be covered by such authority and responsibility will be itemized; and

7.02.A.3 the extent of such authority and responsibilities will be provided.

7.02.B Unless otherwise provided in the Supplementary Conditions, Owner shall have sole authority and responsibility for such coordination.

7.03 Legal Relationships

7.03.A Paragraphs 7.01.A and 7.02 are not applicable for utilities not under the control of Owner.

7.03.B Each other direct contract of Owner under Paragraph 7.01.A shall provide that the other contractor is liable to Owner and Contractor for the reasonable direct delay and disruption costs incurred by Contractor as a result of the other contractor's actions or inactions.

7.04 Mutual Duties and Responsibilities

7.04.A If Contractor causes damage to the Work or property of others, Contractor shall promptly attempt to settle with that party or otherwise resolve the claim. Contractor shall defend, indemnify and hold harmless Owner and Design Professional from and against all claims, as provided in Paragraph 6.20.A, arising out of or resulting from damage by Contractor to the Work or property of others or from Contractor's performance of the Work.

7.04.B If another party causes damage to the Work or property of Contractor, Contractor shall promptly attempt to settle with that party or otherwise resolve the claim. Contractor shall not begin any action against Owner or Design Professional, their consultants, agents or any of their directors, officers, shareholders, agents or employees, or permit any action against them to be maintained in Contractor's name or for Contractor's benefit in any court or tribunal, which action seeks to impose liability or recover damages from Owner or Design Professional for such claim.

7.04.C If Contractor becomes involved in settling or otherwise resolving claims with other persons performing work under the circumstances covered in Paragraphs 7.04.A or 7.04.B, or because of any other similar controversy, including damage to the

Work or other work or a dispute about responsibility for clean-up or any other issue, neither Owner, Design Professional, nor any of their respective consultants, directors, officers, stockholders, employees or agents will be involved in any way in such actions (unless subpoenaed). If Owner incurs costs contrary to the provisions of this Article, Contractor shall reimburse Owner for those costs.

ARTICLE 8 - OWNER'S RESPONSIBILITIES

8.01 Communications to Contractor

8.01.A Except as otherwise provided in these General Conditions, Owner shall issue all communications to Contractor through Design Professional.

8.02 Replacement of Individual or Entity

8.02.A In case of termination of the employment of Design Professional, Owner shall appoint a design professional to whom Contractor makes no reasonable objection, whose status under the Contract Documents shall be that of the former Design Professional.

8.02.B If Design Professional reasonably objects to any of Contractor's personnel because they are unfit, unskilled, disorderly or counter-productive to the Work, Contractor shall promptly correct the problem and, if required, remove such personnel from the Work. Contractor shall defend, indemnify and hold Owner and Design Professional harmless from and against all claims, losses and expenses (including attorneys' fees and costs of defense and appeal, if any) arising from the enforcement of this clause.

8.03 Furnish Data

8.03.A Owner shall promptly furnish the data required of Owner under the Contract Documents.

8.04 Pay When Due

8.04.A Owner shall make payments to Contractor when they are due as provided in Paragraphs 14.02.B and 14.07.E.1.

8.05 Lands and Easements; Reports and Tests

8.05.A Owner’s duties with respect to providing lands and easements and providing engineering surveys to establish reference points are set forth in Paragraphs 4.01 and 4.07. Paragraph 4.02 refers to Owner’s identifying and making available to Contractor copies of reports of explorations and tests of subsurface conditions and drawings of physical conditions relating to existing surface or subsurface structures at the Site.

8.06 Change Orders

8.06.A **Owner is obligated to execute Change Orders as indicated in Paragraph 10.03.**

8.07 Inspections, Tests, and Approvals

8.07.A Owner’s responsibility with respect to certain inspections, tests, and approvals is set forth in Paragraph 13.03.B.

8.08 Limitations on Owner’s Responsibilities

8.08.A The Owner shall not supervise, direct, or have control or authority over, nor be responsible for, Contractor’s means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Owner will not be responsible for Contractor’s failure to perform the Work in accordance with the Contract Documents.

8.08.B Neither (a) Owner's authority to review Contractor's Progress Schedules (as set forth in Article 6), nor (b) Owner's decision to raise or not raise objections about Progress schedule submittal, shall create or impose any duty or responsibility on Owner to exercise any such authority or decision for the benefit of Contractor, any Subcontractor or Supplier or any other person.

8.08.C Neither (a) Owner's authority to review the required certificates and policies of insurance, nor (b) Owner's decision to object or not to object to the certificates or policies, shall create or impose any duty or responsibility on Owner to exercise any such authority or decision for the benefit of Contractor, any Subcontractor or Supplier or any other person.

8.09 Undisclosed Hazardous Environmental Condition

8.09.A Owner’s responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 4.08.

8.10 Compliance with Safety Program

8.10.A While at the Site, Owner’s employees and representatives shall comply with the specific applicable requirements of Contractor’s safety programs of which Owner has been informed pursuant to Paragraph 6.13.D.

ARTICLE 9 - DESIGN PROFESSIONAL'S STATUS DURING CONSTRUCTION

9.01 Owner's Representative

9.01.A Design Professional will be Owner's representative during the construction period. The duties and responsibilities and the limitations of authority of Design Professional as Owner's representative during construction are set forth in the Contract Documents and will not be changed without written consent of Owner.

9.02 Visits to Site

9.02.A Design Professional will make visits to the Site at intervals appropriate to the various stages of construction as Design Professional deems necessary in order to observe as an experienced and qualified design professional the progress that has been made and the quality of the various aspects of Contractor's executed Work. Based on information obtained during such visits and observations, Design Professional, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Design Professional will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. Design Professional's efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, Design Professional will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.

9.02.B Design Professional's visits and observations are subject to all the limitations on Design Professional's authority and responsibility set forth in Paragraph 9.09. Particularly, but without limitation, during or as a result of Design Professional's visits or observations of Contractor's Work, Design Professional will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

9.03 Project Representative

9.03.A If Owner and Design Professional agree, Design Professional will furnish a Resident Project Representative to assist Design Professional in providing more extensive observation of the Work. If Owner designates another representative or agent to represent Owner at the Site who is not Design Professional's consultant, agent or employee, they will be identified, and the responsibilities and authority and limitations thereon of such other individual or entity will be as provided in the Supplementary Conditions.

9.04 Authorized Variations in Work

9.04.A Design Professional may authorize minor variations in the Work from the requirements of the Contract Documents which do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. These may be accomplished by a Field Order and will be binding on Owner and also on Contractor, who shall perform the Work involved promptly. If Owner or Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, or both, and the parties are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

9.05 Rejecting Defective Work

9.05.A Design Professional will have authority to reject Work which Design Professional believes to be defective, or that Design Professional believes will not produce a completed Project that conforms to the Contract Documents or that will prejudice the integrity of the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Design Professional will also have authority to require special inspection or testing of the Work as provided in Paragraph 13.04, whether or not the Work is fabricated, installed, or completed.

9.06 Shop Drawings, Change Orders and Payments

9.06.A In connection with Design Professional's authority, and limitations thereof, as to Shop Drawings and Samples, see Paragraph 6.17.

9.06.B In connection with Design Professional's authority, and limitations thereof, as to design calculations and design drawings submitted in response to a delegation of professional design services, if any, see Paragraph 6.21.

9.06.C In connection with Design Professional's authority as to Change Orders, see Articles 10, 11, and 12.

9.06.D In connection with Design Professional's authority as to Applications for Payment, see Article 14.

9.07 Determinations for Unit Price Work

9.07.A Design Professional will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Design Professional will review with Contractor the Design Professional's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Design Professional's written decision thereon will be final and binding (except as modified by Design Professional to reflect changed factual conditions or more accurate data) upon Owner and Contractor, subject to the provisions of Paragraph 10.05.

9.08 Decisions on Requirements of Contract Documents and Acceptability of Work

9.08.A Design Professional will be the initial interpreter of the requirements of the Contract Documents and judge of the acceptability of the Work thereunder. Design Professional will issue such written clarifications or interpretations of the requirements of the Contract Documents (in the form of Drawings or otherwise) as Design Professional may determine necessary, which shall be consistent with the intent of and reasonably inferable from Contract Documents. All matters in question and other matters between Owner and Contractor arising prior to the date final payment is due relating to the acceptability of the Work, and the interpretation of the requirements of the Contract Documents pertaining to the performance of the Work, will be referred initially to Design Professional in writing within 30 days of the event giving rise to the question.

9.08.B Design Professional will, with reasonable promptness, render a written decision on the issue referred. If Owner or Contractor believes that any such decision entitles them to an adjustment in the Contract Price or Contract Times or both, a Claim may be made under Paragraph 10.05. The date of Design Professional's decision shall be the date of the event giving rise to the issues referenced for the purposes of Paragraph 10.05.B.

9.08.C Design Professional's written decision on the issue referred will be final and binding on Owner and Contractor, subject to the provisions of Paragraph 10.05.

9.08.D When functioning as interpreter and judge under this Paragraph 9.08, Design Professional will not show partiality to Owner or Contractor and will not be liable in connection with any interpretation or decision rendered in good faith in such capacity.

9.09 Limitations on Design Professional's Authority and Responsibilities

9.09.A Neither Design Professional's authority or responsibility under this Article 9 or under any other provision of the Contract Documents nor any decision made by Design Professional in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Design Professional shall create, impose, or give rise to any duty in contract, tort, or otherwise owed by Design Professional to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.

9.09.B Design Professional will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Design Professional will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

9.09.C Design Professional will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.

9.09.D Design Professional's review of the final Application for Payment and accompanying documentation and all maintenance and operating instructions, schedules, guarantees, Bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Paragraph 14.07.C will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals that the results certified indicate compliance with the Contract Documents.

9.09.E The limitations upon authority and responsibility set forth in this Paragraph 9.09 shall also apply to, the Resident Project Representative, if any, and assistants, if any.

9.10 Compliance with Safety Program

9.10.A While at the Site, Design Professional's employees and representatives shall comply with the specific applicable requirements of Contractor's safety programs of which Design Professional has been informed pursuant to Paragraph 6.13.D

ARTICLE 10 - CHANGES IN THE WORK; CLAIMS

10.01 Authorized Changes in the Work

10.01.A Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, order additions, deletions, or revisions in the Work by a Change Order, a Written Amendment, or a Work Change Directive. Upon receipt of any such document, Contractor shall promptly proceed with the Work involved which will be performed under the applicable conditions of the Contract Documents (except as otherwise specifically provided).

10.01.A.1 Contractor may propose modifications to the Work for the purpose of reducing the total cost of construction. Such a proposal shall be identified as an Alternatives Evaluation Proposal and shall be submitted in accordance with Article 6.7 of these General Conditions, "Substitutes and Or-Equal Items."

10.01.A.2 Owner may in its sole discretion accept or reject an Alternatives Evaluation Proposal. The Contract Price is not to be based on the anticipated approval of an Alternatives Evaluation Proposal.

10.01.A.3 If Owner determines that an Alternatives Evaluation Proposal is to be accepted, Contractor will be credited with 25% of the net savings in Contract Price, less certain costs as further defined in Article 6.7 of these General Conditions.

10.01.B If Owner and Contractor are unable to agree on entitlement to, or on the amount or extent, if any, of an adjustment in the Contract Price or Contract Times, or both, that should be allowed as a result of a Work Change Directive, a Claim may be made therefor as provided in Paragraph 10.05.

10.01.C No proposal or Claim by Contractor based on changes in the Work, differing site conditions, quantity variations or any other matter shall be allowed if made after final payment.

10.02 Unauthorized Changes in the Work

10.02.A Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents as amended, modified, or supplemented as provided in Paragraph 3.04, except in the case of an emergency as provided in Paragraph 6.16 or in the case of uncovering Work as provided in Paragraph 13.04.B.

10.03 Execution of Change Orders

10.03.A Owner and Contractor shall execute appropriate Change Orders recommended by Design Professional covering:

10.03.A.1 changes in the Work which are:

10.03.A.1.a ordered by Owner pursuant to Paragraph 10.01.A,

10.03.A.1.b required because of acceptance of defective Work under Paragraph 13.08.A or Owner's correction of defective Work under Paragraph 13.09, or

10.03.A.1.c agreed to by the parties;

10.03.A.2 changes in the Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive; and

10.03.A.3 changes in the Contract Price or Contract Times which embody the substance of any written decision rendered by Design Professional pursuant to Paragraph 10.05; provided that, in lieu of executing any such Change Order, an appeal may be taken from any such decision in accordance with the provisions of the Contract Documents and applicable Laws and Regulations, but during any such appeal, Contractor shall carry on the Work and adhere to the Progress Schedule as provided in Paragraph 6.18.A.

10.03.B A Change Order duly signed by Owner and Contractor, without Contractor's reservation of the right to Claim additional adjustments in Contract Price or Contract Time, constitutes an all- inclusive settlement for all related changes and for all related direct, indirect, supplemental, consequential and cumulative costs and delays; Contractor's signature also constitutes a release and waiver of any and all rights to file a Claim based on the changes covered by the Change Order.

10.03.C A Change Order duly signed by Owner and Contractor, with Contractor's reservation of the right

to Claim additional adjustments, shall become final and binding on Contractor, without consideration of the reservation, unless Contractor delivers to Owner written notice of Claim within thirty (30) days after Contractor signs that Change Order.

10.04 Notification to Surety

10.04.A If the provisions of any bond require notice to be given to a surety of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times), the giving of any such notice will be Contractor's responsibility. The amount of each applicable bond will be adjusted to reflect the effect of any such change.

10.05 Claims

10.05.A Design Professional's Decision Required: All Claims, except those waived pursuant to Paragraph 14.08, shall be referred to the Design Professional for decision. A decision by Design Professional shall be required as a condition precedent to any exercise by Owner or Contractor of any rights or remedies either may otherwise have under the Contract Documents or by Laws and Regulations in respect of such Claims.

10.05.B Notice: Written notice stating the general nature of each Claim, shall be delivered by the claimant to Design Professional and the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto. The responsibility to substantiate a Claim shall rest with the party making the Claim. Notice of the amount or extent of the Claim, with supporting data shall be delivered to the Design Professional and the other party to the Contract within 60 days after the start of such event (unless Design Professional allows additional time for claimant to submit additional or more accurate data in support of such Claim). A Claim for an adjustment in Contract Price shall be prepared in accordance with the provisions of Paragraph 12.01.B. A Claim for an adjustment in Contract Times shall be prepared in accordance with the provisions of Paragraph 12.02.B. Each Claim shall be accompanied by claimant's written statement that the adjustment claimed is the entire adjustment to which the claimant believes it is entitled as a result of said event. The opposing party shall submit any response to Design Professional and the claimant within 30 days after receipt of the claimant's last submittal (unless Design Professional allows additional time).

10.05.C Design Professional's Action: Design Professional will review each Claim and, within 30 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any, take one of the following actions in writing:

10.05.C.1 deny the Claim in whole or in part;

10.05.C.2 approve the Claim; or

10.05.C.3 notify the parties that the Design Professional is unable to resolve the Claim if, in the Design Professional's sole discretion, it would be inappropriate for the Design Professional to do so. For purposes of further resolution of the Claim, such notice shall be deemed a denial.

10.05.D In the event that Design Professional does not take action on a Claim within said 30 days, the Claim shall be deemed denied.

10.05.E Design Professional's written action under Paragraph 10.05.C or denial pursuant to Paragraphs 10.05.C.3 or 10.05.D will be final and binding upon Owner and Contractor, unless Owner or Contractor invoke the dispute resolution procedure set forth in Article 16 within 30 days of such action or denial.

10.05.F No Claim for an adjustment in Contract Price or Contract Times will be valid if not submitted in accordance with this Paragraph 10.05.

10.06 Owner's Right to Audit

10.06.A Owner reserves the right to decrease adjustments made in any Change Order if, upon audit of Contractor's records, the audit discloses Contractor provided false or inaccurate cost and pricing data in negotiating the Change Order. In enforcing this provision, the parties shall follow the procedures provided in Paragraph 10.07.

10.07 Audit Procedure

10.07.A Unless exempted from this clause by meeting one of the following conditions:

10.07.A.1 the pricing is based on adequate competition;

10.07.A.2 prices are set by law;

10.07.A.3 a commercial item is being acquired;

10.07.A.4 a waiver has been granted;

10.07.B A change in the approved cost for a change order may be required due to inaccuracies in the pricing where the value of the change order, including profit, exceeds $550,000 and the change

increased the contract value by a significant amount. A reduction in the contract amount shall be issued if one of the following conditions applies:

10.07.B.1 the furnished pricing was incomplete, inaccurate or not current,

10.07.B.2 a subcontractor furnished pricing that was incomplete, inaccurate or not current,

10.07.B.3 any party furnished any data that is not accurate.

10.07.B.4 the contractor did not submit a Certificate of Current Cost or Pricing Data.

10.07.C Any resulting reduction due to data from a subcontractor who was not awarded the work will be in the amount only by which the actual cost was less than the prospective subcontractor.

10.07.D If a reduction is required, the contractor may not raise the following as a defense:

10.07.D.1 the contractor or subcontractor was a sole source supplier or otherwise in a superior bargaining position and thus would not have modified the contract even if accurate pricing had been submitted.

10.07.D.2 the Owner should have known the pricing was inaccurate

10.07.D.3 the contract was based on a total cost and no agreement was made regarding the cost of individual items.

10.07.E The reduction may be offset if

10.07.E.1 the contractor certifies that it is entitled to the offset, and

10.07.E.2 the contractor can prove that the price was available before the date of the change but was not submitted by that date

10.07.F An offset will not be allowed if:

10.07.F.1 the contractor knew the data was incorrect.

10.07.F.2 the owner demonstrates that the price would not have increased by the amount to be offset even if data were available.

10.07.G If any reduction is for work already paid to contractor, contractor shall be liable to and shall pay to owner at the time such overpayment is repaid:

10.07.G.1 simple interest on the amount of the repayment computed from the date of the overpayment to the date of repayment at a rate of the current federal short-term rate plus 3%, and

10.07.G.2 A penalty equal to the amount of the overpayment if the contractor knowingly submitted incorrect data.

ARTICLE 11 – COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

11.01 Cost of the Work

11.01.A Costs Included: The term Cost of the Work means the sum of all costs, except those excluded in Paragraph 11.01.B, necessarily incurred and paid by Contractor in the proper performance of the Work. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, the costs to be reimbursed to Contractor will be only those additional or incremental costs required because of the change in the Work or because of the event giving rise to the Claim. Except as otherwise may be agreed to in writing by Owner, such costs shall be in amounts no higher than those prevailing in the locality of the Project, shall not include any of the costs itemized in Paragraph 11.01.B, and shall include only the following items:

11.01.A.1 Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor. Such employees shall include, without limitation, superintendents, foremen, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits, which shall include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, bonuses, sick leave, vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, shall be included in the above to the extent authorized by Owner.

11.01.A.2 Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts shall accrue to Contractor unless Owner deposits funds

with Contractor with which to make payments, in which case the cash discounts shall accrue to Owner. All trade discounts, rebates and refunds and returns from sale of surplus materials and equipment shall accrue to Owner, and Contractor shall make provisions so that they may be obtained.

11.01.A.3 Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive Bids from Subcontractors acceptable to Owner and Contractor and shall deliver such Bids to Owner, who will then determine, with the advice of Design Professional, which Bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee shall be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 11.01.

11.01.A.4 Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed for services specifically related to the Work.

11.01.A.5 Supplemental costs including the following:

11.01.A.5.a The proportion of necessary transportation, travel, and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work.

11.01.A.5.b Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, and hand tools not owned by the workers, which are consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of Contractor.

11.01.A.5.c Rentals of all construction equipment and machinery, and the parts thereof whether rented from Contractor or others in accordance with rental agreements, competitive in the local Phoenix metropolitan area, approved by Owner with the advice of Design Professional, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.

11.01.A.5.d Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, as imposed by Laws and Regulations.

11.01.A.5.e Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.

11.01.A.5.f Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of property insurance established in accordance with Article 5), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses shall be included in the Cost of the Work for the purpose of determining Contractor's fee.

11.01.A.5.g The cost of utilities, fuel, and sanitary facilities at the Site.

11.01.A.5.h Minor expenses such as telegrams, long distance telephone calls, telephone service at the Site, express and courier services, and similar petty cash items in connection with the Work.

11.01.A.5.i The costs of premiums for all bonds and insurance Contractor is required by the Contract Documents to purchase and maintain.

11.01.B Costs Excluded: The term Cost of the Work shall not include any of the following items:

11.01.B.1 Payroll costs and other compensation of Contractor's officers, executives, principals (of partnerships and sole proprietorships), general managers, safety managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expediters, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 11.01.A.1 or specifically covered by Paragraph 11.01.A.4, all of which are to be

considered administrative costs covered by the Contractor's fee.

11.01.B.2 Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.

11.01.B.3 Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.

11.01.B.4 Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.

11.01.B.5 Acceleration costs to overcome suspension of Work or other delays which warrant extensions in Contract Time but exclude increases in Contract Price; escalation costs for any part of the Work not delayed beyond the late dates in the Progress Schedule; or delay costs not expressly allowed in this Article.

11.01.B.6 Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraphs 11.01.A.

11.01.C Contractor's Fee: When all the Work is performed on the basis of cost-plus, Contractor's fee shall be determined as set forth in Paragraph 12.01.C unless otherwise set forth in the Agreement. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, Contractor's fee shall be determined as set forth in Paragraph 12.01.C.

11.02 Allowances

11.02.A It is understood that Contractor has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums and by such persons or entities as may be acceptable to Owner and Design Professional.

11.02.B **Cash Allowances**

11.02.B.1 Contractor agrees that the allowances include all costs to the Contractor of materials, equipment, taxes, unloading, handling on the Site, labor, installation costs, overhead, profit, and other expenses required to furnish and install the Work described by the allowances.

11.02.C **Contingency Allowance**

11.02.C.1 Contractor agrees that a contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.

11.02.D Prior to final payment, an appropriate Change Order will be issued as recommended by Design Professional to reflect actual amounts due Contractor on account of Work covered by allowances, and the Contract Price shall be correspondingly adjusted.

11.03 Unit Price Work

11.03.A Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.

11.03.B The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Determinations of the actual quantities and classifications of Unit Price Work performed by Contractor will be made by Design Professional subject to the provisions of Paragraph 9.07.

11.03.C Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.

11.03.D Owner or Contractor may make a Claim for an adjustment in the Contract Price in accordance with Paragraph 10.05 if:

11.03.D.1 the quantity of any item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement; and

11.03.D.2 there is no corresponding adjustment with respect to any other item of Work; and

11.03.D.3 Contractor believes that Contractor is entitled to an increase in Contract Price as a result of having incurred additional expense or Owner believes that Owner is entitled to a decrease in Contract Price and the parties are unable to

agree as to the amount of any such increase or decrease.

ARTICLE 12 - CHANGE OF CONTRACT PRICE; CHANGE OF CONTRACT TIMES

12.01 Change of Contract Price

12.01.A The Contract Price may only be changed by a Change Order. Any Claim for an adjustment in the Contract Price shall be based on written notice submitted by the party making the Claim to the Design Professional and the other party to the Contract in accordance with the provisions of Paragraph 10.05.

12.01.B The value of any Work covered by a Change Order or of any Claim for an adjustment in the Contract Price will be determined as follows:

12.01.B.1 where the Work involved is covered by unit prices contained in the Contract Documents, by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 11.03); or

12.01.B.2 where the Work is not covered by unit prices contained in the Contract Documents, by a mutually agreed lump sum, itemized and supported by substantiating data, (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 12.01.C.2);

12.01.B.3 where the Work involved is not covered by unit prices contained in the Contract Documents and agreement to a lump sum is not reached under Paragraph 12.01.B.2, on the basis of the Cost of the Work (determined as provided in Paragraph 11.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 12.01.C).

12.01.C Contractor's Fee: The Contractor's fee for overhead and profit shall be determined as follows:

12.01.C.1 a mutually acceptable fixed fee; or

12.01.C.2 if a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:

12.01.C.2.a for costs incurred under Paragraphs 11.01.A.1 and 11.01.A.2, the Contractor's fee shall be 15 percent;

12.01.C.2.b for costs incurred under Paragraph 11.01.A.3, the Contractor's fee shall be five percent;

12.01.C.2.c where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraphs 12.01.C.2.a and 12.01.C.2.b is that the Subcontractor who actually performs the Work, at whatever tier, will be paid a fee of 15 percent of the costs incurred by such Subcontractor under Paragraphs 11.01.A.1 and 11.01.A.2 and that any higher tier Subcontractor and Contractor will each be paid a fee of five percent of the amount paid to the next lower tier Subcontractor;

12.01.C.2.d no fee shall be payable on the basis of costs itemized under Paragraphs 11.01.A.4, 11.01.A.5, and 11.01.B;

12.01.C.2.e the amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in cost will be the amount of the actual net decrease in cost plus a deduction in Contractor's fee by an amount equal to five percent of such net decrease; and

12.01.C.2.f when both additions and credits are involved in any one change, the adjustment in Contractor's fee shall be computed on the basis of the net change in accordance with Paragraphs 12.01.C.2.a through 12.01.C.2.e, inclusive.

12.01.D Contractor will establish and maintain records related to the cost of any change in accordance with generally accepted accounting practices and submit in a form acceptable to Design Professional an itemized cost breakdown together with supporting data.

12.02 Change of Contract Times

12.02.A The Contract Times may only be changed by a Change Order or Written Amendment. Any Claim for an adjustment in the Contract Times shall be based on written notice submitted by the party making the Claim to the Design Professional and the other party to the Contract in accordance with the provisions of Paragraph 10.05.

12.02.B Any adjustment of the Contract Times covered by a Change Order or any Claim for an adjustment in the Contract Times will be determined in accordance with the provisions of this Article 12.

12.03 Delays

12.03.A Notwithstanding anything to the contrary in the Contract Documents, Contractor assumes all risks of delays, disruptions and hindrances, and Contractor shall not make any Claim for adjustment

in Contract Price or for damages (or any other kind of compensation) for any delays, disruptions or hindrances from any cause whatsoever, including acts and omissions of Owner or Design Professional, except as provided in Paragraphs 12.03.A.1 and 12.03.A.2

12.03.A.1 Owner and Contractor shall negotiate for the recovery of damages related to expenses incurred by Contractor for delay if, but only if, (a) Owner is responsible for the delay; and (b) the delay is unreasonable under the circumstances; and (c) the delay was not within the contemplation of Owner and Contractor; and (d) Contractor gives Owner notice and submits a Claim in the manner and within the times specified in Article 10. Contractor shall make every effort to avoid the consequences and mitigate damages from any delay.

12.03.A.2 No delay resulting from the negotiations or resolution of changes in the Work, differing site conditions or variation in quantities shall be unreasonable under the circumstances unless the delay exceeds two days plus the time required by Contractor to deliver a related proposal. Such delays are contemplated by Contractor and Owner.

12.03.B Where Contractor is prevented from completing any part of the Work within the Contract Times due to delay beyond the control of Contractor, the Contract Times will be extended in an amount equal to the time lost due to such delay if a Claim is made therefor as provided in Paragraph 12.02.A. An extension in Contract Time will not be justified unless Contractor, demonstrates delay in completing all or a specified part of the Work arising from unforeseeable causes beyond the control and without the fault or negligence of Contractor, and the delay is unreasonable under the circumstances. Examples of events which may justify an extension of Contract Time, subject to the requirements of the Contract Documents, include: acts of God, the public enemy, or acts or neglect by Owner, acts or neglect of utility owners or other contractors performing other work as contemplated by Article 7; acts of the U.S. Government, the State or another Political Subdivision; fires, floods, epidemics, quarantine restrictions; strikes, freight embargoes abnormal weather, including storms, tornados, etc. (abnormal in the sense of expectation, frequency or severity compared with the prior 5 year average); unusually severe shortages of construction materials, considering all feasible sources of supply; newly discovered Underground Utilities; objection, for Owner's convenience, to a nominated Subcontractor; an emergency; incidents with archaeological features suspension of Work; changes in the Work, differing site conditions or variation in quantities of Unit Price Work. Delays attributable to and within the control of a Subcontractor or Supplier shall be deemed to be delays within the control of Contractor.

12.03.C If Contractor is prevented from completing any part of the Work within the Contract Times (or Milestones) for unforeseeable causes beyond the control of both Owner and Contractor, an extension of the Contract Times (or Milestones) in an amount equal to the time lost due to such delay shall be Contractor's sole and exclusive remedy for the delay. In no event shall Owner be liable to Contractor, any Subcontractor, any Manufacturer, any Supplier, any person, any firm, any corporation, or to any surety for or employee or agent of any of them, for damages arising out of or resulting from (a) delays caused by or within the control of Contractor, or (b) delays beyond the control of both parties as specified in Paragraph 12.03.B.

12.03.D No delay in completing the Work, or any specified part of the Work, for which the Owner is responsible, shall be unreasonable under the circumstances or justify an increase in Contract Time or Contract Price, unless, and then only to the extent that, the delay extends completion of the Work, or specified part of the Work, beyond the corresponding Contract Time. Notwithstanding the first sentence of this Paragraph 12.03.D, if the Progress Schedule depicts Total Float whether expressly disclosed or implied by the use of float suppression techniques, the Total Float is owned jointly by Contractor and Owner.

12.03.E Owner, Design Professional and the Related Entities of each of them shall not be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.

ARTICLE 13 - TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

13.01 Notice of Defects

13.01.A Prompt notice of all defective Work of which Owner or Design Professional has actual

knowledge will be given to Contractor. Defective Work may be rejected, corrected, or accepted as provided in this Article 13.

13.02 Access to Work

13.02.A Owner, Design Professional, their consultants and other representatives and personnel of Owner, independent testing laboratories, and governmental agencies with jurisdictional interests will have access to the Site and the Work at reasonable times for their observation, inspection, and testing. Contractor shall provide them proper and safe conditions for such access and advise them of Contractor's safety procedures and programs so that they may comply therewith as applicable.

13.03 Tests and Inspections

13.03.A Contractor shall give Design Professional timely notice of readiness of the Work for all required inspections, tests, or approvals and shall cooperate with inspection and testing personnel to facilitate required inspections or tests.

13.03.B Owner shall employ and pay for the services of an independent testing laboratory to perform all inspections, tests, or approvals required by the Contract Documents except:

13.03.B.1 for inspections, tests, or approvals covered by Paragraphs 13.03.C and 13.03.D below; or

13.03.B.2 that costs incurred in connection with tests or inspections conducted pursuant to Paragraph 13.04.B shall be paid as provided in Paragraph 13.04.C; and

13.03.B.3 as otherwise specifically provided in the Contract Documents.

13.03.C If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Design Professional the required certificates of inspection or approval.

13.03.D Contractor shall be responsible for arranging and obtaining and shall pay all costs in connection with any inspections, tests, or approvals required for Owner's and Design Professional's acceptance of materials or equipment to be incorporated in the Work; or acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work. Such inspections, tests, or approvals shall be performed by organizations acceptable to Owner and Design Professional.

13.03.E If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Design Professional, Contractor shall, if requested by Design Professional uncover such Work for observation.

13.03.F Uncovering Work as provided in Paragraph 13.03.E shall be at Contractor's expense unless Contractor has given Design Professional timely notice of Contractor's intention to cover the same and Design Professional has not acted with reasonable promptness in response to such notice.

13.04 Uncovering Work

13.04.A If any Work is covered contrary to the written request of Design Professional, it must, if requested by Design Professional, be uncovered for Design Professional's observation and replaced at Contractor's expense.

13.04.B If Design Professional considers it necessary or advisable that covered Work be observed by Design Professional or inspected or tested by others, Contractor, at Design Professional's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Design Professional may require, that portion of the Work in question, furnishing all necessary labor, material, and equipment.

13.04.C If it is found that the uncovered Work is defective, Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or other dispute resolution costs) arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05.

13.04.D If, the uncovered Work is not found to be defective, Contractor shall be allowed an increase

in the Contract Price or an extension of the Contract Times, or both, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

13.05 Owner May Stop Work

13.05.A If Work is defective, or Contractor fails to provide sufficient, skilled workers or suitable materials or equipment, or otherwise fails to perform Work in compliance with the Contract Documents, Owner may order Contractor to stop all or part of the Work until any problem is corrected. Contractor shall (a) remain responsible for recovering schedule, (b) not be entitled to any increase in Contract Time or Contract Price, and reimburse Owner for all direct, indirect or consequential costs incurred by Owner resulting from any such stop Work order. Owner's authority to stop all or part of the Work shall not create or impose any duty or responsibility on Owner to exercise any such authority for the benefit of Contractor or any other person.

13.06 Correction or Removal of Defective Work

13.06.A Promptly after receipt of written notice, Contractor shall correct all defective Work, whether or not fabricated, installed, or completed, or, if the Work has been rejected by Design Professional, remove it from the Project and replace it with Work that is not defective. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or other dispute resolution costs) arising out of or relating to such correction or removal (including but not limited to all costs of repair or replacement of work of others).

13.06.B When correcting defective Work under the terms of this Paragraph 13.06 or Paragraph 13.07, Contractor shall take no action that would void or otherwise impair Owner’s special warranty and guarantee, if any, on said Work.

13.07 Correction Period

13.07.A If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the terms of any applicable special guarantee required by the Contract Documents) or by any specific provision of the Contract Documents, any Work is found to be defective, or if the repair of any damages to the land or areas made available for Contractor’s use by Owner or permitted by Laws and Regulations as contemplated in Paragraph 6.11.A is found to be defective, Contractor shall promptly, without cost to Owner and in accordance with Owner’s written instructions:

13.07.A.1 repair such defective land or areas; or

13.07.A.2 correct such defective Work; or

13.07.A.3 if the defective Work has been rejected by Owner, remove it from the Project and replace it with Work that is not defective, and

13.07.A.4 satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others or other land or areas resulting therefrom.

13.07.B If Contractor does not promptly comply with the terms of Owner’s written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or other dispute resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others) will be paid by Contractor.

13.07.C In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so, provided in the Specifications or by Written Amendment.

13.07.D Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this Paragraph 13.07, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

13.07.E The specified warranties and guarantees and Contractor's obligations for correction of Work specified in this Article are in addition to, and not in limitation of, any other specific remedies provided in the Contract Documents or by Law. Nothing contained in this Paragraph, or this Article shall be construed as establishing a period of limitations for,

or limiting the obligations of, Contractor under the Contract Documents.

13.08 Acceptance of Defective Work

13.08.A If, instead of requiring correction or removal and replacement of defective Work, Owner (and, prior to Design Professional's recommendation of final payment, Design Professional) prefers to accept it, Owner may do so. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or other dispute resolution costs) attributable to Owner's evaluation of and determination to accept such defective Work (such costs to be approved by Design Professional as to reasonableness) and for diminished value of the Work to the extent not otherwise paid by Contractor pursuant to this sentence. If any such acceptance occurs prior to Design Professional's recommendation of final payment, a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work, and Owner shall be entitled to an appropriate decrease in the Contract Price, reflecting the diminished value of Work so accepted. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05. If the acceptance occurs after such recommendation, an appropriate amount will be paid by Contractor to Owner.

13.09 Owner May Correct Defective Work

13.09.A If Contractor fails within a reasonable time after written notice from Design Professional to correct defective Work or to remove and replace rejected Work as required by Design Professional in accordance with Paragraph 13.06.A, or if Contractor fails to perform the Work in accordance with the Contract Documents, or if Contractor fails to comply with any other provision of the Contract Documents, Owner may, after seven days written notice to Contractor, correct or remedy any such deficiency.

13.09.B In exercising the rights and remedies under this Paragraph 13.09, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, take possession of Contractor's tools, appliances, construction equipment and machinery at the Site, and incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's representatives, agents and employees, Owner's other contractors, and Design Professional and Design Professional's consultants access to the Site to enable Owner to exercise the rights and remedies under this Paragraph.

13.09.C All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or other dispute resolution costs) incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 13.09 will be charged against Contractor, and a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount of the adjustment, Owner may make a Claim therefor as provided in Paragraph 10.05. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's defective Work.

13.09.D Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner's rights and remedies under this Paragraph 13.09.

ARTICLE 14 - PAYMENTS TO CONTRACTOR AND COMPLETION

14.01 Schedule of Values

14.01.A The Schedule of Values established as provided in the General Requirements will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Design Professional. Progress payments on account of Unit Price Work will be based on the number of units completed.

14.01.B Whenever the Bid Schedule on the Bid Form lists an item of Work entitled "Mobilization Pay Item", such mobilization pay item shall be intended to cover, in part at least:

14.01.B.1 reasonable costs of establishing those temporary offices specified in the Technical Specifications;

14.01.B.2 reasonable cost of transporting to the site and the unloading and assembly of

construction equipment that arrives on site promptly after the Date of Commencement of the Contract Time;

14.01.B.3 fees for permits required to commence the Work;

14.01.B.4 premiums for Performance Bond, Payment Bond and any other performance Bonds required by the Contract Documents;

14.01.B.5 premiums for policies of insurance purchased by the Contractor to comply with the requirements of the Contract Documents;

14.01.B.6 and reasonable costs of demobilization including vacating and clearing the site.

14.01.C Except when seeking progress payment under the mobilization pay item for payroll or other similar costs, the basis of measurement for payment shall be proof of actual payment. Payment shall be based on the requirements of the Contract Documents governing progress payments, subject to the following:

14.01.C.1 Up to forty percent (40%) of the payment earned under this item may be requested for payment with the Application for Payment following receipt by the Owner of a sufficiently responsive initial Progress Schedule (meaning sufficiently responsive based on the requirements of the Contract Documents and the Technical Specifications).

14.01.C.2 Up to eighty percent (80%) of the payment earned under this item may be requested for payment with the Application for Payment following return to the Contractor of the revision of the initial Progress Schedule Submittal marked “Resubmittal Not Required”.

14.01.C.3 The balance of the payment earned under the “Mobilization Pay Item” may be requested for payment with the final Application for Payment. Such payment is intended to cover demobilization costs.

14.02 Progress Payments

14.02.A Applications for Payments

14.02.A.1 At least 21 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Design Professional for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents.

14.02.A.2 with each Application for Payment, Contractor shall submit written consent of the Surety for payment of the amount requested in the Application for Payment.

14.02.A.3 Beginning with the second Application for Payment, each Application shall include an affidavit of Contractor stating that all previous progress payments received on account of the Work have been applied on account to discharge Contractor’s legitimate obligations associated with prior Applications for Payment.

14.02.A.4 SBE Goal Compliance

14.02.A.4.a In addition, with each Application for Payment, Contractor shall submit (in a format acceptable to the Owner) the required information demonstrating its compliance with the SBE goals for this Agreement.

14.02.A.5 Stored Materials and Equipment

14.02.A.5.a If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that Owner has received the materials and equipment free and clear of all Liens and evidence that the materials and equipment are covered by appropriate property insurance or other arrangements to protect Owner’s interest therein, all of which must be satisfactory to Owner.

14.02.A.6 Retainage

14.02.A.6.a The amount of retainage with respect to progress payments will be as stipulated below:

14.02.A.6.b Until the aggregate value of the duly certified and approved Applications for Payment equals fifty percent (50%) of the Contract Price (i.e. 50% completion), Owner will make payments in an amount equal to 90% of Work completed (i.e. Owner will retain 10% of each estimate as additional guarantee for complete performance of the Work), less the aggregate of payments previously made and less such deductions as Design Professional or Owner determines are appropriate to cover claims requiring a greater sum to be retained (as provided in Paragraph 14.02.C and elsewhere in the Contract Documents);

14.02.A.6.c Upon fifty percent (50%) completion, one-half of the amounts retained under the 10% retainage provision shall be paid to Contractor, provided Contractor is making satisfactory progress on the Work and there is no specific cause or claim requiring a greater amount to be retained. After fifty percent (50%) completion, Owner will retain five percent (5%) providing Contractor is making satisfactory progress, coupled with such deductions as Design Professional or Owner determines are appropriate to cover claims requiring a greater sum to be retained.

14.02.A.6.d Prior to reduction in or partial release of retainage, Contractor shall submit AIA Document G707A (Consent of Surety to Reduction in or Partial Release of Retainage) certifying the Surety agrees that such reduction in or partial release of retainage shall not relieve the Surety of any of its obligations under the Performance and Payment Bonds.

14.02.A.6.e If at any time Owner, with the advice of Design Professional, determines satisfactory progress is not being made, ten percent (10%) retainage shall be reinstated for all subsequent payments, in accordance with ARS, Title 34 Chapter 2.

14.02.A.6.f Except as qualified in Paragraph 14.04.A.6.C, upon final completion and acceptance of the Work on which separate final completion and acceptance and Contract Price are specified and upon compliance with all other terms and conditions of the Contract Documents, payment may be made in full, including retainage withheld, less such deductions as Design Professional may recommend or Owner may withhold to cover claims requiring a greater sum to be retained and liquidated damages.

14.02.A.6.g In lieu of retention, the Contractor may provide as a substitute, an assignment of money market accounts, demand deposit accounts, or time certificates of deposit (CDs) from a bank licensed by Arizona, securities guaranteed by the United States, securities of the United States, the State of Arizona, Arizona counties, Arizona municipalities, Arizona school districts, or shares of savings and loan institutions authorized to transact business in Arizona. These securities are referred to as “Qualified Securities.”

14.02.A.6.h Qualified Securities deposited in lieu of retention must be deposited into a separate account with a bank having a branch located in the City of Phoenix and be assigned exclusively for the benefit of the City of Phoenix pursuant to the City’s form of escrow and/or deposit agreement.

14.02.A.6.i Escrow Agreement and Deposit Agreement forms may be obtained from the Contracts Specialist assigned to the project.

14.02.B **Review of Applications**

14.02.B.1 Design Professional will, within seven (7) days after receipt of each Application for Payment, either certify, approve and present the Application to Owner, or return the Application to Contractor indicating in writing Design Professional's reasons for refusing to recommend payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application. Fourteen (14) days after presentation of the Application for Payment to Owner, the amount recommended will, subject to the provisions of Paragraph 14.02.B.6 of the General Conditions, become due and when due will be paid by Owner to Contractor.

14.02.B.2 All payments will be available to the Contractor at the Finance Department, Accounts Division, Customer Service-Accounts Payable Section, on the fourteenth (14th) day, unless Contractor arranges with the Finance Department to mail payments. Mailed payments shall be deemed paid on the date deposited in the mail as established by the U.S. Postal Service postmark. If payment is not made when due, simple interest, as provided in ARS Title 34 Chapter 2 as amended, shall be paid by Owner to Contractor (excluding any Fee to Contractor)

14.02.B.3 Design Professional’s recommendation of any payment requested in an Application for Payment will constitute a representation by Design Professional to Owner, based on Design Professional’s observations on the Site of the executed Work as an experienced and qualified design professional and on Design Professional's review of the Application for Payment and the accompanying data and schedules, that to the best of Design Professional’s knowledge, information and belief:

14.02.B.3.a the Work has progressed to the point indicated;

14.02.B.3.b the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, to the results of any subsequent tests called for in the Contract Documents, to a final determination of

quantities and classifications for Unit Price Work under Paragraph 9.07, and to any other qualifications stated in the recommendation); and

14.02.B.3.c the conditions precedent to Contractor's being entitled to such payment appear to have been fulfilled in so far as it is Design Professional's responsibility to observe the Work.

14.02.B.3.d the Record Drawings have been redlined by the Contractor to the same limit as the finished Work claimed on the Application for Payment.

14.02.B.4 By recommending any such payment Design Professional will not thereby be deemed to have represented that:

14.02.B.4.a inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to Design Professional in the Contract Documents; or

14.02.B.4.b that there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.

14.02.B.5 Neither Design Professional's review of Contractor's Work for the purposes of recommending payments nor Design Professional's recommendation of any payment, including final payment, will impose responsibility on Design Professional:

14.02.B.5.a to make any examination to ascertain how or for what purposes Contractor has used the moneys paid on account of the Contract Price, or

14.02.B.5.b to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.

14.02.B.6 Design Professional may refuse to recommend the whole or any part of any payment if, in Design Professional's opinion, it would be incorrect to make the representations to Owner stated in Paragraph 14.02.B.1. Design Professional may also refuse to recommend any such payment or, because of subsequently discovered evidence or the results of subsequent inspections or tests, revise or revoke any such payment recommendation previously made, to such extent as may be necessary in Design Professional's opinion to protect Owner from loss because:

14.02.B.6.a the Work is defective, or completed Work has been damaged, requiring correction or replacement;

14.02.B.6.b the Contract Price has been reduced by Written Amendment or Change Order.

14.02.B.6.c Owner has been required to correct defective Work or complete Work in accordance with Paragraph 13.09; or

14.02.B.6.d Design Professional has actual knowledge of the occurrence of any of the events enumerated in Paragraph 15.02.A.

14.02.B.6.e the Record Drawings have not been redlined by the Contractor to the same limit as the finished Work claimed on the Application for Payment.

14.02.C **Reduction in Payment**

14.02.C.1 Owner may refuse to make payment of the full amount recommended by Design Professional because:

14.02.C.1.a claims have been made against Owner on account of Contractor's performance or furnishing of the Work;

14.02.C.1.b Liens have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens;

14.02.C.1.c there are other items entitling Owner to a set off against the amount recommended; or

14.02.C.1.d Owner has actual knowledge of the occurrence of any of the events enumerated in Paragraphs 14.02.B.6.a through 14.02.B.6.c or Paragraph 15.02.A.

14.02.C.1.e Either the Contractor has failed to submit the SBE Utilization Report with any Application for Payment or has failed to meet the SBE utilization goals as established in the Agreement (Section 00500, Article 11).

14.02.C.1.f Owner may deduct from each progress payment and final payment an amount equal to Owner's estimate of the liquidated damages then due or that would become due based on Owner's estimate of late completion of the Work, provided Contractor fails to submit and implement a recovery schedule as detailed in the General Requirements.

14.02.C.2 If Owner refuses to make payment of the full amount recommended by Design Professional, Owner will give Contractor immediate written notice (with a copy to Design Professional)

stating the reasons for such action and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, when Contractor corrects to Owner's satisfaction the reasons for such action.

14.02.C.3 If it is subsequently determined that Owner's refusal of payment was not justified, the amount wrongfully withheld shall be treated as an amount due as determined by Paragraph 14.02.C.1.

14.03 Contractor's Warranty of Title

14.03.A Contractor warrants and guarantees that title to all Work, materials, and equipment covered by any Application for Payment, whether incorporated in the Project or not, will pass to Owner no later than the time of payment free and clear of all Liens.

14.04 Substantial Completion

14.04.A When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Design Professional in writing that the entire Work is substantially complete, in accordance with the General Requirements, (except for items specifically listed by Contractor as incomplete) and request that Design Professional issue a certificate of Substantial Completion.

14.04.B Within a reasonable time thereafter, Owner, Contractor and Design Professional shall make an inspection of the Work to determine the status of completion. If Design Professional does not consider the Work substantially complete, Design Professional will notify Contractor in writing giving the reasons therefor.

14.04.C If Design Professional considers the Work substantially complete, including all applicable ADA requirements, Design Professional will deliver to Owner a tentative certificate of Substantial Completion which shall fix the date of Substantial Completion. There shall be, attached to the certificate, a tentative list of items (typically referred to as a "punch list") to be completed or corrected before final payment. The punch list will be prepared and issued by the Design Professional. Owner shall have seven days after receipt of the tentative certificate during which to make written objection to Design Professional as to any provisions of the certificate or attached punch list. If, after considering such objections, Design Professional concludes that the Work is not substantially complete, Design Professional will within 14 days after submission of the tentative certificate to Owner notify Contractor in writing, stating the reasons therefor. If, after consideration of Owner's objections, Design Professional considers the Work substantially complete, Design Professional will within said 14 days execute and deliver to Owner and Contractor a definitive certificate of Substantial Completion (with a revised tentative list of items to be completed or corrected) reflecting such changes from the tentative certificate as Design Professional believes justified after consideration of any objections from Owner. The Contractor shall have seven days after receipt of the tentative certificate to prepare and submit to the Design Professional a punch list schedule showing orderly completion of punch list items occurring prior to final acceptance date.

14.04.D At the time of delivery of the tentative certificate of Substantial Completion, Design Professional will deliver to Owner and Contractor a written recommendation as to division of responsibilities pending final payment between Owner and Contractor with respect to security, operation, safety, and protection of the Work, maintenance, heat, utilities, insurance, and warranties and guarantees. Unless Owner and Contractor agree otherwise in writing and so inform Design Professional in writing prior to Design Professional's issuing the definitive certificate of Substantial Completion, Design Professional's aforesaid recommendation will be binding on Owner and Contractor until final payment.

14.04.E Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to complete or correct items on the tentative list.

14.04.F The Owner and Design Professional have thirty (30) days from the date of substantial completion to add incorrect or incomplete items to the punch list. The Contractor is required to complete all of these items prior to final acceptance. After the expiration of the thirty (30) day period, the Owner may continue to add items to the punch list, but the Contractor must only endeavor to complete them by the final acceptance date. Any such items added after the 30-day period that is not completed prior to final acceptance must be completed during the warranty period.

14.05 Partial Utilization

14.05.A Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Design Professional, and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by Owner for its intended purpose without significant interference with Contractor's performance of the remainder of the Work, subject to the following conditions.

14.05.A.1 Owner at any time may request Contractor in writing to permit Owner to use or occupy any such part of the Work which Owner believes to be ready for its intended use and substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor will certify to Owner and Design Professional that such part of the Work is substantially complete and request Design Professional to issue a certificate of Substantial Completion for that part of the Work.

14.05.A.2 Contractor at any time may notify Owner and Design Professional in writing that Contractor considers any such part of the Work ready for its intended use and substantially complete and request Design Professional to issue a certificate of Substantial Completion for that part of the Work.

14.05.A.3 Within a reasonable time after either such request, Owner, Contractor, and Design Professional shall make an inspection of that part of the Work to determine its status of completion. If Design Professional does not consider that part of the Work to be substantially complete, Design Professional will notify Owner and Contractor in writing giving the reasons therefor. If Design Professional considers that part of the Work to be substantially complete, the provisions of Paragraph 14.04 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.

14.05.A.4 No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Article 5 regarding property insurance.

14.06 Final Inspection

14.06.A Upon written notice from Contractor that the entire Work or an agreed portion thereof is complete, Design Professional will promptly make a final inspection with Owner and Contractor and will notify Contractor in writing of all particulars in which this inspection reveals that the Work is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

14.07 Final Payment

14.07.A Upon written notice from Contractor that Contractor considers the entire Work, or a specified part of the Work for which final acceptance is specified in the Contract Documents, complete and ready for final payment, Design Professional will make a corresponding final inspection with Owner and Contractor and will notify Contractor in writing of all instances of incomplete or defective Work revealed by the final inspection. Contractor shall immediately undertake all necessary measures to correct the deficiencies.

14.07.B Contractor may apply for final payment and acceptance.

14.07.B.1 after completing correction of the deficiencies to satisfaction of Design Professional and delivering all maintenance and operation instructions, warranties and guarantees, certificates of inspection, revised record documents (reflecting revisions made after Substantial Completion), required Bonds and all other required documents, and

14.07.B.2 after Design Professional has consented to review the Work for final acceptance.

14.07.C The final Application for Payment and acceptance shall enclose.

14.07.C.1 evidence of insurance (including, but not limited to completed operations insurance) and an affidavit certifying that the insurance coverage will not be canceled, adversely changed or renewal refused except as provided under Article 5,

14.07.C.2 AIA Document G707 (Consent of Surety to Final Payment) certifying the Surety agrees that final payment shall not relieve the Surety of any of its obligations under the Performance and Payments Bonds,

14.07.C.3 a "Contractor's Affidavit Regarding Settlement of Claims" (available from Owner) and complete and legally effective releases or waivers acceptable to Owner in the full amount of the Contract Price, or if any Subcontractor or Supplier refuses or fails to furnish such release or waiver, a Bond or other security acceptable to Owner to indemnify Owner against any payment claim, and

14.07.C.4 a list of all pending property damage and personal injury or death insurance claims arising out of or resulting from the Work, identifying the claimant and the nature of the claim.

14.07.D If based on Design Professional's observation of the Work, final inspection, and review of the final Application for Payment and acceptance,

14.07.D.1 Design Professional is satisfied that the Work, or a part of the Work for which separate final acceptance is specified in the Contract Documents, has been completed and Contractor's other obligations under the Contract Documents have been fulfilled, Design Professional will, within thirty (30) days after receipt of the final Application, furnish to Owner and Contractor the Design Professional's recommendation of final payment and acceptance.

14.07.D.2 If Design Professional is not satisfied, Design Professional will return that final Application for Payment to Contractor, indicating in writing the reasons for not recommending final payment and acceptance, in which case Contractor shall make the necessary corrections and resubmit the Application.

14.07.E Owner's Acceptance of Application:

14.07.E.1 If Owner concurs with Design Professional's recommendation of final payment and acceptance, Owner will, within fifteen (15) days, file a written notice of completion and acceptance of the Work, or separable part of the Work for which final acceptance is specified, and notify Contractor and Design Professional of Owner's acceptance. Within sixty (60) days of receipt of Design Professional's recommendation of final payment, Owner shall pay to Contractor the balance of the Contract Price, subject to any withholdings and those other provisions governing final payment specified in the Agreement.

14.07.E.2 If Owner does not concur with Design Professional's determination, Owner will return the Application to Contractor, through Design Professional, indicating in writing the reasons for refusing final payment and acceptance. Contractor shall promptly make the necessary corrections and resubmit the Application to Design Professional. Owner's written determination shall bind Contractor, unless Contractor delivers to Owner, through Design Professional, written notice of a Claim as provided in Paragraph 10.05, after receipt of that determination.

14.07.E.3 If recommended by Design Professional, Owner may, upon receipt of Contractor's final Application for Payment and without terminating the Agreement, make payment of the balance due for that portion of the Work fully completed and accepted, if final completion of the Work is significantly delayed through no fault of Contractor. If the balance to be held by Owner for Work not fully completed or corrected is less than the retainage on that Work, the affidavits specified in Paragraph 14.07.C and the release or waiver, or Bonds, shall be furnished as required and submitted by Contractor. Payment of the balance due shall be made under the provisions for final payment but shall not constitute a waiver of Claims.

14.07.F Owner shall pay with reasonable promptness any amounts deducted from the final payment, upon resolution of the Claims for which the amounts were withheld.

14.08 Waiver of Claims

14.08.A Final payment does not constitute a waiver by Owner of any rights relating to Contractor's continuing obligations under the Contract Documents, nor does it constitute a waiver of any Claims by Owner against Contractor arising from unaudited payments, defective Work appearing after final inspection or failure by Contractor to comply with the Contract Documents or the terms of any special warranties or guarantees provided by the Contract Documents or by Laws or Regulations.

14.08.B Final payment constitutes a waiver of all Claims by Contractor against Owner other than those Claims previously filed in writing with Owner on a timely basis and still unsettled.

ARTICLE 15 - SUSPENSION OF WORK AND TERMINATION

15.01 Owner May Suspend Work

15.01.A At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by notice in writing to Contractor and Design Professional which will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed.

15.01.B Contractor shall be allowed an adjustment in the Contract Price or an extension of the Contract Times, or both, directly attributable to any such suspension if Contractor makes an approved Claim therefor as provided in Paragraph 10.05, except that Contractor shall not be entitled to recover profit

for suspensions of Work. No adjustment in Contract Price will be made for delays in Work which would have been deferred, stopped, slowed, suspended, interrupted or extended due to any other cause.

15.02 Owner May Terminate for Cause

15.02.A The occurrence of any one or more of the following events will justify termination for cause:

15.02.A.1 Contractor's persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the Progress Schedule);

15.02.A.2 Contractor's disregard of Laws or Regulations of any public body having jurisdiction;

15.02.A.3 Contractor's disregard of the authority of Design Professional;

15.02.A.4 Contractor's violation in any substantial way of any provisions of the Contract Documents;

15.02.A.5 if the Contractor fails to meet the SBE utilization goals as set forth in the Agreement (Section 00500, Article 11).

15.02.B Unless superceded by the termination procedures of the performance bond obtained in accordance with Article 5, if one or more of the events identified in Paragraph 15.02.A occur, Owner may, after giving Contractor (and surety) seven days written notice of its intent to terminate the services of Contractor:

15.02.B.1 exclude Contractor from the Site, and take possession of the Work,

15.02.B.2 incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere, and

15.02.B.3 complete the Work as Owner may deem expedient.

15.02.C If Owner proceeds as provided in Paragraph 15.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or other dispute resolution costs) sustained by Owner arising out of or relating to completing the Work, such excess will be paid to Contractor. If such claims, costs, losses, and damages exceed such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Design Professional as to their reasonableness and, when so approved by Design Professional, incorporated in a Change Order. When exercising any rights or remedies under this Paragraph Owner shall not be required to obtain the lowest price for the Work performed.

15.02.D Notwithstanding Paragraphs 15.02.B and 15.02.C, Contractor's services will not be terminated if Contractor begins within seven days of receipt of notice of intent to terminate to correct its failure to perform and proceeds diligently to cure such failure within no more than 30 days of receipt of said notice.

15.02.E Where Contractor's services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue. Any retention or payment of moneys due Contractor by Owner will not release Contractor from liability.

15.03 Owner May Terminate For Convenience

15.03.A Upon seven days written notice to Contractor and Design Professional, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):

15.03.A.1 completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;

15.03.A.2 expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses;

15.03.A.3 all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or other dispute resolution costs) incurred in settlement of terminated contracts with Subcontractors, Suppliers, and others; and

15.03.A.4 reasonable expenses directly attributable to termination.

15.03.A.5 If it is determined, after notice of termination of the services of Contractor for any of the causes listed in Paragraph 15.02 of the General Conditions that Contractor was not in default, the termination shall be deemed to have been for the convenience of Owner. In such event Contractor may recover payment in accordance with Paragraph 15.03 of the General Conditions.

15.03.B Contractor shall not be paid on account of loss of anticipated profits or revenue or other economic loss arising out of or resulting from such termination.

15.04 Contractor May Stop Work or Terminate

15.04.A If, through no act or fault of Contractor, (i) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (ii) Design Professional fails to act on any Application for Payment within 30 days after it is submitted, or (iii) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon seven days written notice to Owner and Design Professional, and provided Owner or Design Professional do not remedy such suspension or failure within that time, terminate the Contract and recover from Owner payment on the same terms as provided in Paragraph 15.03.

15.04.B In lieu of terminating the Contract and without prejudice to any other right or remedy, if Design Professional has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, seven days after written notice to Owner and Design Professional, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The provisions of this Paragraph 15.04 are not intended to preclude Contractor from making a Claim under Paragraph 10.05 for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor's stopping the Work as permitted by this Paragraph.

ARTICLE 16 - DISPUTE RESOLUTION

16.01 Methods and Procedures

16.01.A Either Owner or Contractor may request mediation of any Claim submitted to Design Professional for a decision under Paragraph 10.05 before such decision becomes final and binding. The mediation will be governed by the Construction Industry Mediation Rules of the American Arbitration Association in effect as of the Effective Date of the Agreement. The request for mediation shall be submitted in writing to the American Arbitration Association and the other party to the Contract. Timely submission of the request shall stay the effect of Paragraph 10.05.E.

16.01.B Owner and Contractor shall participate in the mediation process in good faith. The process shall be concluded within 60 days of filing of the request. The date of termination of the mediation shall be determined by application of the mediation rules referenced above.

16.01.C If the Claim is not resolved by mediation, Design Professional's action under Paragraph 10.05.C or a denial pursuant to Paragraphs 10.05.C.3 or 10.05.D shall become final and binding 30 days after termination of the mediation unless, within that time period, Owner or Contractor:

16.01.C.1 elects in writing to invoke any dispute resolution process provided for in the Supplementary Conditions, or

16.01.C.2 agrees with the other party to submit the Claim to another dispute resolution process, or

16.01.C.3 gives written notice to the other party of the intent to submit the Claim to a court of competent jurisdiction.

16.02 Certification of Contractor Claims

16.02.A For all Contractor claims alleging an increase in Contract Price or Contract Time, Contractor shall submit an affidavit executed by an officer or partner in charge at Contractor's plant or location involved, or by a responsible senior officer or general or managing partner of Contractor, certifying that the claim is made in good faith; the amount claimed accurately reflects the adjustments in Contract Price or Contract Time for which Contractor believes Owner is liable; the claim covers all costs and delays to which Contractor is entitled from the Occurrence of the claimed event; and that supporting cost and pricing data are current, accurate, complete and represent Contractor's best knowledge and belief.

16.03 Venue: Service of Process

16.03.A Contractor consents and submits to jurisdiction and venue of, and will not commence any proceeding elsewhere than, the Superior Court of Arizona in and for Maricopa County only, regardless of residence or domicile, for any action

at law or suit in equity arising out of or relating to the bidding, award, performance or completion of the Work; payment for Work performed; termination; or any other claim based on the Contract Documents. Contractor consents and submits to service of process at the address specified in the Agreement.

16.03.B Paragraph 16.03.A shall apply to all Sub agreements and all agreements between Contractor and Contractor's sureties and insurers, altering that Paragraph only to identify properly the contracting parties.

ARTICLE 17 - MISCELLANEOUS

17.01 Giving Notice

17.01.A Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if:

17.01.A.1 delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended, or

17.01.A.2 delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice.

17.02 Computation of Times

17.02.A When any period of time is referred to in the Contract Documents by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

17.03 Cumulative Remedies

17.03.A The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract Documents. The provisions of this Paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply.

17.04 Survival of Obligations

17.04.A All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract Documents, as well as all continuing obligations indicated in the Contract Documents, will survive final payment, completion, and acceptance of the Work or termination or completion of the Contract or termination of the services of Contractor.

17.05 Controlling Law

17.05.A This Contract is to be governed by the law of the State of Arizona.

17.06 Headings

17.06.A Article and paragraph headings are inserted for convenience only and do not constitute parts of these General Conditions.

17.07 Professional Fees and Court Costs Included:

17.07.A Whenever reference is made to "claims, costs, losses and damages," it shall include in each case, but not be limited to, all fees and charges of engineers, architects, attorneys and other professionals and all court or other dispute resolution costs.

17.08 Project Staffing

17.08A **Key Personnel:** Before starting work, Contractor must submit detailed résumés of key personnel involved in that work for City's approval (which City will not unreasonably withhold). If Contractor later desires to change key personnel involved in that work, Contractor must submit detailed résumés of the new personnel for City's approval (which City will not unreasonably withhold).

17.08B **Qualified Staff:** Contractor must maintain an adequate and competent staff of qualified persons—as City may determine in its sole discretion—during performance of this Master Agreement. If City in its sole discretion determines that any of Contractor's staff is objectionable, Contractor must take prompt corrective action or replace that staff with new personnel, subject to City's approval.

17.08C **Third-Party Employment Brokers:** Contractor and Subcontractors will not utilize a third-party labor broker for any construction worker under this Agreement. The Contractor and Subcontractors must be the employers of record for its construction staff under this Agreement.

---END OF SECTION 00700---

SECTION 00800 - SUPPLEMENTARY CONDITIONS

Add the following new paragraph to the General Conditions:

SC-1.01.A.19.a. The Design Professional's Consultant is identified as:

Wilson Engineers, LLC

Add the following new paragraphs to the General Conditions identifying the additional insured:

SC-2.01.B.1. Additional insured to be named in the insurance policies to be provided by the Contractor are identified:

SC-2.01.B.1.a. City of Phoenix
SC-2.01.B.1.b Wilson Engineers, LLC

Add the following new paragraphs to the General Conditions regarding electronic data:

SC-3.08.A.1. The following electronic data may be relied upon in lieu of hard copies:

SC3.08.A.1.a. None

The following new Paragraphs supplement Paragraph 4.02.A.1 in the General Conditions which identify the "reports of subsurface conditions" that the Owner has knowledge of pursuant to Paragraph 4.02.A.1.:

SC-4.02.A.1.a. Geotechnical Evaluation, West Anthem Water and Wastewater Infrastructure, Ninyo & Moore. Dated October 13th, 2017, Project No. 604929001

Report on Geotechnical Investigation, West Anthem Wastewater Improvements, Index no. WS90500278, WS9040067, WS90501005, Dated May 17th, 2017

West Anthem Wastewater Improvements Pioneer Road to Carefree Highway, Seismic Refraction Surveys, Dated October 16, 2017

The following new paragraphs supplement Paragraph 4.02.A.2 in the General Conditions which identify the "drawings of physical conditions" that the Owner has knowledge of pursuant to Paragraph 4.02.A.2.:

SC-4.02.A.2.a. West Anthem Lift Station No. 76, Project No. WS90400067, Volume 4 of 5, Stanley Consultants, Dated December 4th, 2018

The following new paragraphs supplement Paragraph 4.02.B. in the General Conditions, which identify the "technical data" that the Contractor may relay on pursuant to Paragraph 4.02.B:

SC-4.02.B.1.a. None

Add the following new Paragraphs following Paragraph 4.05.A.2.d in the General Conditions, which concerns information on Underground Facilities and as so amended Paragraphs 4.05.A thru 4.05.A.2.d, remain in effect.

SC-4.05.A.3. West Anthem Lift Station No. 76, Project No. WS90400067, Volume 4 of 5, Stanley Consultants, Dated December 4th, 2018

The following new paragraphs supplement Paragraph 4.08. in the General Conditions, which identify the "Hazardous Environmental Condition" that the Contractor may rely on pursuant to Paragraph 4.08.

SC-4.08.A.1. Lift Station 76 Project, Limited Lead and Asbestos Survey, Dated November 17th, 2023 By RFI

Add the following new paragraph following Paragraph 5.05.A.4. of the General Conditions:

SC-5.05.A.5 Contractor shall furnish only those specialty insurance coverages, which are checked below, with limits of liability no less than the amounts stated below:

Contractors Pollution Liability $ 1,000,000

Asbestos Abatement Liability $ 1,000,000

Lead Abatement Liability $ 1,000,000

Amend the last sentence of Paragraph 5.05.C.1 of the General Conditions to read as follows:

“Such notice shall be sent directly to the Water Services Department’s Project Manager at the address indicated below via certified mail, return receipt requested:

Marcel Begay
200 W. Washington St, 8th Floor
Phoenix, AZ 85003

Amend the last sentence of Paragraph 5.05.E3. of the General Conditions to read as follows:

“All certificates required by this Contract shall be

sent directly to the Water Services Department’s Project Manager at the address indicated below:

Marcel Begay
200 W. Washington St, 8th Floor
Phoenix, AZ 85003

Amend Paragraph 6.02.C of the General Conditions to read as follows:

SC-6.02.C The combined premium time charges of Design Professional and Owner shall be defined as $190 per hour for each hour exceeding a 10-hour work day or a 50-hour work week.

Add a new paragraph immediately after Paragraph 6.09.A. of the General Conditions, which is to read as follows:

SC-6.09.A.1 Owner has secured or will secure the following permits, approvals and licenses and has paid or will pay any associated charges and fees:

SC-6.09.A.1.a. MCESD Approval to Construct and Approval of Construction
SC-6.09.A.1.b City of Phoenix Building Permit

Add a new paragraphs immediately after Paragraph 6.13.C. of the General Conditions, which is to read as follows:

SC-6.13.C.1 Following are those Owner’s safety programs or requirements:

SC-6.13.C.1.a. Confined Space Entry Plan

Replace Paragraph 7.02.B with the following:

"Other work being performed at the Site during this Project, consisting of, _____ shall be coordinated for the Owner by _____"

Add the following paragraph after Paragraph 7.02.B of the General Conditions:

SC-7.02.C. Other contracts currently active or which may be active during the performance of the Work on this Project are identified below:

SC-7.02.C.1. None

--- END OF SECTION 00800--

CITY OF PHOENIX

WATER SERVICES DEPARTMENT

LIFT STATION 76 PHASE II EXPANSION

PROJECT NUMBER WS90400067

VOLUME 2 OF 3

GENERAL REQUIREMENTS AND TECHNICAL SPECIFICATIONS

DIVISIONS 01 THRU 17

DECEMBER 2023

MAYOR

Kate Gallego

CITY COUNCIL

District 1 – Ann O'Brien
District 2 – Jim Waring
District 3 – Debra Stark
District 4 – Laura Pastor
District 5 – Betty Guardado
District 6 – Sal DiCiccio
District 7 – Yassamin Ansari
District 8 – Carlos Garcia

CITY MANAGER

Jeffery Barton

CITY ENGINEER

Eric J. Froberg, P.E

WATER SERVICES DIRECTOR

Troy Hayes, P.E

EXPIRES 06/30/2025

VOLUME 2 OF 3

GENERAL REQUIREMENTS AND TECHNICAL SPECIFICATIONS

TABLE OF CONTENTS

GENERAL REQUIREMENTS

Section No.	**Section Name**
01110	Summary of Work
01111	Schedule of Completion
01112	Partnering
01140	Work Restrictions
01141	Work in Highway Rights-of-Way
01143	Coordination with OWNERS Operations
01271	Measurement and Payment
01291	Schedule of Values
01301	Pre-construction Conference
01311	Project Coordination
01312	Progress Meetings
01320	Progress Schedule
01323	Construction Photographs
01330	Submittal
01331	Reference Forms
01332	Shop Drawings Procedure
01333	Samples
01412	Stormwater Pollution Prevention Plan and Permit
01414	Earthmoving and Dust Control
01415	Confined Space Entry Plan
01416	Special Inspections
01420	References
01452	Testing Laboratory Services Furnished by CONTRACTOR
01510	Temporary Construction Facilities
01511	Temporary Electricity
01512	Temporary Lighting
01514	Temporary Water

Section No.	Section Name
01515	Temporary Sanitary and First Aid Facilities
01516	Temporary Fire Protection
01550	Access Roads and Parking Areas
01561	Security
01570	Temporary Controls
01580	Project Identification and Signs
01600	General Equipment Provisions
01620	Installation of Equipment
01630	Computerized Maintenance Management Tags
01651	Transportation and Handling of Materials and Equipment
01661	Storage of Materials and Equipment
01721	Protection of the Work and Property
01723	Cutting and Patching
01724	Connections to Existing Facilities
01731	Installation Data
01740	Cleaning
01751	Starting and Placing Equipment and Operation
01752	Equipment and System Startup and Performance Testing
01781	Operating and Maintenance Data Submittal
01782	Record Documents
01783	Spare Parts and Maintenance Materials
01784	Post Final Inspection
01785	Preventive Maintenance Data Specification
01810	Commissioning
01821	Instruction of Operating and Maintenance Personnel

TECHNICAL SPECIFICATIONS

Section No.	Section Name
02145	Diversion of Water or Sewage Flow and Dewatering
02220	Demolitions
02230	Clearing
02315	Structural Excavation and Backfill
02318	Crushed Stone, Gravel and Decomposed Granite

Section No.	Section Name
02531	Manholes
02981	Decorative Stone Landscaping
03100	Concrete Formwork
03200	Concrete Reinforcement
03251	Concrete Joints
03252	Anchorage in Concrete
03300	Cast-in-place Concrete
03400	Pre-cast Structures
03600	Grout
05051	Anchor Bolts, Toggle Bolts, and Concrete Inserts
05501	Miscellaneous Metal Fabrications
05522	Aluminum Handrails and Railings
05561	Castings
07920	Caulking and Sealants
09900	Painting
11000	Electric Motors 250 Horsepower or Less
11212	Vertical Submersible Well Pumps
13124	Odor Control Biofilter (Granular Media)
15050	Piping Systems
15051	Buried Piping Installation
15052	Exposed Piping Installation
15061	Pipe Hangers and Supports
15101	Ductile Iron Pipe
15108	Fiberglass Reinforced Plastic Process Pipe
15112	Eccentric Plug Valves Operators and Appurtenances
15114	Check Valves and Appurtenances
15119	Specialty Valves and Appurtenances
15120	Piping Specialties and Accessories
15812	Corrosion Resistant Ductwork and Accessories
15831	Centrifugal Fan
16050	General Provisions
16061	Grounding Systems
16121	Instrumentation Cable
16122	600 Volt Cable

Section No.	Section Name
16131	Rigid Conduit
16132	Flexible Conduit
16133	Sealing Fittings
16134	Expansion-Deflection Fittings
16135	Pull Boxes
16137	Underground Duct Banks
16143	Disconnect Switches
16215	Power System / Arc Flash Analysis
16423	Motor Control Centers
17001	Process Control System General Requirements
17051	Process Control Description
17052	Process Control System Primary Sensors and Field Instruments
17053	Process Control System Instrumentation Index
17226	Process Control System IO List
17260	Control Panels

SECTION 01110

SUMMARY OF WORK

PART 1 - GENERAL

1.1 LOCATION AND DESCRIPTION OF WORK

A. The Work is located on the site of the Lift Station 76 at 38107 North Pioneer Road, in Phoenix, Arizona.

B. The Contract Documents include the following:
- Volume 1 of 3 Divisions 0 Specifications
- Volume 2 of 3 Divisions 1 Through 16 Specifications
- Volume 3 of 3 Drawings

C. The Contract Documents for the Work to be performed include the following, but are not limited to:
1. Construction and Installation of a new sanitary sewer pipeline, manholes, biofilter and ancillary equipment, lift station wet well, force main, and reconnection to existing onsite electrical and instrumentation equipment as detailed and described in the contract drawings.
2. Maintenance of Operations of Lift Station 76 during construction and installation of the new sanitary sewer pipeline, manholes, biofilter, wet well, and force main.
3. Maintenance of Operations of Lift Station 76 for a minimum of sixty (60) days following successful and accepted construction and installation of the Lift Station 76 new sanitary sewer pipeline, manholes, biofilter, wet well, and force main.
4. Coordination to safely de-energize and/or decommission energized Lift Station 76 equipment as detailed and described in the contract drawings.
5. Demolition of Lift Station 76 equipment as detailed and described in the contract drawings.

1.2 CONTRACT

A. The Work shall be constructed under one prime contract.

1.3 OTHER CONSTRUCTION CONTRACTS

A. Other construction contracts have been or will be awarded by the OWNER that are in close proximity to or border on the Work of this Contract. Work under these other contracts is briefly described as follows:
1. None

1.4 WORK BY OWNER

A. OWNER will perform the following work:
   1. Operation of all existing system gates, valves and equipment, unless specified otherwise.
   2. Shall notify the CONTRACTOR when cleared to proceed to de-energize and decommission the Lift Station 76 equipment as detailed and described in the contract drawings.

1.5 OWNER-FURNISHED EQUIPMENT AND MATERIALS

A. The items of equipment and materials to be furnished by OWNER for installation by CONTRACTOR are:
   1. None

F. CONTRACTOR'S Responsibilities:
   1. Responsibilities for equipment and materials delivered to the Lift Station 76 site will begin on CONTRACTOR'S acceptance of the equipment and materials at that location.
   2. Receive and unload equipment and materials at site. Provide all labor and equipment for unloading. Perform unloading promptly. All charges for demurrage due to negligence or delay shall be paid by CONTRACTOR.
   3. Inspect for completeness or damage, jointly with OWNER, and reject all defective items. OWNER, however, reserves the right to accept items rejected by CONTRACTOR and to authorize their use in the Work.
   4. Indicate to OWNER signed acceptance of delivery on a copy of the shipping invoice.
   5. Increase property insurance specified in the General Conditions to reflect replacement value of the OWNER furnished equipment and materials.
   6. Handle, store, and maintain equipment and materials.
   7. Repair or replace equipment and materials which are missing or lost or are damaged after receipt. Replacements shall conform to OWNER'S original procurement specifications.
   8. Review OWNER'S approved Shop Drawings, product data, installation drawings, and Samples.
   9. Install, connect, and startup in accordance with manufacturer's instructions, unless otherwise specified.

1.6 ASSIGNED PROCUREMENT CONTRACTS

A. Contracts for the procurement of products described in this Paragraph will be assigned to CONTRACTOR as specified in the Agreement.
   1. None

1.7 SEQUENCE AND PROGRESS OF WORK

A. Submit a Construction Schedule covering the entire Work in accordance with Section 01320, Progress Schedule.

B. Incorporate the requirements of Section 01111, Schedule of Completion, and Section 01143, Coordination with OWNER'S Operations, into the Construction Schedule. CONTRACTOR'S construction schedule may use a different sequence from that shown or specified, if techniques and methods known will result in cost and time savings to the OWNER, still achieve the required objective and maintain the same or greater level of treatment. The ENGINEER'S determination on the acceptability of any alternative sequence from that shown or specified shall be final.

C. CONTRACTOR: The project electric motor requirements, specified in Section 11000, Electric Motors, do not allow standard “off the shelf” motors. Make provisions in sequence and progress of Work to account for longer manufacturing and delivery lead times for the motors and equipment requiring electric motors under this project.

1.8 CONTRACTOR'S USE OF PREMISES

A. Coordinate use of the premises, for his storage and the operations of his workmen, with OWNER, ENGINEER and utility service companies.

B. The full use of the premises for storage, the operations of workmen and for all other construction activities will not be available to CONTRACTOR. Must operate entirely within the space allowed to him.

C. Sole responsibility for obtaining and paying all costs in connection with any additional work area, storage sites, access to the site or temporary right-of-way which may be required for proper completion of the Work, belongs to CONTRACTOR.

D. It shall be understood that responsibility for protection and safe-keeping of equipment and materials on or near the site will be entirely that of CONTRACTOR and that no claim shall be made against the OWNER or his authorized representatives by reason of any act. It shall be further understood that should any occasion arise necessitating access to the sites occupied by these stored materials or equipment, the ENGINEER shall direct CONTRACTOR owning or responsible for the stored materials and equipment to immediately move the same. No materials or equipment may be placed upon the property of the OWNER, other than in the designated areas as shown on the Drawings, or as described in the specifications, unless the ENGINEER has agreed to the location contemplated by CONTRACTOR to be used for storage. All stored materials shall be labeled according to the appropriate contractor or subcontractor with the manufacturer's label as well. Appropriate material safety data sheets (e.g., MSDS) shall be provided.

E. Required to share use of the premises with other contractors whose services the OWNER has obtained or will obtain for construction of other facilities on the site.

1.9 EASEMENTS AND RIGHTS-OF-WAY

A. Easements and rights-of-way determined by the OWNER to be required to perform the Work will be provided by OWNER. Confine construction operations within the limits indicated on the Drawings. Use due care in placing construction tools, equipment, excavated materials, and pipeline materials and supplies in order to avoid damage to property and interference with traffic. Do not enter any private property outside the designated construction easement boundaries without written permission from the ENGINEER and the owner of the property. Any private property or rights-of-way owned by other than the OWNER, which CONTRACTOR wishes to utilize during the performance of the Work, shall be provided by CONTRACTOR.

B. On Private Property: Private property is indicated on the Drawings and will not be utilized to perform the work.

C. Within Highway and Railroad Rights-of-Way: Permits will be obtained by CONTRACTOR. All Work performed and all operations of CONTRACTOR, its employees, or subcontractors within the limits of railroad and highway rights-of-way shall conform to the requirements and be under the control of the railroad or highway authority owning, or having jurisdiction over and control of, the right-of-way.

1.10 NOTICES TO OWNERS AND AUTHORITIES OF PROPERTIES ADJACENT TO THE WORK

A. Notify owners of adjacent properties and utilities when prosecution of the Work may affect them.

B. When it is necessary to temporarily obstruct access to property, or when any utility service connection must be interrupted, give notices sufficiently in advance to enable the affected persons to provide for their needs. Conform notices to any applicable local ordinance and, whether delivered orally or in writing, include appropriate information concerning the interruption and instructions on how to limit inconvenience caused thereby.

C. Utilities and other concerned agencies shall be notified at least 72 hours prior to cutting or closing streets or other traffic areas or excavating near underground utilities or pole lines.

1.11 SALVAGE OF EQUIPMENT AND MATERIALS

A. Existing equipment and materials removed, and not shown or specified to be reused as a part of the Work, shall become CONTRACTOR'S property, except the following items which shall remain OWNER'S property:
   1. Facility staff will review removed equipment and components to be salvaged under item "C". The contact person is: Earon Shepard.

B. Existing equipment and materials removed by CONTRACTOR shall not be reused in the Work, except where so specified or indicated.

C. Carefully remove, in a manner to prevent damage, all equipment and materials specified or indicated to be salvaged and reused or to remain the property of OWNER. Store and protect salvaged items specified or indicated to be reused in the Work. Replace in kind or with new items any items damaged in removal, storage, or handling through carelessness or improper procedures.

D. Furnish and install new items, with ENGINEER'S approval, instead of those specified by OWNER or indicated to be salvaged and reused, in which case such removed items will become CONTRACTOR'S property.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01111

SCHEDULE OF COMPLETION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Commence the Work promptly upon the date established in the Notice to Proceed and shall pursue it to completion in accordance with the Agreement (Section 00500) as described in this Section.

B. The Schedule of Completion describes selected project components only and is not intended to describe all project Work or constraints, interrelationships, or sequentially required Work.

C. Completion of certain activities are directly related to treatment capacities at the Lift Station 76 site. A Shutdown Schedule, consisting of all plant or facility shutdowns, is included in Section 01143, Coordination with OWNER'S Operations.

D. Contract times, as well as liquidated damages for failure to Substantially Complete the Schedule of Completion specified in this Section, are defined in the Agreement (Section 00500).

1.2 SCHEDULE OF COMPLETION

A. Submit Shop Drawings in accordance with Section 01332, Shop Drawing Procedures, and the individual specification Sections. Submit early Shop Drawings as noted and as required to meet the Schedule of Completion.

B. The Schedule of Completion for the Lift Station 76 Phase II Expansion Project shall be 18 months from the notice to proceed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01112

PARTNERING

PART 1 - GENERAL

1.1 COVENANT OF GOOD FAITH AND FAIR DEALING

A. Scope:
   1. The Work imposes an obligation of good faith and fair dealing in its performance and enforcement.
   2. CONTRACTOR, ENGINEER and OWNER, with a positive commitment to honesty and integrity, agree to the following mutual duties:
      a. Each will function within the laws and statues applicable to their duties and responsibilities.
      b. Each will assist in the other's performance.
      c. Each will avoid hindering the other's performance.
      d. Each will proceed to fulfill its obligations diligently.
      e. Each will cooperate in the common endeavor of the Work.

1.2 VOLUNTARY PARTNERING

A. OWNER intends to encourage the foundation of a cohesive partnership with the ENGINEER and CONTRACTOR and its principal subcontractors and suppliers. This partnership will be structured to draw on the strengths of each organization to identify and achieve reciprocal goals. The objectives are effective and efficient contract performance and completion within budget, on schedule, and in accordance with the Contract Documents.

B. This partnership will be bilateral in makeup, and participation will be totally voluntary. All costs associated with effecting this partnering will be agreed to by the OWNER, ENGINEER and CONTRACTOR and will be shared equally.

C. To implement this partnering initiative prior to starting of Work in accordance with the requirements of Section 01110, Summary of Work, and prior to the Pre-construction Conference, CONTRACTOR'S management personnel and the OWNER will initiate a partnering development seminar/team building workshop. The ENGINEER will make arrangements to determine attendees at the workshop, agenda of the workshop, duration, and location. Persons required to be in attendance will be the OWNER, ENGINEER, and key project personnel, CONTRACTOR'S on-site Project Manager and other key project supervision personnel of both the principal subcontractors and suppliers. During the workshop, the participants shall develop and sign the Project Partnership Charter.

D. Follow-up workshops may be held periodically throughout the duration of the Work as agreed by CONTRACTOR, ENGINEER and OWNER.

E. The establishment of the Project Partnership Charter will not change the legal relationship of the parties to the Work nor relieve either party from any of the terms of the Work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01140

WORK RESTRICTIONS

PART 1 - GENERAL

1.1 USE OF PREMISES

A. Limit use of premises to Work in areas indicated. Do not disturb portions of site beyond areas in which Work is indicated.
   1. Limits: Confine construction operations to designated areas located within Lift Station 76 and related project scope areas within City of Phoenix property boundaries. Confine storage of materials and support facilities to designated areas located within staging site approved by the Owner. Contractor shall provide a plan of his or her proposed staging area for review and approval. Do not enter areas located outside the defined project areas located within Lift Station 76, and outside the related project scope areas within City of Phoenix property boundaries and public right of ways.
   2. Driveways and Entrances: At all times, keep driveways and entrances serving premises clear and available to OWNER, OWNER'S employees, and emergency vehicles. Coordinate with the requirements of Section 01550, Access Roads, and Parking Areas. Do not use these areas for parking or storage of materials.
      a. Schedule deliveries to minimize use of driveways and entrances.
      b. Schedule deliveries to minimize space and time requirements for on-site storage of materials and equipment.

B . Promptly repair damage to premises caused by construction operations. Upon completion of the Work, restore premises to original condition.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01141

WORK IN HIGHWAY RIGHTS-OF-WAY

PART 1 - GENERAL

1.1 SCOPE

A. Obtain all necessary permits, arrange all inspections required by the state and pay all charges. Conform with all applicable State Highway Department rules and regulations.

B. Work may be installed by the open cut method; however, traffic flow shall be maintained. A minimum of two lanes of traffic shall be kept flowing.

C. Take all means necessary to prevent accidents. Sufficient flagmen, barricades, lights, signs and all other precautions necessary shall be furnished to provide safe conditions.

D. Work shall be located as shown, and install materials, pipe, fittings, and adapters that are required to implement crossings of existing pipelines, utilities or other structures. A supply of pipe fittings, adapters and short lengths shall be on hand to expedite the crossings.

E. Pavement: When backfill is stabilized in accordance with State Highway Department requirements and these Specifications, replace the street pavement and base with pavement of similar type and equal thickness to the pavement which was removed. This pavement and base shall be constructed in complete accordance with the requirements of the State Highway Department.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01143

COORDINATION WITH OWNER'S OPERATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The intent of this Section is to provide CONTRACTOR a sequence to perform the Work in such a manner that continuous, uninterrupted Lift Station Processes and all essential services and facilities are maintained operational throughout the construction period, totaling eighteen (18) months.

B. The sequences of Work and Schedule of Completion are specified under Section 01110, Summary of Work, and Section 01111, Schedule of Completion. The sequences have been assembled to maintain plant operations during construction.

C. Except for the shutdown durations specified in this Section, CONTRACTOR'S means and methods shall be implemented such that the existing plant or facility, shall remain in continuous satisfactory operation during the entire construction period. Work shall be so scheduled and conducted by CONTRACTOR such that it shall not impede any lift station process, compromise security, create potential hazards to operating equipment and personnel, or cause odor or other nuisances. In performing the Work shown and specified, plan and schedule the Work to meet both the constraints outlined in this Section and lift station operating requirements.

D. Work not specifically covered in Section 01110, Summary of Work; and Section 01111, Schedule of Completion or in the following paragraphs may, in general, be done at anytime during normal work hours during the Contract period, subject to the operating requirements outlined in this Section. All references to days in this Section are consecutive calendar days.

E. The option of providing additional temporary facilities that can eliminate a constraint provided it is done without additional cost to the OWNER, presents no safety hazards, and provided that all requirements of these Specifications are fulfilled.

F. Responsible for coordinating all shutdowns with the OWNER and ENGINEER. Whenever possible, combine discrete shutdown procedures identified in this Section or by CONTRACTOR into a single shutdown when the duration of the shutdowns or the Work requirements allow such combining to occur on a unit process or work area. The intent of combining procedures is to minimize the impacts upon operations and processes by limiting the number of shutdowns required.

G. Not shut-off or disconnect any operating system of the lift station, unless approved by the ENGINEER, in writing. All equipment operations and shutdowns shall be executed by the OWNER, unless otherwise noted. Seal OWNER operated gates and valves to prevent unnecessary leakage. After CONTRACTOR'S Work has been completed, remove the seal to the satisfaction of the ENGINEER.

H. This Section of the Specifications contains several references to equipment, piping, material and appurtenances to be removed or reinstalled. Refer to the Drawings, Section 02220, Demolitions, and other applicable Sections, for definition of the equipment, piping, material and appurtenances to be removed, turned over to the OWNER and stored on site, or to become the property of CONTRACTOR and removed from the site.

I. Responsible for supplying all temporary pipelines, valves, pumps, meters, spare parts, electrical, controls, any other appurtenances, and labor required for the installation and operation of temporary bypass lines, pumping systems, or conveyance systems required to maintain operations of the lift station during construction activities. All pumps shall be provided with magnetic flowmeters capable of providing a 4 to 20 mADC output signal. Man all pumps continuously (24 hours per day) when in service. Submit to the ENGINEER, for information only, the design for all temporary lines, pumping, or conveyance systems at least seven (7) days prior to the commencement of the Work.

J. Unless otherwise specified, dewater wet well and pipelines at the beginning of each shutdown. Responsible for washing down and cleaning all wet well, pipelines and other Work areas. Also for the removal of all washdown, cleaning and storm water that accumulates in the Work areas. Approximate depth of sludge, grit and other debris (with a solids concentration of approximately 6-8 percent) which can be expected to accumulate in the bottom of basins, pipelines, and wet wells is 18-inches. Responsible for removing this material and disposing of on site, as directed by the ENGINEER, into one of the treatment processes. Removal of material shall be included as a separate item on CONTRACTOR'S Schedule of Values.

K. Contractor shall be responsible for supplying all temporary pipelines, valves, pumps, meters, spare parts, electrical, controls, any other appurtenances, and labor required for the installation and operation of temporary bypass lines, pumping systems, or conveyance systems required to maintain operations of the lift station facility during construction activities. All pumps shall be provided with magnetic flowmeters capable of providing a 4 to 20 mADC output signal. Man all pumps continuously (24 hours per day) when in service. Submit to the ENGINEER, for information only, the design for all temporary lines, pumping, or conveyance systems at least fourteen (14) days prior to the commencement of the Work. Bypass pumping system shall be capable of pumping 4 MGD total flow (peak

flow). The temporary bypass system shall include four pumps, each with a capacity of 1,400 gpm at 95 feet. Normally, no more than two pumps shall be operational. The other two pumps are for bypass pumping redundancy in the event there is a failure with the primary pumps. CONTRACTOR shall take their own flow measurements to confirm proposed values. Flow measurements and pumping sizing assumptions shall be included in Temporary Bypass MOPO.

1.2 GENERAL CONSTRAINTS

A. Article 1.3, below, and Section 01111, Schedule of Completion, specify the sequence and shutdown durations, where applicable, for plant units which are to be taken out of service. The operational status of new or existing units other than the designated units shall not be interrupted by CONTRACTOR during the specified time periods. New units may only be used after the specified testing is completed and the units are accepted for use by the ENGINEER, in writing.

B. The following constraints shall be applied to all equipment and appurtenant utility systems on the plant site.
   1. Load limits on Access Roads: Not exceed the weight limit of access roads and driveways as specified by the jurisdiction.
   2. Access to Facility Site: An unobstructed traffic route through all plant gates shall be maintained at all times.
   3. Safety Barriers: Place safety barriers around unsafe areas located around operational areas accessible to plant Personnel.
   4. Personnel Access: Facility Personnel shall have access to all areas which remain in operation throughout the construction period.
   5. Potable Water System: The existing potable water system shall be kept in operation at all times, unless otherwise specified in Article 1.3, below.
   6. Plumbing Facilities: Sanitary facilities in the existing structures shall be operational at all times for Operating Personnel, unless otherwise specified in Article 1.5, below. All other building plumbing systems, such as roof and floor drains, pumping, etc., shall be maintained for all structures.
   7. Storm drainage: Storm drainage on the site shall be operational at all times, unless otherwise specified in Article 1.3, below.
   8. Power, Light and Communication Systems: Electric power, lighting service and communication systems shall be maintained in uninterrupted operation in all areas, unless otherwise specified in Article 1.3, below.
   9. Sump Pumps and Sumps: All existing sumps shall be maintained in an operable condition with either existing pumps or temporary pumps provided by CONTRACTOR. Interim piping, power and controls shall be provided by CONTRACTOR, as required by the construction sequence and as directed by the ENGINEER.
   10. Seal and Service Water Piping: A supply of service and seal water and the necessary connections to existing equipment shall be maintained during construction, unless otherwise specified in Article 1.3, below. Interim piping shall be provided by CONTRACTOR, as required.

11. The OWNER will assist CONTRACTOR in dewatering the wet well and other lift station Work areas. It is CONTRACTOR'S responsibility to maintain a clean and dry Work area by pumping and properly disposing of all washdown and cleaning water and stormwater that accumulates in the Work areas.
12. Draining Process Pipes and Conduits:
    a. Unless otherwise specified, the contents of pipes and conduits undergoing modifications shall be transferred to the active sanitary sewer collection system using hoses, piping, pumps, or other applicable means.
    b. If a drain is not available on the pipe to be drained, then a wet tap shall be made by CONTRACTOR using a tapping saddle and valve approved by the ENGINEER. No uncontrolled spillage of a pipe's contents shall be allowed.
    c. Any spillage shall be brought to the ENGINEER'S attention immediately in writing. Wash down any spillage to floor drains, sumps and sump pump discharge piping and then flush out the system to prevent clogging and septic odors. If spillage is not suitable for drainage system, e.g. chemical spills, etc, as determined by the ENGINEER, remove spillage by other method such as Vactor truck, as approved by the ENGINEER.
13. Temporary Partitions and Enclosures: Provide temporary partitions and enclosures necessary to maintain dust-free, heated and ventilated spaces in all areas which are adjacent to his Work and which must be kept operational.
14. Dead End Valves or Pipe: Provide blind flanges on all valves or pipes which dead-end a line on a temporary or permanent basis. Blind flanges shall be braced and blocked, as required or as directed by the ENGINEER in the field.
15. Schedule all start-ups for Monday through Thursday. No start-ups will be allowed on Friday, Saturday, and Sunday.

1.3 SHUTDOWNS

A. General:
    1. A shutdown shall be defined as a portion of the normal operation of a Lift Station unit or conduit that has to be suspended or taken out of service in order to perform the specified Work. For each shutdown, compile an inventory of labor and materials required to perform tasks, provide an estimate of the time required (including time for the OWNER to take down and start-up the Lift Station unit or conduit), and a written description of steps required to complete all tasks. The inventory, the estimate, and written procedures shall be submitted to the ENGINEER for review thirty (30) calendar days prior to the proposed start date of the shutdown. Request, in writing from the ENGINEER, approval for each shutdown a minimum of fourteen (14) calendar days prior to the proposed shutdown date. No shutdown shall be initiated until the inventory of materials and labor is

verified by the ENGINEER on site at least one (1) week(s) prior to the proposed start date.

2. The Work required herein and any other Work required by the ENGINEER which may interrupt the normal plant operations shall be accomplished at such times that will be convenient to the OWNER.
3. Have on hand and located in close proximity to the Work area, all tools, equipment, spare parts and materials, both temporary and permanent, necessary to complete each Work category without interruption. Adequate numbers of personnel shall be scheduled for each shutdown, so that the Work shall be accomplished within the specified time frame. Prefabrication of all piping and other assemblies shall be completed, to the greatest degree possible, prior to any shutdowns. The ENGINEER shall be satisfied that CONTRACTOR has complied with these requirements, to the fullest extent possible, before shutdowns will be authorized.
4. If CONTRACTOR'S procedures cause an unscheduled shutdown of the facilities, perform Work as necessary to immediately re-establish satisfactory operation. Notify the ENGINEER, in writing, immediately of any unscheduled shutdown. Permit OWNER'S personnel to work with CONTRACTOR'S personnel, as required, to maintain the plant in continuous satisfactory operation. Unscheduled shutdowns or interruptions of continued safe and satisfactory operation of the facilities that result in fines levied by the U.S. Environmental Protection Agency, Arizona Department of Environmental Quality, Maricopa County Health Department Bureau of Air Pollution Control, or the Maricopa County Department of Environmental Management shall be the responsibility of CONTRACTOR if it is demonstrated that CONTRACTOR was negligent in the Work or did not exercise proper precautions in the conduct of the Work.
5. The scheduled shutdowns during the period of CONTRACTOR'S Work will be as shown in Table 01143-A. All Work requiring the plant to be out-of-service shall be performed during the scheduled shutdowns shown. It should be noted plant staff shall continue to perform administrative, operation and maintenance functions during shutdowns.
6. Electrical Ductbank Installation: Shutdown and relocation of conflicting utilities alignments with electrical ductbank will only be allowed for certain types of process pipelines. Any shutdown and relocations shall follow a strict time schedule in order to minimize impact to Lift Station operations.

B. Shutdowns of Electrical Systems: Lock out and tag circuit breakers and switches operated by the OWNER and shall check cables and wires to be sure that they are de-energized to ground potential before Work begins. Upon completion of the Work, remove the locks and tags and notify the ENGINEER that the facilities are available for use.

1.4 OVERTIME

A. All overtime Work by CONTRACTOR necessary to conform to the requirements of this Section shall be performed by CONTRACTOR, at no additional cost to the OWNER and shall be performed in accordance with the General Conditions. Make no claims for extra compensation as a result thereof.

1.5 MAINTENANCE OF PLANT OPERATIONS SCHEDULE

A. In order to maintain a continuous plant operation during construction, a Maintenance of Plant Operations (MOPOs) Schedule is included at the end of this Section.

B. Within each MOPO item's procedural steps, time and scheduling constraints and milestone dates may be outlined and are intended to assist CONTRACTOR in developing a sequence of Work and timing in order to maintain continuous operation of the plant.

C. Develop a detailed description of the complete sequence of construction for all the MOPO events contained herein. The sequences shall be submitted to the ENGINEER for review and approval thirty (30) days following the Notice to Proceed.

D. The procedures contained herein were developed based upon available information. This list does not address all required tie-ins, but only those anticipated to be of significant impact to lift station operations.

E. Is required to make all tie-ins, connections, and replacements necessary to perform the Work.

F. Is advised that Work in multiple areas of the lift station, gravity sewer and force main system shall be performed simultaneously in order to complete the entire scope of the Work within the allotted Contract time.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

1.0 Maintenance of Operations Schedule – Lift Station 76 Electrical Shutdown

MOPO No.	DWG. NO.	ITEM DESCRIPTION	PROCESS UNITS OPERATING PRIOR TO SHUTDOWN	PROCESS UNITS OPERATING DURING SHUTDOWN	PROCESS UNITS OUT-OF-SERVICE DURING SHUTDOWN	IMPACT ON OTHER PROCESS UNITS	PROCEDURE	CONSTRAINTS AND REMARKS	DURATION OF SHUTDOWN
1.1	C04	Demolish existing Lift Station 76 wet well, pumps, electrical system, controls system, inlet sewer to wet well, and discharge piping. Construction of new wet well, pumps, electrical, controls, inlet sewer system, and discharge piping.	Entire Lift Station 76 Facility.	Bypass Pumping System	Lift Station 76 Facilities, such as wet well, pumps, controls, electrical, inlet sewer and discharge piping.	No Lift Station 76 Facilities in Operation During Shut down to allow for construction of new wet well, pumps, electrical, controls, inlet sewer, and discharge piping..	• Contractor shall not open or close City valves, start or stop pumps, shut off electrical and instrumentation equipment. This effort must be completed by City Staff. • Contractor to prepare MOPO identifying required outages utilizing City form. A MOPO shall be submitted for each outage event separately. • Contractor shall accommodate flows to Lift Station 76 at all times via bypass pumping system during shutdown. Limit bypass pumping duration as much as possible by constructing the new wet well and sewer inlet prior to taking existing wet well facility offline. • Prior to taking any facility offline at Lift Station 76, bypass pumping should be installed and tested for a 5 day period. • Prior to taking existing Lift Station 76 offline, Contractor shall build new wet well, install pumps, portion of inlet sewer, electrical, and controls to the maximum extent possible while existing facilities are online. • New wet well facilities can operate without chemical feed system and Biofilter. Biofilter and chemical system can be commissioned separately after the completion of the new lift station wet well system and associated electrical and controls systems.	• Work to be performed as part of this MOPO shall be completed between the Shutdown timeframe • Bypass pumping shall accommodate a maximum peak flow of 4 MGD at any given time over a 24 hour period. • Bypass pumping capability shall receive flows from an upstream manhole from the Lift Station 76 Facility and discharge the flows into the Lift Station 76 discharge manifold. • A limited shut down will be allowed to connect to the existing discharge manifold. • New Lift Station 76 wet well and pump facilities can operate without chemical feed system and Biofilter. Biofilter and chemical system can be commissioned separate. • New Lift Station 76 wet well and pump facilities must be tested and commissioned for a 30 day period prior to removal of the temporary bypass system.	Shutdown limited to 1 hour for discharge piping connection. Inlet flows to Lift Station 76 shall be accommodated at all times via bypass pumping or operation of the Lift Station 76 facility. Work during shutdown period should be performed outside peak flow hours, morning and evening

SECTION 01271

MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. The items listed below, beginning with Article 1.4, refer to and are the same pay items listed in the Bid Form. They constitute all of the pay items for the completion of the Work. No direct or separate payment shall be made for providing miscellaneous temporary or accessory works, plant services, CONTRACTOR'S or ENGINEER'S field offices, layout surveys, job signs, sanitary requirements, testing, safety devices, approval and Record Drawings, water supplies, power, traffic maintenance, removal of waste, watchmen, bonds, insurance, or all other requirements of the General Conditions, Supplementary Conditions, and the Contract Requirements. Compensation for all such services, items and materials shall be included in the prices stipulated for the lump sum and unit price pay items listed herein.

B. Each lump sum and unit bid price shall be deemed to include an amount considered by CONTRACTOR to be adequate to cover CONTRACTOR'S overhead and profit for each separately identified item.

1.2 ENGINEER'S ESTIMATE OF QUANTITIES

A. ENGINEER'S estimated quantities for unit price pay items, as listed in the Bid Form, are approximate only and are included solely for the purpose of comparison of Bids. OWNER does not expressly or by implication agree that the nature of the materials encountered below the surface of the ground, or the actual quantities of material encountered or required shall correspond therewith and reserves the right to increase or decrease any quantity or to eliminate any quantity as OWNER may deem necessary. Not entitled to any adjustment in a unit bid price as a result of any change in an estimated quantity and agrees to accept the aforesaid unit bid prices as complete and total compensation for any additions or deductions caused by changes or alterations in the Work directed by OWNER.

1.3 RELATED PROVISIONS

A. Payments to CONTRACTOR: Refer to General Conditions and Agreement.

B. Changes in Contract Price: Refer to General Conditions.

C. Schedule of Values: Refer to Section 01291, Schedule of Values.

D. Pay Application: Refer to Section 01331, Reference Forms.

1.4 GENERAL

A. **Item 1 –** Mobilization and Demobilization Pay Item, as specified in Specification Section 00700 of the Bid Documents:
   1. A lump sum (LS) payment for Item 1 includes Mobilization and Demobilization, insurance, and bonds complete in every detail and all inclusive, as specified in Bid Documents. A maximum payment of 4% of total extended prices will be made for this item. This bid item shall include furnishing all labor, tools, equipment, and materials and performing the work necessary, as needed to meet the requirements defined in the Contract Drawings and specifications.

B. **Item 2 –** Site Work:
   1. A lump sum (LS) payment for Item 2 includes site earthwork, materials, excavation, backfill, compaction, grading, decomposed granite toping, riprap, asphalt pavement, and testing as specified in the Bid Documents.

C. **Item 3** – Furnish and Install 5-foot Diameter Manhole:
   2. A per each (EA) payment for Item 3 will be full compensation for manhole materials, connections, penetrations, appurtenances, excavation, bedding, backfill, compaction, and testing as specified in Bid Documents.

D. **Item 4** – Furnish and Install 16’ x 8’ Precast Polymer Wet well:
   1. A per each (EA) payment for Item 4 will be full compensation for acid resistant polymer structure materials, connections, penetrations, appurtenances, excavation, bedding, backfill, compaction, and testing as specified in Bid Documents.

E. **Item 5** – Furnish and Install New Reinforced Concrete:
   1. A per cubic yard (CY) payment for Item 5 will be full compensation for reinforced concrete work. The work includes but is not limited to, all required formwork, fabrication and placement of reinforcement including but not limited to bars, ties, and supports, and welded wire fabric for concrete, and encasements, leveling, and surface finishing as specified in the Bid Documents. ALL work pertaining to excavation, subgrade preparation, backfill, and labor shall be completed by the CONTRACTOR at no additional cost.

F. **Item 6** – Furnish and Install Wet Well Access Hatch:
   1. A per each (EA) payment for Item 6 will be full compensation for the wet well hatch materials and appurtenances as specified in Bid Documents.

G. **Item 7** – Furnish and Install Protective Finishes:
   1. A per lump sum (LS) payment for Item 7 will be based on percent complete to provide all proper finishes and apply paint systems to all applicable surfaces except the wet well including but not limited to yard piping, electrical facilities, removable bollards, new odor control facilities, yard hydrants, and other equipment that exposed to the elements as required by the drawings and specifications and specifically per specification 09900. This includes proper surface preparation and painting of all new and existing interior and exterior items and surfaces. Measurement of the percent complete will be made by the CONTRACTOR and verified by the ENGINEER.

H. **Item 8** – Furnish Submersible Pump Units:
   1. A per each (EA) payment for Item 8 will be full compensation for submersible pump unit, base elbow, guide rails, and appurtenances as specified in Bid Documents.

I. **Item 9** – Submersible Pump Unit Installation, Startup, and Testing:
   1. A per lump sum (LS) payment for Item 9 will be full compensation for installation of two (2) submersible pumping units. This item includes pumps, pump equipment, and appurtenances as specified in Bid Documents.

J. **Item 10** – Furnish and Install Yard Piping:
   1. A per lump sum (LS) payment for Item 10 will be full compensation for pipe materials, fittings, restrained joints, appurtenances, excavation, bedding, backfill, and testing as specified in Bid Documents.

K. **Item 11** – Furnish and Install 14-inch Check Valves:
   1. A per each (EA) payment for Item 11 will be full compensation for check valve materials, appurtenances, and testing as specified in Bid Documents.

L. **Item 12** – Furnish and Install 14-inch Plug Valves:
   1. A per each (EA) payment for Item 12 will be full compensation for plug valve materials, appurtenances, and testing as specified in Bid Documents.

M. **Item 13** – Furnish and Install 6-inch Plug Valves:
   1. A per each (EA) payment for Item 13 will be full compensation for plug valve materials, appurtenances, and testing as specified in Bid Documents.

N. **Item 14** – Furnish and Install 2-inch Combination Air/Vacuum Release valve:
   1. A per each (EA) payment for Item 14 will be full compensation for combination air/vacuum valve materials, appurtenances, and testing as specified in Bid Documents.

O. **Item 15** – Furnish and Install 14-inch Double Barrel Force Main only (2-14-inch Pipes):
   1. A per linear foot (LF) payment for Item 15 will be full compensation for pipe materials, fittings, appurtenances, excavation, bedding, backfill, compaction, bypassing, and testing as specified in Bid Documents.

P. **Item 16** – Furnish and Install 8-inch Single Barrel Force Main only (1-8-inch Pipe):
   1. A per linear foot (LF) payment for Item 16 will be full compensation for pipe materials, fittings, appurtenances, excavation, bedding, backfill, compaction, bypassing, and testing as specified in Bid Documents.

Q. **Item 17** – Furnish and Install New Magnetic Flow Meter:
   1. A per (EA) payment for Item 17 will be full compensation for new magnetic flow meters and appurtenances, complete and operational, as required by the Bid Documents. CONTRACTOR to ensure that flow meter is operational.

R. **Item 18** – Furnish and Install New Biofilter Odor Control Facilities:
   1. A per lump sum (LS) payment for Item 18 will be full compensation for installation of the biofilter odor control facilities. Provide all labor, materials, equipment, and incidentals needed to install the biofilter odor control facilities as required by the Bid Documents. CONTRACTOR shall ensure installation and operation of the following, biofilter control facilities, media, blower, utilities relocation, duct work, housekeeping pads per detail on sheet 76 of drawing, dampers, and horizontal grease filter. CONTRACTOR shall provide all excavation, subgrade preparation, and backfill as required by the drawings and specifications. CONTRACTOR shall provide record drawings, administration oversight, quality control, and testing, along with all required permits, including environmental permits as required by authorities having jurisdiction, other overhead and incidental costs pertaining and associated with the installation of new biofilter odor control facilities.

S. **Item 19** – Furnish and Install New Bioxide Odor Control Facilities:
   2. A per lump sum (LS) payment for Item 19 will be full compensation for installation of the bioxide odor control system facilities including but not limited to, the 4,350-gallon double wall high density cross-linked polyethylene storage tank, chemical feed pump skid, instrumentation and level sensors, chemical injection lines, and electrical supply.

T. **Item 20** – Furnish and Install 2” Drain Piping:
   1. A per linear foot (LF) payment for Item 20 will be full compensation for installation of all new 2” diameter drain lines and other appurtenances, as required by the Bid Documents.

U. **Item 21** – Furnish and Install Pipe Supports:
   2. A per (EA) payment for Item 21 will be full compensation for new pipe supports. Provide all labor, materials, concrete, all required formwork, fabrication and placement of reinforcement including but not limited to bars, ties, supports, equipment, and incidentals required to furnish and install all new pipe supports and appurtenances as shown on sheet 19 of the drawings.

V. **Item 22** – Furnish and Install Removable Handrail
   1. A per lump sum (LS) payment for Item 22 will be full compensation for new removable handrails. Provide all labor, materials, equipment, and incidentals needed to furnish and install all new removable handrails and other appurtenances complete and operational as required by the drawings and specifications and specifically shown on the bid documents.

W. **Item 23** – Furnish and Install Removable Guard Posts:
   1. A per (EA) payment for Item 23 will be full compensation for new removable guard posts. Provide all labor, material, equipment, and incidentals needed to install new removable bollards and other appurtenances, as required by the Bid Documents.

X. **Item 24** – Furnish and Install 2" Ball Valves:
   1. A per each (EA) payment for Item 24 will be full compensation for ball valve materials, appurtenances, and testing as specified in Bid Documents.

Y. **Item 25** – Furnish and install 1" Ball Valves:
   1. A per each (EA) payment for Item 26 will be full compensation for ball valve materials, appurtenances, and testing as specified in Bid Documents.

Z. **Item 26** – Concrete Pavement Removal and Replacement:
   1. A per square yard (SY) payment for Item 25 will be full compensation for concrete pavement removal and replacement. This item includes sawcut, removal of existing concrete pavement, concrete materials, raised pavement markings, earthwork, and testing as specified in Bid Documents.

AA. **Item 27** – Furnish and Install Electrical:
   1. A per lump sum (LS) payment for Item 26 will be full compensation for electrical work, materials, equipment, components, appurtenances, and startup and testing as specified in Bid Documents.

BB. **Item 28** – Furnish and install Instrumentation and Controls:
   1. A per lump sum (LS) payment for Item 28 will be full compensation for instrumentation and controls work, materials, equipment, components, appurtenances, and startup and testing as specified in Bid Documents.

CC. **Item 29** – Temporary Bypass Pumping:

1. A per lump sum (LS) payment for Item 29 will be full compensation for temporary bypass pumping as required based on percent complete. Measurement of the percent complete shall be made by the CONTRACTOR and verified by the ENGINEER. This bid item shall include all labor, materials, pumps, piping, access points, repair or replacement of infrastructure removed or damaged by creating access points, and supervision required to temporarily bypass flow around the work in accordance with the specified needs of the rehabilitation method being utilized and dewater the wet well in preparation for cleaning and rehabilitation per specification 02145 and replacement of piping, appurtenances, electrical items, and other work required by the contract documents. CONTRACTOR to provide the design of the bypass arrangement and describe the means and methods of accomplishing the bypass and submit to the OWNER and ENGINEER to determine conformance to project objectives. CONTRACTOR shall provide MOPOs, record drawings, administration oversight, quality control, startup and testing along with all required permits, including environmental permits as required by authorities having jurisdiction, other overhead and incidental costs pertaining and associated with the installation of temporary bypass pumping.

DD. **Item 30** – Startup and Testing

1. A per lump sum (LS) payment for Item 30 will be full compensation for performing lift station startup and testing. This bid item shall include furnishing all labor, tools, equipment, and materials to perform startup and testing along with all required permits, including environmental permits as required by authorities having jurisdiction, other overhead and incidental costs pertaining and associated with the testing and adjustment on equipment, manholes, drain lines, sewer pipes, pumps, motors, biofilter, bioxide system, electrical, and instrumentation, all as needed to meet the requirement defined in the Contract Drawings and specifications.

EE. **Item 31** – Rock Removal

1. A per ton (TON) payment for Item 31 will be full compensation for removal and hauling of any and all boulders, cobbles, and stones encountered at the site during excavation.

FF. **Item 32** – Demolition of Existing Lift Station Site and Facilities:

1. A per lump sum (LS) payment for Item 32, to provide all labor, equipment, disposal, and other incidentals required for the demolition of existing electrical facilities, lift station piping and accessories, and other site features as shown on the drawings. Demolition and removals shall conform to the requirements of section 02220 Demolitions. All materials and equipment removed from the site, shall become the property of CONTRACTOR, except for those which OWNER

has identified and marked for their use per drawings or identified by the OWNER at the preconstruction meeting.

GG. **Item 33** – Contingency Allowance for All Other Work Not Previously Listed
1. A per unit cost (EA) payment for Item 33 will be full compensation for any miscellaneous work not listed in Items 1 through 33 above. This bid item shall include furnishing all labor, tools, equipment, and materials and performing the work necessary, as needed to meet the requirements as defined and agreed to by the Owner.

HH. **Item 34** – Contingency Allowance for Additional Electrical Items:
1. A per unit cost (EA) payment for Item 34 will be an allowance used at the discretion of the Owner for any additional electrical work that may be required due to unforeseen items determined during construction.

II. **Item 35** – Contingency Allowance for Additional Programming:
1. A per unit cost (EA) payment for Item 35 will be an allowance used at the discretion of the Owner for any additional programming requirements.

JJ. **Item 36** – Contingency Allowance for Unforeseen Conditions:
1. A per unit cost (EA) payment for Item 36 for unforeseen conditions for items and conditions that are requested and authorized in writing by the OWNER. Payments shall be made based on the terms agreed to in writing by the OWNER and CONTRACTOR for unforeseen conditions.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01291

SCHEDULE OF VALUES

PART 1 - GENERAL

1.1 DESCRIPTION

A. The Preliminary Schedule of Values is an itemized list that establishes the value or cost of each major part of the Work and the division of Work between CONTRACTOR and subcontractors.

B. The Preliminary Schedule of Values shall include all items of Work in the Contract Documents.

C. The Schedule of Values is a detailed itemized list that establishes the value or cost of each detailed part of the Work. It and the Progress Schedule updates specified in Section 01320, Progress Schedule, shall be used as the basis for preparing progress payments. The Schedule of Values may be used as a basis for negotiations, concerning additional work or credits, which may arise during the construction. Quantities and unit prices shall be included in the schedule, when approved by or required by the ENGINEER.

D. The Preliminary Schedule of Values and Schedule of Values itemized list of Work, for each major part of the Work and division of Work shall be grouped under the following index areas:

1. Mobilization and Demolition, and Temporary Facilities
2. Site Work
3. 5-foot Diameter Manholes
4. Pre-Cast Polymer Wet Well
5. New Reinforced Concrete
6. Wet Well Access Hatch
7. Protective Finishes
8. Submersible Pumps
9. Yard Piping
10. Valves
11. Biofilter Odor Control Facilities
12. Bioxide Odor Control Facilities
13. Electrical Work
14. Instrumentation and Controls
15. Temporary Bypass Pumping
16. Startup and Testing
17. Rock Removal
18. Allowance for Unforeseen Conditions

E. The Schedule of Values shall include an itemized list of Work for all Maintenance of Plant Operations (MOPO) Work as specified in Section 01143, Coordination with OWNER'S Operations. Itemized MOPO Work shall be included within applicable major Work area.

1.2 PREPARATION

A. The Preliminary Schedule of Values:
   1. Preliminary Schedule of Values shall show all Work under the index areas listed in Paragraph 1.1.D., above.
   2. Preliminary Schedule of Values shall show the division of Work between CONTRACTOR and subcontractors by two methods, one for each Section of the Specifications and also one for each structure.
   3. Preliminary Schedule of Values shall show breakdown of labor, materials equipment and other costs used in preparation of the Bid for CONTRACTOR and subcontractors.
   4. Costs shall be in sufficient detail to indicate separate amounts for each Section of the Specifications and for each structure.
   5. May include an item for bond, insurance, and temporary facilities.
   6. Preliminary Schedule of Values shall be prepared on 8-1/2-inch by 11-inch white paper.
   7. Use Table of Contents of the Specifications as basis for Preliminary Schedule of Values format and identify each item with number and title in the Table of Contents. Also, use each structure as basis for Schedule of Value format. List sub-items of major products or systems, as appropriate or when requested by ENGINEER.
   8. When requested by ENGINEER, support values with data that will substantiate their correctness.
   9. The sum of the individual values shown on the Preliminary Schedule of Values shall equal the total Contract Price.
   10. Each item shall include a directly proportional amount of CONTRACTOR'S overhead and profit.

B. The Schedule of Values:
   1. Schedule of Values shall show breakdown of quantities, labor, materials, equipment, and other costs used in preparation of the Bid for each item in the Schedule of Values.
   2. Schedule of Values shall show all Work under the index areas listed in Paragraph 1.1.D., above.
   3. Costs shall be prepared by two methods, one for each Section of the Specifications and one for each structure. They shall be in sufficient detail to indicate separate amounts for each Section of the Specifications and subsections therein and also separate amounts for each structure. Amounts shall be included for each type of Work specified, in a manner approved by the ENGINEER.

4. Include separate pay items for Mobilization and Demobilization, as specified in the Contract Documents.
5. Fifteen percent of the total cost of each item is allotted to the cost of Shop Drawing preparation, Operation and Maintenance Manuals, Testing and Training. This amount will be released upon approval, by the ENGINEER, three percent is apportioned to Testing and four percent each to the remaining items.
6. Schedule of Values shall be prepared on 8-1/2-inch by 11-inch white paper.
7. Use Table of Contents of the Specifications and the form included with Section 01330, Submittals, as basis for Schedule of Values format and identify each item with number and title in the Table of Contents. Also, use each structure as basis for schedule format. List sub-items of major products or systems, as appropriate or when requested by ENGINEER.
8. When requested by ENGINEER, support values with data that will substantiate their correctness.
9. The sum of the individual values shown on the Schedule of Values shall equal the total Contract Price.
10. Each item shall include a directly proportional amount of CONTRACTOR'S overhead and profit.
11. Schedule of Values shall show the purchase and delivery costs for materials and equipment that CONTRACTOR anticipates he shall request payment for prior to their installation.
12. Include a separate pay item for Maintenance of Plant Operations (MOPO) Work for each major Work area.
13. Include a separate pay item for: Construction Photographs; Temporary Facilities; Temporary Controls; Progress Schedule; General Conditions; and Field Engineering.
14. Include a separate pay item for all Allowances and Extra Unit quantities.
15. The Schedule of Values shall be prepared to a level of detail equal to or greater than required by the Supplementary Conditions.

1.3 SUBMITTALS

A. Submit two copies of the Preliminary Schedule of Values to ENGINEER for review within fourteen (14) days after the Notice to Proceed.

B. Submit two copies of the Schedule of Values to ENGINEER for review within thirty (30) days after the Notice to Proceed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01301

PRE-CONSTRUCTION CONFERENCE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Date, Time and Location: Conference will be held after notice of award of the Contract. ENGINEER will fix the date, time and location of the meeting, within seven (7) days of notice of award.

B. ENGINEER shall prepare agenda, preside at meeting, and prepare and distribute a transcript of proceedings to all parties.

C. Provide data required, contribute appropriate items for discussion, and be prepared to discuss all items on agenda.

D. Unless previously submitted to ENGINEER, bring to the conference a preliminary schedule of each of the following:
   1. Progress Schedule.
   2. Shop Drawing and Sample submittals.
   3. Schedule of Values.

1.2 REQUIRED ATTENDANCE

A. Conference shall be attended by CONTRACTOR'S Project Manager, its superintendent and its major subcontractors and major equipment suppliers as CONTRACTOR deems appropriate.

B. OWNER'S representative.

C. ENGINEER.

D. Representatives of governmental agencies having any degree of control or responsibility, if available.

E. Utility company representatives.

1.3 PURPOSE

A. The purpose of the Pre-construction conference is to designate responsible personnel and establish working relationships. Matters requiring coordination will be discussed and procedures for handling such matters will be established. A complete agenda will be furnished to CONTRACTOR prior to the Pre-construction conference date. However, be prepared to discuss all of the following: but will not necessarily be limited to the following:
   1. Designation of responsible personnel.
   2. Subcontractors.
   3. Coordination with other contractors and projects.
   4. Progress schedule.
   5. Processing of Shop Drawing Submittals.
   6. Schedule of Shop Drawing submittals.
   7. Processing of Field Orders, Requests for Information and Clarification and Change Orders.
   8. Requirements for copies of Contract Documents.
   9. Insurance in force.
   10. Schedule of values.
   11. Processing and Schedule of Payments.
   12. Use of premises.
   13. CONTRACTOR responsibility for safety and first aid procedures.
   14. Site Security.
   15. Housekeeping.
   16. Field Offices.
   17. Maintaining Record Drawings.
   18. Letter of Notice to Proceed.
   19. Permits.
   20. Emergency Telephone Numbers.
   21. Operation and Maintenance Manuals.
   22. Temporary Utilities.
   23. I&C Inspection & Testing Services Coordination
   24. Electrical Arc Flash Coordination
   25. Any other project related items.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01311

PROJECT COORDINATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. As more fully set forth in of the General Conditions, sole responsibility for coordination of all of the Work, belongs to CONTRACTOR. Supervise, direct and cooperate fully with all subcontractors, manufacturers, fabricators, suppliers, distributors, installers, testing agencies and all others whose services, materials or equipment are required to ensure completion of the Work within the Contract Time.

B. Not be responsible for damage done by contractors not under CONTRACTOR'S jurisdiction. Will not be liable for any such loss or damage, unless it is through the negligence of CONTRACTOR.

D. Coordinate the Work with the work of others to assure compliance with schedules.

E. Attend and participate in all project coordination or progress meetings and report on the progress of all Work and compliance with schedules.

G. It is the duty of the CONTRACTOR to determine that all necessary permits have been obtained. The CONTRACTOR, at his own expense, obtain, maintain, and close all the required permits which have not been furnished.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01312

PROGRESS MEETINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Date and Time:
   1. Regular Meetings: Every two weeks on a day and time agreeable to OWNER, ENGINEER and CONTRACTOR.
   2. Other Meetings: As needed and/or required in other specific specification sections.

B. Place: CONTRACTOR'S field office at Project site, or other mutually agreed upon location.

C. The CONTRACTOR shall conduct weekly progress meetings, record and distribute minutes of the meeting to all attendees and others as requested. At a minimum, the agenda will include: Requests for Information (RFI) and submittal status, past week's progress and a 3-week look-ahead schedule to include upcoming inspections, current issues, long lead items, critical issues and the next scheduled meeting date.

D. Provide data required and be prepared to discuss all items on agenda.

1.2 MINIMUM ATTENDANCE

A. CONTRACTOR:
   1. When needed for the discussion of a particular agenda item, require representatives of subcontractors or suppliers to attend a meeting.

B. ENGINEER.

C. OWNER'S representative, if required.

D. Others, as appropriate.

E. Representatives present for each party shall be authorized to act on their behalf.

1.3 AGENDA

A. Agenda will include, but will not necessarily be limited to, the following:
   1. Transcript of previous meeting.
   2. Progress since last meeting.

a. CONTRACTOR'S.
b. Subcontractors'.

3. Completion status.
4. Planned progress for next period including a 3-week look-ahead schedule to include upcoming inspections.
5. Document and track to correction and closure any problems, conflicts, issues, and observations that are voiced by anyone of the project team.
6. Status of Shop Drawings, submittals, long lead items, RFI and RFAs.
7. Change Orders.
8. Pay Requests.
9. Quality Standards and Control.
10. Schedules, updated Project Schedules, including off-site fabrication and delivery schedules; corrective measures, if required.
11. Coordination between parties.
12. Permits.
13. Safety concerns.
14. Construction Photographs.
15. Record Drawings.
16. Warranty Requests.
17. Punch List Status.
18. Other business.
19. Next meeting date.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01320

PROGRESS SCHEDULE (BAR CHART)

PART 1 - GENERAL

1.1DESCRIPTION

A. Provide Project Schedule which conforms to the requirements below.

B. Schedule Updates shall be submitted every month until issuance of Certificate of Substantial Completion.

1.2CONTENT

A. List all major, long lead or critical equipment, or material to be ordered, indicating:
1. Shop Drawing submittal dates and required approval dates.
2. Product delivery dates.
3. Factory and field-testing dates.

B. Dates for beginning and completing each phase of the Work by activity and by trades.

C. Milestones.

1.3FORMAT

A. Bar chart
1. Bar chart diagram shall show:
a. Activity ID.
b. Activity Description.
c. Early Start and Early Finish dates.
d. Original and Remaining Durations.
e. Responsibility Codes.
f. Logical flow of activities with respect to each other.
g. Time Scale shall indicate the first date in each work week.
h. Sheet size shall be 24-inches by 36-inches, or 11-inches by 17-inches, or as accepted by the ENGINEER.
i. Title block shall include project, revision number and date on each page.

B. Organization:
1. Group shop drawing submittals and reviews into a separate sub-schedule.
2. Group product deliveries into a separate sub-schedule.
3. Group construction work into a separate sub-schedule by activity.

C. Activities

1. Activity Identification (ID) Numbers:

a. Each activity shall have a unique ID number. It shall consist of letters, numbers, or any alphanumeric combinations.

b. Preceding activities shall have lower numbers; succeeding activities shall have higher numbers.

c. Activity Description shall clearly describe work location and phase or staging.

D. Activity Durations

1. Expressed in full working days.

2. Limitation on duration of an activity shall be Ten (10) working days except for procurement of long lead materials or equipment.

1.4SUBMITTALS

A. Initial Submission package shall include Three (3) sets labeled "Baseline Schedule".

a. Submit for review within Ten (10) calendar days of Notice to Proceed.

b. No change from accepted Baseline Schedule will be permitted without written consent of the ENGINEER.

B. Monthly Updates

1. Schedule Updates shall be as of the end of each month, or as directed by the ENGINEER, and submitted within Five (5) work days.

2. Submit a narrative report:

a. A listing of all changes made to each schedule update.

b. Discussion of problems causing delays, anticipated length of delays, and proposed countermeasures.

C. Submittal of Updates

1. Transmit to the ENGINEER Three (3) copies of each submittal set for review.

2. Supplementary updates, such as recovery schedules and delay claims, shall be submitted, in addition to monthly updates, when directed by the ENGINEER, at no additional cost to the OWNER.

D. Software

1. Baseline Schedule and monthly schedule updates shall be submitted on compact disc "CD" or other media approved by the ENGINEER. Each CD or media shall be appropriately labeled with its content and date of preparation.

2. Use scheduling software such as "Microsoft Project", "Primavera Products", or as accepted by the ENGINEER.

E. All schedule submittals shall be made to the ENGINEER, unless specified otherwise.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01323

CONSTRUCTION PHOTOGRAPHS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Retain a professional photographer or an acceptable person, as determined by the ENGINEER, to perform the services specified below.

B. Obtain ENGINEER'S approval of the photographer selected prior to taking first photographs. Submit qualifications and experience record of photographer to ENGINEER.

1.2 PHOTOGRAPHS

A. The maximum number of color digital photographs required will be determined on as needed basis.

B. Take a minimum of twenty-four (24) color digital photographs of the completed or substantially completed Work at Project Completion. These photographs shall be submitted with the Final Application for Payment. These photographs are not part of the photographs required under Paragraph 1.2.A., above.

C. The CONTRACTOR shall take color digital photographs daily of all underground work in progress; work being done that will be exposed above ground shall be photographed on a bi-weekly basis. Photographs shall be taken in such a way to include an area or directional landmark. A minimum of five overall general project photographs depicting the over all project activities shall be taken monthly. A photograph log shall be maintained throughout the project with the following information for each photo: photograph number, a brief description, date, job title, location or station of pipeline (if applicable), and direction of the view in the photograph. The CONTRACTOR shall submit a plan that illustrates how the photograph log will be organized for approval by the OWNER.

D. ENGINEER will approve the views to be taken and select the time at which they will be taken. All photographs need to be viewable (digital), otherwise they will not be allowed off-site (refer to paragraph 1.4.A). Views will vary depending on the Progress Schedule.

E. A minimum of sixteen (16) color digital photographs will be taken each time the photographer is at the site.

F. Submit aerial photographs of the site with Initial and Final Application for Payment. One oblique photograph shall be taken from each cardinal direction (North, South, East, and West). Provide 2 copies of each. One copy for the ENGINEERS use and the other to be turned over to the OWNER.

1.3 PRINTS

A. Furnish three prints of each photograph to the ENGINEER with each Monthly Progress Payment.

B. Furnish additional photographs or prints requested by ENGINEER at cost. Maximum number additional photographs required will be fifty (50).

C. Provide high quality 5-inch by 7-inch standard weight prints with a satin finish. Aerial photographs shall be at least 20 by 24-inches, standard weight prints with a satin finish.

D. Provide high quality digital photographs on CDs. The file format shall be "jpg". The digital photographs shall be provided in addition to the standard photographs required under Paragraph 1.3.C., above. Need to provide a file for all required under paragraph 1.2.A.

E. Provide interior and exterior photographs of each buried structure prior to burial. Provide a minimum of four internal views and four external views of each structure. One view shall be provided of each wall, detail, floor and top of structure.

F. Place the following information on the back of each print and on front for digital photographs:
   1. Date photograph was taken.
   2. Title of Project, WS #.
   3. Description of view shown in photograph.
   4. North Arrow reference.

1.4 PRE-CONSTRUCTION PHOTOGRAPHS

A. Policy

   1. Photography on facility grounds is strictly controlled. All personnel must submit a written application request to Water Services Department, Security Management Unit for photography and receive written permission. Application must include name of company, the photographer, and area of interest. If written application is not submitted prior to the commencement of photography activities, on-site security personnel will stop the activities, confiscate the media materials and notify the Security Management Unit.

2. Once permission is received, the on-site security personnel and Security Management Unit (602-388-5244) must be notified before photos or videotapes are made.
3. Prior to departing from the site, photographer must have the materials reviewed by either the Facility Supervisor or the O&M Supervisor. For media that's not readily viewable, such as film that needs to be developed, the photographer must allow the Facility Supervisor or O&M Supervisor to review the materials prior to any use of the materials.

B. General
1. It is the CONTRACTORS responsibility to provide pre-construction photographs and video, so as to resolve any disputes which may arise regarding the considerations prior to and subsequent to construction, belongs to CONTRACTOR.
2. If a dispute arises where no Pre-construction photographs were provided, the disputed area shall be restored to the extent directed by the ENGINEER and to the complete satisfaction of the ENGINEER.
3. Prior to the start of any construction activities the CONTRACTOR shall furnish (2) sets of color pre-construction photographs and video for approval; one for the ENGINEER and one for City of Phoenix.
4. Pre-construction photographs taken by CONTRACTOR will not be considered as part of the required number of construction photographs required in Paragraph 1.2, above.
5. A high-quality video of the site in digital format shall be made and submitted by the CONTRACTOR.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01330

SUBMITTALS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Submittal of documents described in the General Conditions, Supplementary Conditions and hereinafter are required prior to, during and at the end of the construction period. The submittals shall conform to the requirements described in this Section and all referenced Sections or Articles.

1.2 GENERAL SUBMITTAL REQUIREMENTS

A. A submittal shall be made for each complete system. Piece-meal submittals will not be accepted.
B. Submittals requiring ENGINEER review only will be processed within fourteen (14) calendar days after receipt from CONTRACTOR. Submittals requiring ENGINEER and OWNER review will be processed within twenty-one (21) calendar days after receipt from CONTRACTOR.
C. CONTRACTOR shall maintain a file of all approved submittal documents at the work site.
D. CONTRACTOR shall show his executed internal review and approval marking. Submittals which are received from sources other than through CONTRACTOR'S Office or which have not undergone CONTRACTOR review will be returned "Rejected".

1.3 PROCEDURE

A. Submittals within fourteen (14) days after the Notice to Proceed: Submit the following items within fourteen (14) days after the Notice to Proceed. Location of information concerning each submittal is referenced and a copy of each required form is included in Section 01331, Reference Forms.
   1. Preliminary Schedule of Values: Prepare and submit in accordance with Section 01291, Schedule of Values.
   2. Preliminary Schedule of Shop Drawings and Sample Submittal in accordance with the General Conditions and Section 01332, Shop Drawing Procedures.
   3. Preliminary Progress Schedule: Prepare and submit in accordance with Section 01320, Progress Schedule.

B. Submittal within thirty (30) days after the Notice to Proceed: Submit the following items within thirty (30) days after the Notice to Proceed. Location of information concerning each submittal is referenced and a copy of each required form is included in Section 01331, Reference Forms.

1. Schedule of Values: Prepare and submit in accordance with Section 01291, Schedule of Values.
2. Submittal Schedule: Prepare and submit schedule of all Shop Drawings in accordance with Section 01332, Shop Drawing Procedures.
3. Monthly payment schedule.
4. Maintenance of Plant Operations Schedule, in accordance with Section 01143, Coordination with OWNER'S Operations.
5. Ninety-day Bar Chart Schedule: Prepare and submit a 90-day Bar Chart Schedule within thirty (30) days, in accordance with Section 01320, Progress Schedule.

C. Submit the following items within thirty (30) days after the Notice to Proceed. Location of information concerning each submittal is referenced and a copy of each required form is included in Section 01331, Reference Forms.
   1. Progress Schedule: Prepare and submit a Progress Schedule within thirty (30) days, in accordance with Section 01320, Progress Schedule.

D. Submit the following items at the Pre-construction Conference: Refer to Section 01332, Shop Drawing Procedures.

E. Submittals Prior to Beginning the Work: Refer to the General Conditions and Supplementary Conditions of the Contract Documents.

F. Submittals During Construction: During progress of the construction, provide the following submittals in a timely manner to prevent any delay in the Work schedule:
   1. Updates to Progress Schedule: Provide an assessment of Work progress in relation to the Progress Schedule in accordance with Section 01320, Progress Schedule.
   2. Shop Drawings, Product Data and Samples: Submit Shop Drawings, product data and samples in accordance with Section 01332, Shop Drawing Procedures, and as required in various Sections of the Contract Documents.
   3. Progress Payments: Submit applications for partial payments as specified in the General Conditions. MBE/WBE Utilization Form, included in Section 01331, Reference Forms, shall be submitted with each progress payment.
   4. Request for Information: Submit a Request for Information (RFI), included in Section 01331, Reference Forms, when any of the following are required: an interpretation of the Specifications; additional details; information not shown on the Drawings or in the Specifications; or clarification of discrepancies is needed. Retain one copy and submit two (2) hard copies and one (1) electronic PDF format copy to the ENGINEER for response. Once the RFI is commented on by the ENGINEER, an electronic PDF format copy will be forwarded to the OWNER.

   5. Change Orders: Forms shown in Section 01331, Reference Forms. A proposal for a Change Order may be submitted by CONTRACTOR in accordance with the General Conditions. The Change Order Proposal included in Section 01331, Reference Forms, must be in writing and must include sufficient information to

assess the need for a change in the Work, the Contract time or the Contract amount. Whenever the ENGINEER determines the need for a Change Order, a Request for Change Order Proposal Form included in Section 01331, Reference Forms, will be issued to CONTRACTOR. Upon receipt of a Request for Change Order Proposal Form or when CONTRACTOR determines the need for a Change Order, prepare and submit three copies of a Change Order Proposal. The Change Order Proposal must be approved by CONTRACTOR, ENGINEER, and OWNER. When a Change Order Proposal has been accepted, a Work Change Directive shall be submitted. Each Work Change Directive shall include a Change Order Pricing Sheet, included in Section 01331, Reference Forms. After the Work Change Directive has been accepted by the OWNER, a Change Order included in Section 01331, Reference Forms, will be prepared and executed. Not authorized to begin work on a Change Order until it is fully executed. Any Work done by CONTRACTOR prior to execution of a Change Order is entirely at his own risk.

6. Use of CONTRACTOR'S Contingency: Shown in Section 01331, Reference Forms: Submit the CONTRACTOR'S Contingency Usage Request including a description for use of the contingency and costs associated for review by the ENGINEER and acknowledgement by the OWNER.
7. CONTRACTOR'S Daily Report: Shown in Section 01331, Reference Forms: Submit four copies of CONTRACTOR'S Daily Report. CONTRACTOR and each subcontractor shall prepare and submit a daily report on forms shown in Section 01331, Reference Forms. The report shall contain, as a minimum, information on the location and description of the Work being performed, size, quantity and description of materials and equipment installed or delivered, coordination or scheduling concerns, requests for clarifications, and any discrepancies noted in the Contract Documents or on the as-built conditions. The report shall also contain CONTRACTOR'S daily workforce count by craft, general weather conditions, any Work performed other than during established working hours, and any other pertinent items relative to the Work, and as required by ENGINEER. The report is due at the ENGINEER'S office by 9:00 a.m. on the following Work day and shall be signed by a responsible member of CONTRACTOR'S staff.
8. Submittal Schedule: Shown in Section 01331, Reference Forms. Submit an updated Shop Drawing, Product Data and Sample Submittal Schedule with each Progress Payment Request. Three updated Submittal Schedules shall be submitted with each month's Progress Payment Request.
9. Construction Photographs: Submit Construction Photographs and Aerial Photographs with each month's Progress Payment Request as specified in Section 01323, Construction Photographs.
10. Operation and Maintenance Manuals and Lesson Plans: Submit Equipment Operation and Maintenance Manuals for approval, by the ENGINEER, within 30 days after approval of Equipment Shop Drawing. Submit Equipment Training Lesson Plans for approval, by the ENGINEER, 60 days prior to commencement of training. Submit Operation and Maintenance Data and Lesson Plans in

accordance with Section 01781, Operation and Maintenance Data and Section 01821, Instruction of Operations and Maintenance Personnel.

11. Submit test procedures for Start up, Burn-in, Field Operations Checks and Commissioning a minimum of fourteen (14) days prior to commencement of the first scheduled test date. The CONTRACTOR should allow up to seven (7) days for ENGINEER'S review.
12. Submit preventive maintenance data associated with the equipment/asset shop drawing package at the same time as the shop drawing. The preventive maintenance data submittal requirement is further described in Section 01785 – PREVENTIVE MAINTENANCE DATA.

G. Submittal at Substantial Completion: Submit all Operations and Maintenance Data for each item of Work commissioned into operation.

H. Submittal At Project Closeout: With a written Notice of Completion, submit the following items in the proper form as a condition of Final Acceptance of the Work:
   1. Project Record Documents: Submit in accordance with Section 01782, Record Documents.
   2. Guarantees, Warranties and Bonds: Submit as required in the General Conditions and listed in various Sections of the Specifications, and Section 01781, Operation and Maintenance Data.
   3. Operations and Maintenance Data: Submit all remaining product data, field test data and manuals as specified in various Sections of the Specifications, and Section 01781, Operation and Maintenance Data.
   4. Survey notes.
   5. Construction photographs of all completed Work, in accordance with Section 01323, Construction Photographs.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01331

REFERENCE FORMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section contains the required forms for CONTRACTOR use in documenting testing Work and other Work required under this Contract. This Section supplements but does not supersede specific testing requirements found elsewhere in the Contract Documents.

B. The forms listed below are included in this Section are referenced from other Sections in the Contract Documents. Forms will include, but will not necessarily be limited to the list below. The forms provided indicate minimum requirements. If desired to use a supplemental form the document must be submitted for review and approval by the ENGINEER.

Form No.	Title
00800-A	Certificate of Substantial Completion
00800-B	Contractor's Affidavit Regarding Settlement of Claims
01143-A	Extended Construction Work Hours Permit Application
01330-A	Schedule of Values
01330-B	Shop Drawings, Product Data/Sample Submittal Schedule
01330-C	Authorized Signatures Form
01330-D	Application for Payment
01330-E	MBE/WBE Utilization Form
01330-F	Request for Change Order Proposal
01330-G	Change Order Proposal
01330-H	Work Change Directive
01330-I	Change Order Pricing Sheet
01330-J	Change Order
01330-K	Request for Information
01330-L	Request for Alteration
01330-M	Contractor's Daily Construction Report
01330-N	TV Inspection Request
01330-O	Contractor Submittal Review Checklist
01330-P	Submittal Review Form
01330-Q	Contractors Contingency Usage Request
01332-A	Submittal Transmittal Form
01332-B	Shop Drawing Review Checklist
01415-A	Confined Space Data Sheet
01415-B	Confined Space Entry Permit
01415-C	Confined Space Hot Work Permit
01600-A	Equipment Information Form

01600-B	Unit Responsibility Certification Form
01600-C	Equipment Manufacturer Vendor Installer Info Form
01620-A	Manufacturer's Installation Certification Form
01620-B	Delivery Inspection Form
01752-A	Equipment Test Report
01781-A	Operating and Maintenance Contractor Checklist
01781-B	Operating and Maintenance Engineer and PM Checklist
01781-C	Operating and Maintenance Binder Spines
01781-D	Operating and Maintenance Cover and Title Page
01781-E	Operating and Maintenance Table of Contents
01781-F	Operating and Maintenance CD Label
01783-A	Spare Parts Receiver Form
01785-A	Preventive Maintenance Data Submittal Form
01821-A	Manufacturers Instruction Certification Form
01821-B	Training Request Form
11000-A	Motor Data Form
16000-A	Wire and Cable Resistance Test Data Form
16000-B	Conduit and Wire Termination Sheet
16000-B	Installed Motor Test Data Form
16215-A	Power System Arc Flash Sign-off Form
17001-C	Functional Acceptance Test
17260-A	Factory Acceptance Test Report

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

Form 00800-A

CITY OF PHOENIX
WATER SERVICES DEPARTMENT

CERTIFICATE OF SUBSTANTIAL COMPLETION

PROJECT NUMBER	PROJECT TITLE

DATE OF ISSUANCE: _____ OWNER'S CONTRACT NO.:_____

OWNER: **CITY OF PHOENIX**

ENGINEER: _____

CONTRACTOR: _____

This Certificate of Substantial Completion applies to all Work under the Contract Documents or to the following specified parts thereof:

OVERALL PROJECT

To: **CITY OF PHOENIX**
OWNER

And to_____
CONTRACTOR

The Work to which this Certificate applies has been inspected by authorized representatives of OWNER, CONTRACTOR and ENGINEER, and that Work is hereby declared to be substantially complete in accordance with the Contract Documents on

TYPE DATE HERE
DATE OF SUBSTANTIAL COMPLETION

A tentative list of items to be completed or corrected is attached hereto. This list may not be all-inclusive, and the failure to include an item in it does not alter the responsibility of CONTRACTOR to complete all the Work in accordance with the Contract Documents. The items in the tentative list shall be completed or corrected by CONTRACTOR by Final Completion.

Form 00800-B

CONTRACTOR'S AFFIDAVIT
REGARDING SETTLEMENT OF CLAIMS

Project No.:_____

Contract No.:_____

Gentlemen:

This is to certify that all lawful claims for materials, rental of equipment and labor used in connection with the construction of the above project, whether by subcontractor or claimant in person, have been duly discharged.

The undersigned, for the consideration of $_____as set out in the final pay estimate, as full and complete payment under the terms of the contract, hereby waives and relinquishes any and all further claims or right of lien under, in connection with, or as a result of the above described project. The undersigned further agrees to indemnify and save harmless the City of Phoenix against any and all liens, suits, damages, charges and expenses whatsoever, which said City may suffer arising out of the failure of the undersigned to pay for all labor performance and materials furnished for the performance of said installation.

_____
Contractor

_____
By

_____
Title

State of_____

County of_____

The forgoing instrument was subscribed and sworn to before me this ___ day of _____, 20____.

_____
Notary Public

_____
Commission Expiration Date

City of Phoenix
DEVELOPMENT SERVICES DEPARTMENT

Extended Construction Work Hours
Permit Application

City Code Section 23-14 (h) authorizes issuance of permits for extended construction work hours if there is an emergency condition or if the public peace and quiet will not be unreasonably disturbed. A permit is required for any work performed on Saturdays or Sundays throughout the year, for work on weekdays **before 7:00 a.m. or after 7:00 p.m. from October 1 through April 30,** or for work on weekdays **before 6 a.m. or after 7:00 p.m. from May 1 through September 30.**

CONDITIONS OF APPROVAL

If application is approved, the following conditions must be met:

A. **Construction traffic is limited to major streets. Use of residential neighborhood streets is prohibited.**
B. **Maximum practical distance shall be maintained between residences and work sites.**
C. **If a term longer than 30 days is required to complete work, the applicant may request renewal of this permit.**
D. **This permit may be immediately revoked if unresolved complaints are brought to the attention of the Development Services Department.**
E. **Special Conditions:** _____

_____

APPLICATION FOR EXTENDED CONSTRUCTION WORK HOURS

Complete Items 1 through 4

1. PROJECT DEVELOPMENT ACTIVITY

Project Name _____

Project Location Address _____

Name of On-Site Job Superintendent _____

Phone _____

Extension Requested For:

Date From _____ Date To _____

Day(s) of Week _____

Time(s) of Day _____

2. APPLICANT INFORMATION

Name _____

Firm/ Organization _____

Address _____

_____

Phone _____ FAX _____

Email _____

Applicant's Signature _____

Date _____

3. RATIONALE: PLEASE ATTACH A WRITTEN RATIONALE FOR REQUESTING AN EXTENDED HOURS PERMIT.
Note: All requests for projects located in or near a residential area must be accompanied by a site plan showing proximity to residents. An approved haul plan and a permit are prerequisites for extended hauling hours.

4. FEES: ☐ **Original** - $300 (up to 30 days) ☐ **Renewal** - $150 (up to 30 days)

FOR STAFF USE ONLY

☐ Approved ☐ Approved w/ modifications ☐ Denied **Ext Hrs Permit Number** ☐ EXTH _____ ☐ EXTR _____

Date, Day(s) of Week, Hours _____

Authorizing Signature _____ Phone _____ Date _____

Fee Collected $ _____ Date Paid _____ Receipt # _____

Project Info: Project # _____ Permit Type/# _____ Qtr Section _____

cc: City Council District _____ Police Patrol Division _____ Other _____

Applications will be accepted at 200 West Washington, 2nd Floor,
or they may be faxed to the attention of Extended Hours Permit Coordinator at (602) 534-3274

This publication can be made available in alternate formats (Braille, large print, computer diskette, or audiotape) upon request. Contact the Development Services Department at (602) 262-7811 voice or (602) 534-5500 TTY.

Extended Construction Work Hours Permit Information Sheet

A permit is required for any work performed on Saturdays or Sundays throughout the year, for work on weekdays **before 7:00 a.m. or after 7:00 p.m. from October 1 through April 30,** or for work on weekdays **before 6 a.m. or after 7:00 p.m. from May 1 through September 30.**

1. Obtain an Extended Hours Construction Permit application form from the Development Services Department, 200 West Washington, 2nd Floor, Plan Review Reception Area (west side of the 2nd floor). A fillable pdf form may also be obtained on-line at http://phoenix.gov/DEVPRO/extendhrs.pdf.

2. Fill out the application requesting the dates and times you would like to work outside the permissible hours.

3. Provide a reason the work must be done outside the allowable times. Please be specific as this rationale is part of the criteria used to evaluate your request.

4. Your application will be reviewed by a member of the Project Coordination Team. The project coordinator researches whether the location is near a residential development, and whether neighborhood complaints have been received by the Development Services Department or another city department.

5. One of three actions will occur in response to your application.
   - The extended hours permit application may be approved as it is requested.
   - The application may be approved with a modified schedule.
   - The application may be denied.

   A response to your request is typically made within two (2) working days of receiving the application. **If you are near occupied residences, please allow additional time for research.** Moreover, you may be required to create and distribute flyers with contact information before obtaining your permit. A template containing required information is available on the 2nd Floor or by calling the phone number below.

6. After your application has been reviewed, researched and action taken, you will be called. If a permit is granted, you may obtain and pay for your permit at City Hall, Development Services Department Plan Review Reception Office, 200 West Washington, 2nd Floor.

7. A new permit is valid for a maximum of 30 days. The fee for the first permit is $300. An application for renewal may be made following the same process if a renewal application is submitted **prior to expiration** of the existing permit. The renewal fee is $150, also for a maximum of 30 days. If your permit has expired, the permit fee will be $300.

8. Flyers are required for concrete pours or any other construction work which will disturb the public peace and quiet in or near a residential area. The flyer must contain the following information:
   - Work hours
   - Date of the pour(s)
   - Name and number of a contact person who will be on-site and available to discuss complaints at the time of the construction activity.

   A template is available detailing required information at City Hall, Development Services Department Commercial Reception Office, 200 West Washington, 2nd Floor. One can also be Emailed to you.

9. Subcontractors requesting to work outside the permissible hours must submit a letter of consent from the developer with the application.

Questions may be directed to the Development Services Department at (602) 534-5482.

Form 01330-A

SCHEDULE OF VALUES

Sheet _____of _____

Section No. _____

Item Description	Material	Labor	Equipment	Total

Form 01330-B

SHOP DRAWINGS, PRODUCT DATA AND SAMPLE SUBMITTAL SCHEDULE

CONTRACTOR _____
Project Name _____
Project No. _____ Date _____ Page ___ of_____

Item No.	Description	Specification Section Number	Date To Be Submitted	Approval Needed By	Date Submitted	Date Reviewed	Transmittal Number

Form 01330-C

AUTHORIZED SIGNATURES FORM
(Corporation)

Gentlemen:

WHEREAS, _____, a(n) (Name of State) _____ Corporation, is required to execute documents which are necessary for the prompt and efficient execution of the corporate business:

NOW, THEREFORE, BE IT RESOLVED, (by the Board of Directors of the Corporate Name), that name of parties listed below be authorized to execute and sign on behalf of said corporation the following documents:

1. The Proposal
2. The Contract
3. The Bond
4. Payrolls
5. Claims
6. Change Orders
7. Application for Payment
8. Work Change Directives
9. All other papers necessary for the corporation's affairs and the execution of the contract.

The powers and duties herein granted shall be and is hereby granted for the duration of the contract for the construction of the _____, Project No. _____, or until express notice of revocation has been duly given in writing, whichever is the lesser period.
Dated and passed by the Board of Directors this _____ day of _____, 20__.

NAME	SIGNATURE	TITLE	DOCUMENTS
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

I, _____ of the _____, a corporation, do hereby certify that the above is a true and correct copy of a resolution adopted by the Board of Directors of said corporation, at a meeting of said board held on _____, day of 20___, and that the same is in full force and effect at this time.

(Seal of Corporation)

_____
(OFFICER OF CORPORATION)

_____
(NAME & TITLE)

STATE OF _____

COUNTY OF _____

This instrument was acknowledged before me this _____ day of _____. 20 _____
By _____ appearing before the undersigned Notary Public, and stated that he executed such instrument on behalf of said corporation for the purpose and consideration therein expressed.

My Commission Expires: _____ _____
(NOTARY PUBLIC)

Form 01330-D

CITY OF PHOENIX
WATER SERVICES DEPARTMENT

DISTRIBUTION:
ACCOUNTS PAYABLE
CENTRAL FILES
PAYMENT FILE

APPLICATION FOR PAYMENT

To: Project Manager
200 W. Washington Street, 8th Floor
Phoenix, Arizona 85003

Progress Payment No. __

Payment Period: From mm/dd/yy to mm/dd/yy

Project No.	Project Name	Contract No.
WSXXXXXXXX-1	**NAME OF PROJECT**	**XXXXX**

Name of Contractor	Telephone	Fax
NAME OF CONTRACTOR	**(XXX) XXX-XXXX**	**(XXX) XXX-XXXX**

Address	Notice To Proceed Date
CONTRACTOR'S ADDRESS	**MM/DD/YY**

ITEM NO.	DESCRIPTION List Contract Items, Change Order Items, and Deductions, Each with Subtotals	CONTRACT AMOUNT	ESTIMATED AMOUNT THIS PERIOD	AMOUNT PREVIOUSLY INVOICED	AMOUNT COMPLETED TO DATE
xxxxx	Xxxxxxxxxxxxxxxxxxxxxxxxxxx	$xx,xxx,xxx.xx	$xx,xxx,xxx.xx	$xx,xxx,xxx.xx	$xx,xxx,xxx.xx

ATTACHMENTS: SCHEDULE OF VALUES	GROSS AMOUNT DUE:	$xx,xxx,xxx.xx
	☐ RETAINAGE - 10%	$xx,xxx,xxx.xx
	☐ SECURITIES - 10%	$xx,xxx,xxx.xx
	NET AMOUNT DUE TO DATE:	$xx,xxx,xxx.xx
	LESS AMOUNT PREVIOUSLY PAID:	$xx,xxx,xxx.xx
	AMOUNT DUE THIS APPLICATION:	**$xx,xxx,xxx.xx**

CITY OF PHOENIX: Water Services Department
PROJECT NAME: Lift Station 76 Phase II Expansion
PROJECT NUMBER: WS90400067

CERTIFICATION OF CONTRACTOR: I certify that all items and amounts shown on the face of this Application for Payment are correct, that to the best of my knowledge and belief, all work has been performed and/or material supplied in full accordance with the requirements of the referenced contract, and/or duly authorized deviations, substitutions, alterations, and/or additions; that the foregoing is true and correct statement of the contract account up to and including the last day of the period covered by this Application that no part of the "Amount Due This Application" has been received, and that the undersigned and subcontractors have: (check applicable line).

☐ a. Complied with all labor provisions of said contract.

☐ ☐ b. Complied with all the labor provisions of said contract except in those instances where a dispute exists with respect to said labor provisions. (If "b" is checked, include attachment briefly describing nature of dispute.)

Contractor Representative _____ Date _____

Title _____

CERTIFICATION OF ENGINEER: I certify that all work described was inspected, and that to the best of my knowledge and belief the work was performed and/or supplied in full accordance with the requirements of this contract.

Resident Project Representative _____ Date _____

I certify that I have checked and verified the above and foregoing Application for Payment; that to the best of my knowledge and belief it is a true and correct statement of work performed and/or material supplied by the contractor; that all work and/or material included in this Application has been inspected and that it has been performed and/or supplied in full accordance with the requirements of the referenced contract; and that payment claimed and requested by the Contractor is correctly computed on the basis of work performed and/or material supplied to date.

Project Manager/Engineer _____ Date _____

Firm _____

CITY USE ONLY BELOW THIS LINE

RECOMMENDED BY:

Project Manager _____ Date _____

APPROVED BY:

Superintendent _____ Date _____

CITY OF PHOENIX
WATER SERVICES DEPARTMENT

CONTINUATION OF APPLICATION FOR PAYMENT

PROGRESS PAYMENT NO. 1

Project No. **WSXXXXXXXX-1**	Project Name **NAME OF PROJECT**				Contract No. **XXXXX**
ITEM NO.	DESCRIPTION List Contract Items, Change Order Items, and Deductions, Each with Subtotals	CONTRACT AMOUNT	ESTIMATED AMOUNT THIS PERIOD	AMOUNT PREVIOUSLY INVOICED	AMOUNT COMPLETED TO DATE
XXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXX	$XX,XXX,XXX.XX	$XX,XXX,XXX.XX	$XX,XXX,XXX.XX	$XX,XXX,XXX.XX

Form 01330-E

CITY OF PHOENIX EQUAL OPPORTUNITY DEPARTMENT
CONTRACTOR'S MONTHLY STATEMENT OF MBE/WBE UTILIZATION

CONTRACTOR: _____ PAY REQUEST NO.: _____ REPORT PERIOD FROM: _____ to _____

Project Number: _____	**Base Bid Amount:** $
Project Description: _____	**Required Goals**: MBE _____% WBE _____%
	Proposed Goals: MBE _____ % WBE _____%

M/WBE Business Name Representative Name and Telephone Number	MBE or WBE	Original Contract Amount	Contract Adjustments	Revised Contract Amount	AMOUNT EARNED THIS PERIOD	AMOUNT EARNED TO DATE	Amount Retained this Period	Amount Retained to Date	Percentage Completed to Date
Minority Owned Business Enterprise Totals									
Woman Owned Business Enterprise Totals									

Authorized Signature: _____ **Date:** _____

Name and Title: _____

FOR CITY OF PHOENIX USE
Percent of total project complete _____ % Date: _____

City Project Manager _____
Signature

Form 01330-F

REQUEST FOR CHANGE ORDER PROPOSAL

Date: _____

CONTRACTOR _____

_____

_____

Project Name _____

Project No. _____

Change Order No. _____

NOTICE TO CONTRACTOR: Please submit a Change Order Proposal for the proposed modifications to the Contract Documents as described below. If acceptable, a Change Order will be issued to authorize the work. THIS IS NOT A CHANGE ORDER FOR AUTHORIZATION TO PROCEED WITH THE WORK AS DESCRIBED!

SCOPE OF WORK:

OWNER _____

Form 01330-G

CHANGE ORDER PROPOSAL

Date _____

Subject: Project Name _____

Project No._____

Change Order No._____

Dear Sir:

Certain items of extra work have been found necessary which are not covered by the Contract for the above referenced Project. Therefore, we submit the following amounts as the basis of compensation for such extra work:

JUSTIFICATION:

The Contract completion time will be (increased)(decreased) ___ consecutive calendar days.

Total Cost of Extra Work Covered by Above:	$_____
Previously Approved Extra Work:	$_____
Original Contract Amount	$_____
TOTAL:	$_____

By: _____

Title:_____

CONTRACTOR: _____

Form 01330-H
CHANGE ORDER DIRECTIVE

CITY OF PHOENIX
WATER SERVICES DEPARTMENT

WORK CHANGE DIRECTIVE NUMBER X

Project No.	Project Title
WSXXXXXXX	**NAME OF PROJECT**

CONTRACTOR:_____ CONTRACT NUMBER: _____

IN ACCORDANCE WITH THIS CONTRACT, THE FOLLOWING CHANGE IS ORDERED.

DESCRIPTION:

Γ AUTHORIZATION FOR WORK DESCRIBED HEREIN TO PROCEED ON A NEGOTIATED COST BASIS.

Γ AUTHORIZATION FOR WORK DESCRIBED HEREIN TO PROCEED ON A TIME AND MATERIALS BASIS.

COST:

NET AMOUNT OF THIS WORK CHANGE DIRECTIVE = $_____

THE ENGINEER HAS REVIEWED THE COST FOR THIS WORK CHANGE DIRECTIVE AND CONSIDERS IT REASONABLE FOR THE LABOR AND MATERIAL NECESSARY TO COMPLETE THE WORK.

CONTRACT TIME: Γ INCREASE BY _____ DAYS. Γ NO CHANGE.

RECOMMENDED BY:_____ DATE: _____
ENGINEER

ACCEPTED BY: _____ DATE: _____
CONTRACTOR

APPROVED BY: _____ DATE: _____
OWNER

01330-I CHANGE ORDER PRICING SHEET

CHANGE ORDER PRICING SHEET **CITY OF PHOENIX - WATER SERVICES DEPARTMENT** **PROJECT: WSXXXXXXXX**	**Description of Work:**	**Prepared by:** **Date:**

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Item No.	Description	Quantity	Unit of Measure	Labor Unit Cost From Table 1 Column S	Labor Total Cost (C x E)	Material Unit Cost 11.4.2	Material Total Cost (C x G)	Equipment Unit Cost 11.4.5.3	Equipment Total Cost (C x I)	Supplemental 11.4.4/11.4.5 11.6.2.4	Supplemental Total Cost (C x K)	Subcontract Unit Cost 11.6.2.3	Subcontract Total Cost (C x M)	Subtotal (F+H+J+L+N)
1					$0.00		$0.00		$0.00		$0.00		$0.00	$0.00
2					$0.00		$0.00		$0.00		$0.00		$0.00	$0.00
3					$0.00		$0.00		$0.00		$0.00		$0.00	$0.00
4					$0.00		$0.00		$0.00		$0.00		$0.00	$0.00
5					$0.00		$0.00		$0.00		$0.00		$0.00	$0.00
6					$0.00		$0.00		$0.00		$0.00		$0.00	$0.00
7					$0.00		$0.00		$0.00		$0.00		$0.00	$0.00
8					$0.00		$0.00		$0.00		$0.00		$0.00	$0.00
9					$0.00		$0.00		$0.00		$0.00		$0.00	$0.00
10					$0.00		$0.00		$0.00		$0.00		$0.00	$0.00
11					$0.00		$0.00		$0.00		$0.00		$0.00	$0.00
12					$0.00		$0.00		$0.00		$0.00		$0.00	$0.00
13					$0.00		$0.00		$0.00		$0.00		$0.00	$0.00
14					$0.00		$0.00		$0.00		$0.00		$0.00	$0.00
15					$0.00		$0.00		$0.00		$0.00		$0.00	$0.00
16					$0.00		$0.00		$0.00		$0.00		$0.00	$0.00
17					$0.00		$0.00		$0.00		$0.00		$0.00	$0.00
18					$0.00		$0.00		$0.00		$0.00		$0.00	$0.00
19					$0.00		$0.00		$0.00		$0.00		$0.00	$0.00
20					$0.00		$0.00		$0.00		$0.00		$0.00	$0.00
COLUMN SUBTOTALS					$0.00		$0.00		$0.00		$0.00		$0.00	$0.00
11.6.2.1 Fee for work by Contractor		15.00%			$0.00		$0.00							$0.00
11.6.2.5 Fee for net credit Change Order		5.00%			$0.00		$0.00							$0.00
11.6.2.2 Fee for work by Subcontractor		5.00%											$0.00	$0.00
COLUMN TOTALS					$0.00		$0.00		$0.00		$0.00		$0.00	$0.00

TABLE 1 - Labor Rates 11.4.1			
P. Work Classification	Q. Base Hourly Wage Rate	R. Burden (Submit Detail)	S. Total Hourly Rate
			$0.00
			$0.00
			$0.00
			$0.00
			$0.00

NOTES:

1. See Contract General Conditions Article 11.
2. Also submit CHANGE ORDER PRICING SHEET for Subcontract work listed above and exceeding $500.

SUBTOTAL CHANGE ORDER AMOUNT	**$0.00**
ADJUSTMENTS	
GRAND TOTAL CHANGE ORDER AMOUNT	**$0.00**

ROUTE TO:

GRAY - CITY CLERK
PINK - FINANCE
GREEN - CONTRACTOR
BLUE - CENTRAL FILES
GOLDENROD - WATER DEPT.
CANARY - PROJECT MANAGER
WHITE - ENGINEER

CITY OF PHOENIX: Water Services Department
PROJECT NAME: Lift Station 76 Phase II Expansion
PROJECT NUMBER: WS90400067

Form 01330-J
CHANGE ORDER

CITY OF PHOENIX
WATER SERVICES DEPARTMENT
CONSTRUCTION MANAGEMENT DIVISION

☐ Form A
☐ Form B
☐ Form C

CONTRACT CHANGE ORDER NO. X

PROJECT NUMBER	PROJECT TITLE		
WSXXXXXXXX-1	**NAME OF PROJECT**		
CONTRACT NUMBER	NAME OF CONTRACTOR	% COMPLETE($)	% TIME USED
XXXXX	**NAME OF CONTRACTOR**	**XX%**	**XX%**

In accordance with this contract, the following change is ordered, resulting in: (Check all that apply).

☐ Increase in Contract Amount ☐ No Change in Contract Amount ☐ Decrease in Contract Amount
☐ Increase in Contract Time ☐ No Change in Contract Time ☐ Decrease in Contract Time

DESCRIPTION: **COST:** _____

Work Change Directive No:
Prepared BY:

THIS CHANGE ORDER:	PRIOR CHANGE ORDER(S):	ORIGINAL CONTRACT:	ADJUSTED CONTRACT:
AMOUNT: $_____ TIME (Days): _____	AMOUNT: $_____ TIME (Days): _____	AMOUNT: $ _____ TIME (Days): _____	AMOUNT: $ _____ TIME (Days): _____
Notice to Proceed Date: _____	Original Contract Completion Date: _____		Adjusted Contract Completion Date: _____

We, the undersigned, have given careful consideration to the change proposed, and hereby agree, if this proposal is approved, that we will provide all equipment, furnish all materials, except as may otherwise be noted above, and perform all services necessary for the work specified, and will therefore, accept as full payment, the fees or prices and adjustments in contract time shown above. This Change Order includes all direct costs such as labor, material, job overhead, profit, costs for modifications or changes in sequence of work to be performed, delays, rescheduling, disruptions, extended direct overhead or general overhead, acceleration, material or other escalation which include wages and other impact costs.

REVIEWED BY:
_____ _____
(Engineer) DATE

RECOMMENDED BY:
_____ _____
(A or B - Project Manager) (C – Superintendent) DATE

ACCEPTED (Contractor):

COMPANY/FIRM:
NAME OF CONTRACTOR

SIGNATURE: _____

TITLE: _____ DATE: _____

PREPARED BY:

_____
PROJECT MANAGER

RECOMMENDED BY:
_____ _____
(A or B - Project Manager) (C – Superintendent) DATE

APPROVED BY:
_____ _____
(A or B - Superintendent) (C - Assistant Director) DATE

AUTHORIZED FOR THE CITY MANAGER BY:
_____ _____
(A or B - Assistant Director) (C – Director) DATE

Form 01330-K
REQUEST FOR INFORMATION

CONTRACTOR_____ RFI#_____
Requested By_____ Directed to _____
Subject_____ Date Received _____
Spec. Section_____ Date Transmitted _____
Drawing References_____ Date Reply Received _____
Date Reply Needed_____ Date Reply Transmitted _____

INFORMATION NEEDED:

Date _____ Signature _____

REPLY:

Date _____ Signature _____

Form 01330-L
REQUEST FOR ALTERATION

CONTRACTOR_____ RFA# _____
Requested By_____ Directed to _____
Subject_____ Date Received _____
Spec. Section_____ Date Transmitted _____
Drawing References_____ Date Reply Received _____
Date Reply Needed_____ Date Reply Transmitted _____

REQUESTED ALTERATION:

Date _____ Signature _____

REPLY:

Date _____ Signature _____

Form 01330-M
CONTRACTOR'S DAILY CONSTRUCTION REPORT

CONTRACTOR _____

Project Name _____
Project No. _____ Report No. _____ Date _____

CONTRACTORS WORK FORCE:		SUBCONTRACTORS WORK FORCE:		EQUIPMENT ON SITE:	In Use	Not in Use
Administrative		Mechanical		Cranes		
Supervisors		Electrical		Loaders		
Carpenters		Instrumentation		Dozers		
Iron Workers		Site work		Scrapers		
Operators		Masonry		Compactors		
Finishers		Roofing		Compressors		
Welders		Rebar		Welders		
Electricians		Foundation		Graders		
Laborers		Painting		Trucks		
				Backhoe		

Work Performed: _____

Material and Equipment Delivered: _____

Remarks: _____

By: _____

Title: _____

Form 01330-N
TV INSPECTION REQUEST

CITY OF PHOENIX
WATER SERVICES DEPARTMENT

DATE: _____ REQUESTOR: _____

PHONE #: _____

LOCATION: _____

_____

REASON FOR INSPECTION: _____

_____

Q.S.: _____

(PLEASE PROVIDE COPY OF SECTION TO BE INSPECTED)

LINEAL FT. TO INSPECT: _____

C/O-MH#: _____ TO C/O-MH#: _____

PIPE DIAM.: _____

PIPE TYPE: _____

DEPTH OF FLOW: _____ IN.

MH DEPTH: _____

DATE WHEN LAST CLEANED: MH=S: _____ MAIN: _____

COMMENTS: _____

_____

_____

_____

FOR TV SECTION ONLY

DATE RECEIVED: _____

ASSIGNED TO: _____ DATE: _____ EQUIP: _____

COMPLETED: _____ DATE: _____

COMMENTS: _____

_____

Form 01330-O

CONTRACTOR SUBMITTAL REVIEW CHECKLIST

Contractor shall provide the completed review checklist with submittal to engineer. Submittals provided to the engineer without the completed checklist shall be rejected.

Project Name:_____
Project No.: _____
Project Location:_____
Contractors Name:_____
_____
Received By:_____
Date:_____

Submittal Description: _____
Submittal No.: _____
Specifications: _____
Section: _____
Page No.: _____
Para. No.: _____
Drawing No.: _____ of _____

Review Checklist

Item	Review Description	Yes	No	N/A
1	Submittal Meets Requirements per Specification 01330	☐	☐	☐
2	Submittal Meets Requirements of Referenced Specification Sections	☐	☐	☐
3	If Submittal is a Shop Drawing Check Form 01332-B is Attached	☐	☐	☐
4	If Submittal is an O&M Manual Check Form 01781 is Attached	☐	☐	☐

Contractor

Certify either A or B:

____A. We have verified that the material or equipment contained in this submittal meets all the specified requirements, including coordination with all related work. (no exceptions).

____B. We have verified that the material or equipment contained in this submittal meets all the requirements specified except for the attached deviations.

No.	Deviation
_____	_____
_____	_____
_____	_____

_____ _____
CONTRACTOR'S SIGNATURE: DATE

Form 01330-P

SUBMITTAL REVIEW FORM

(Company Name)

WS#

CONTRACT #

Address:

Phone:
FAX :

Submittal Review

Project Title:	**Submitting Firm:**	**Received Date:**
Facility:	**Reviewer:**	**Reviewed Date:**
Submittal Title:	**Reviewer Phone:**	

ITEM	SPEC/DWG REFERENCE	COMMENT	RESPONSE

Additional comments: *(your remarks here)*

Response Column:

- Inc. - Incorporated verbatim
- Inc. / Edit – Incorporated with modification – include explanation of modification
- N/I – Not Incorporated – include explanation

FORM 01330-Q

CONTRACTORS CONTINGENCY USAGE REQUEST

City of Phoenix
Water Services Department
Construction Management Division

CONTRACTOR CONTINGENCY USAGE REQUEST NUMBER XX

Project No.	Project Title
WS90400081-3	**Lift Station 60 Decommissioning**

CONTRACTOR: _____ CONTRACT NUMBER:

Item	Description	Cost
1		$0.00
2		$0.00
	Total Deduction from Contractor Contingency	$0.00

ADJUSTMENTS:

This Contingency Amount	Prior Contingency Amount	Original Contingency Amount	Adjusted Contractors Contingency
$0.00	**$0.00**	**$0.00**	**$0.00**

CONTRACT TIME: X INCREASE BY 0 DAYS ____ No Change

RECOMMENDED BY: _____ DATE: _____
CONTRACTOR

REVIEWED BY: _____ DATE: _____
ENGINEER

AKNOWLEDGED: _____ DATE: _____
OWNER

Form 01332-A

SUBMITTAL TRANSMITTAL

Project Name:_____ Project No.:_____

Contractor Name:_____ Contract No.: _____

Received By:_____ Date:_____

Provided By:_____ Transmittal No.:_____

Submittal Type: ☐ Pre-Construction ☐ Construction

☐ Substantial Completion ☐ Project Close Out

Submittal Description:_____ Section No.:_____

Submittal Review No.:_____

	Date	No. Copies	Review Action	Review Comments Attached		Review Check List Attached		Reviewer Initials
Contractor				**Yes**	**No**	**Yes**	**No**	
				☐	☐	☐	☐	
Engineer				☐	☐	☐	☐	

Review Action: A - Approved; AC - Approved as Corrected; ACR - Approved as corrected Resubmit
RR - Revise and Resubmit; NR -Not Reviewed; NA - Not Approved
I - For Information Only

_____ _____
CONTRACTOR SIGNATURE/DATE ENGINEER SIGNATURE/DATE

Form 01332-B

SHOP DRAWING REVIEW CHECKLIST

Project Name:_____ Project No.:_____

Shop Drawing Description:_____

Manufacturer:_____ Specification No.:_____

Shop Drawing Review Checklist

Item	Review Description	Contractor			Engineer		
		Yes	No	N/A	Yes	No	N/A
1	Equipment Parts List Provided with Manufacturer Model Number	☐	☐	☐	☐	☐	☐
2	Equipment Manufacturer Catalog Datasheets Provided per piece of Equipment	☐	☐	☐	☐	☐	☐
3	Suggested Spare Parts List Provided	☐	☐	☐	☐	☐	☐
4	Equipment Drawings Provided	☐	☐	☐	☐	☐	☐
5	Equipment and System Wiring Diagrams Provided	☐	☐	☐	☐	☐	☐
6	Applicable Certificates are Provided	☐	☐	☐	☐	☐	☐
7	Mounting Templates, Instructions and Design Calculations were Provided as Required	☐	☐	☐	☐	☐	☐
8	Required Maintenance Operations for Equipment 24 month Idle Period Provided	☐	☐	☐	☐	☐	☐
9	Unloading and Handling Methods Provided	☐	☐	☐	☐	☐	☐
10	Storage Requirements Provided	☐	☐	☐	☐	☐	☐
11	Equipment Paint Submittal Provided and Meets Requirements of Division 9	☐	☐	☐	☐	☐	☐
12	Drawings of Equipment Dimensions Field Verifications	☐	☐	☐	☐	☐	☐
13	Materials that Contact Drinking Water Comply with Specifications for Drinking Water	☐	☐	☐	☐	☐	☐
14	Submittal Includes requirements of Specification 01821 Instruction of Operations and Maintenance Personnel	☐	☐	☐	☐	☐	☐
15	Equipment Specification Requirements have been meet	☐	☐	☐	☐	☐	☐

_____ _____

CONTRACTOR'S SIGNATURE/DATE: ENGINEER'S SIGNATURE/DATE

Form 01415-A
Confined Space Data Sheet

Name of Confined Space:_____

Location of Confined Space:_____

Division/Section Responsible for Confined Space:_____

PRE-ENTRY SYSTEM CONTROL	**Check**
Mechanical: Isolate, lockout and de-energize to zero potential energy.	☐
Engulfment: Blank/block/cap/bleed off lines. Lock out gates, valves, pumps.	☐
Electrical: Lockout/Tagout	☐
Inerting: Flush/Purge/Vent	☐

Special Precautions:_____

ATMOSPHERE

Date of least measured values: _____

Constituent	**O_2**	**Explosive**	**H_2S/Toxic**	**CO**	**Date/Time**	
Permissible	**19.5%-**	**<10%**	**<10ppm H_2S**	**<35ppm**	**Completed**	**Initials**
Range	**23.5%**	**LFL**				
Last Measured Values	_____	_____	_____	_____	_____	_____

SITE AND PERSONAL SAFETY (check if required, list type where applicable)

Personal Protective Equipment:
Safety Harness ☐ Life Lines ☐ Hard Hats ☐ Fall Protection ☐ Retrieval ☐ Eye ☐ Ear ☐
Face ☐ Hand ☐ Foot ☐ Respiratory ☐(type)_____ Clothing ☐(type)_____
Other: ☐_____

Rescue and Emergency Equipment:
Retrieval Equipment ☐ Fire Extinguishers ☐ Radios/Telephone ☐ Ladder ☐
Other ☐ _____
Equipment on Standby for Rescue Personnel ☐_____

Site Safety:
Explosion-Proof Lighting ☐ Barriers/Shield/Barricades ☐(type)_____
Postings/Flagging ☐
Other ☐_____

List specific equipment isolated, de-energized, and locked out.

_____
_____
_____
_____
_____
_____
_____

Form 01415-B
Confined Space Entry Permit

ENTRY TEAM

Division:_____ **Facility:**_____

Specific Confined Space Being Entered:_____

Purpose of Entry (Describe the Work):_____

_____

_____

Date:_____ **Time:**_____ **Expected Job Duration (days/hours):**_____

Entry Supervisor:_____ **Designated Attendant:**_____
Authorized/Qualified Entrants:_____

_____

_____

Entry-Team Rotation:

Date:_____ **Time:**_____

Entry Supervisor:_____ **Designated Attendant:**_____
Authorized/Qualified Entrants:_____

_____

_____

Entry-Team Rotation:

Date:_____ **Time:**_____ **Expected Job Duration (days/hours):**_____

Entry Supervisor:_____ **Designated Attendant:**_____
Authorized/Qualified Entrants:_____

_____

_____

Communication Procedures:
Entry Team:_____

_____

_____

Standby/Rescue Personnel: _____

_____

_____

Sign Offs:
Person Authorizing This Entry:_____

Entry Supervisor:_____

Person Terminating Permit:_____ **Date:**_____ **Time:**_____

Distribution To:_____

Form 01415-C

Confined Space Hot Work Permit

Division:_____ **Facility:**_____

Specific Confined Space Being Entered: _____

Date:_____ **Time:**_____

Expected Job Duration (days/hours):_____

Purpose of Entry (Describe the Work):_____
_____
_____

Explain Why Work Cannot Be Done Outside Of The Confined Space:_____
_____
_____

Safety Equipment Required:

Fire Extinguishers: Yes ☐ No ☐ Number:_____ **Type:**_____

Respirators: Yes ☐ No ☐ Number:_____ **Type:**_____

Other Equipment:_____
_____
_____

Authorizing Supervisor:

Print Name:_____

Signature:_____

Date Signed:_____

Form 01600-A

EQUIPMENT INFORMATION FORM
INSTRUCTIONS

EACH PIECE OF EQUIPMENT PROVIDED WILL REQUIRE AN INDIVIDUAL EQUIPMENT INFORMATION FORM TO BE PROVIDED IN RESPECTIVE O&M MANUAL (I.E., PUMP AND MOTOR, FLOW METER AND TRANSMITTER, PUMP, MOTOR AND V.F.D., SLUICE GATES ETC.).

TITLE BLOCK (HEADER): INSERT PROJECT TITLE.

FACILITY LOCATION: LIST NAME OF WATER SERVICES DEPARTMENT FACILITY WHERE PROJECT IS LOCATED.

SERVICE DESC: PROVIDE DESCRIPTION AS STATED ON DRAWINGS, EXAMPLE: FOR THE DISCHARGE FLOWMETER ON PRIMARY SLUDGE PUMP #1, STATE: PRIMARY SLUDGE PUMP #1 DISCHARGE FLOW.

PROCESS LOCATION: WHERE IN THE PROCESS AT THIS FACILITY DOES ITEM RESIDE, (AS STATED ON THE DRAWINGS).

DRAWING REF: AS SHOWN ON THE ISSUED FOR CONSTRUCTION DRAWINGS. IF NOT AVAILABLE, LEAVE BLANK. (DO NOT STATE THE MANUFACTURERS DRAWINGS OR SCHEMATICS).

"CMMS TAG" # AND SERIALIZED KEY #: AS STATED ON DRAWINGS. IF NOT AVAILABLE, LEAVE BLANK.

VENDOR: PROVIDE NAME OF LOCAL EQUIPMENT REP/VENDOR, (I.E., HENNESY EQUIPMENT, JAMES, COOKE & HOBSON, SOUTHWEST CONTROLS, ETC.).

ASSOC. EQUIP'T: IF ITEM IS PART OF A LARGER PIECE OF EQUIPMENT, EXAMPLE: LUBE OIL PUMP ON BLOWER, THE BLOWER IS THE ASSOC. EQUIPMENT.

MANUF: MOYNO, FLYGT, MILLTRONICS, EATON, DEZURIK, TRANE, CARRIER, ETC.

TYPE: I.E., POSITIVE DISPLACEMENT, SUBMERSIBLE, CENTRIFUGAL, PORTABLE, SINGLE STAGE, TWO STAGE, ETC.

SIZE: VALVES AND GATES: LINE SIZE IN INCHES. AIR CONDITIONING SYSTEMS, OVERHEAD CRANES, AND BRIDGE CRANES: RATING IS IN TONS.

Form 01600-A

(INSERT PROJECT TITLE)

EQUIPMENT INFORMATION FORM

Facility Location:_____ Date:_____

Service Desc:_____ Process Location:_____

Spec Section #:_____ Drawing Ref:_____

CMMS TAG #:_____ Serialized Key #:_____

Vendor:_____ Assoc. Equipment:_____

Manuf:_____ Type:_____

Model #:_____ Size:_____

Serial #:_____ GPM: _____

Temperature Range:_____ PSI Range:_____

CFM:_____ Operating Range:_____

Electrical Equipment or Motor Data:

Manufacturer Name:_____ Horsepower:_____ Volts:_____ Amp's:_____

Phase:_____ AC or DC:_____ RPM's:_____ Frame #:_____

Enclosure Nema Rating:_____ Service/Power Factor:_____ Insulation Class: _____

Miscellaneous Info:_____

_____

_____

Mechanical Data:

Belt Manufacturer:_____ Belt Model #:_____ Number of Belts:_____

Bearing Manufacturer:_____ Bearing Model #:_____

Weight Oil Used:_____ Amount Oil Required:_____

Miscellaneous Info:_____

_____

_____

Form 01600-B
CERTIFICATE OF UNIT RESPONSIBILITY

(Job Title)

CERTIFICATE OF UNIT RESPONSIBILITY
for Specification Section _____

_____
(Section title)

In accordance with Paragraph 01600.1.2.B of the Contract Documents, the undersigned manufacturer accepts unit responsibility for all components of equipment furnished under specification Section _____. We hereby certify that these components are compatible and comprise a functional unit suitable for the specified performance and design requirements.

_____
Notary Public

_____
Commission expiration date

Seal:

_____
Name of Corporation

_____
Address

By: _____
Duly Authorized Official

_____
Legal Title of Official

Date: _____

Form 01600-C

EQUIPMENT MANUFACTURER/VENDOR/INSTALLER INFORMATION FORM

Project Title:

Equipment Type:

MANUFACTURER:
Name: _____
Address: _____
City/State/Zip Code: _____

Office Phone: _____
Fax: _____

Web site: _____
E-mail address: _____

LOCAL REPRESENTATIVE:
Name: _____
Address: _____
City, State, Zip: _____

Office Phone: _____
Fax: _____

Web site: _____
E-mail address: _____

INSTALLER:
Name: _____
Address: _____
City, State, Zip: _____

Office Phone: _____
Fax: _____

Web site: _____
E-mail address: _____

Form 01620-A

MANUFACTURER'S INSTALLATION CERTIFICATION FORM

Contract No.:_____ Specification Section:_____

Equipment Name:_____

CONTRACTOR: _____

Manufacturer of Equipment Item: _____

The undersigned manufacturer of the equipment item described above hereby certifies that he has checked the installation of the equipment and that the equipment, as specified in the Contract Documents, has been provided in accordance with the manufacturer's recommendations, and that the trial operation of the equipment item has been satisfactory.

Comments: _____
_____
_____
_____
_____
_____

Date:_____ Manufacturer

_____
Signature of Authorized Representative

Date:_____ CONTRACTOR

_____
Signature of Authorized Representative

Form 01620-B

DELIVERY INSPECTION FORM

Project Name:_____ Project No.:_____

Contractor Name:_____ Contract No.:_____

Equipment Description:_____ Equipment Tag No.:_____

Submittal No.:_____ Specification Section No.:_____

Materials and Equipment Supplier:_____

Sender:_____ Manufacturer:_____

Received By:_____ Date:_____

P.O. No.:_____ USPS Tracking No._____

Storage Facility Location:_____

Delivery Checklist

Item	Review Description	Yes	No	N/A
1	Equipment Delivered to Approved Storage Area per Specification 01661	☐	☐	☐
2	Equipment Shop Drawings have been Approved by Engineer	☐	☐	☐
3	Required FAT Test have been Provided	☐	☐	☐
4	Equipment has been Provided in Original, Unopened, Legible Labeled Containers which are intact.	☐	☐	☐
5	Quantities Provided are Correct	☐	☐	☐
6	Engineer has been Provided a Copy of the Delivery Inspection Form	☐	☐	☐

The CONTRACTOR has inspected the materials and equipment item(s) described above and hereby certifies that he has verified the satisfactory delivery of the materials and equipment and that the materials and equipment , as specified in the Contract Documents, has been provided in accordance with the manufacturer's recommendations, and that the status of the materials equipment item(s) has been satisfactory delivered and stored as requires in Section 01651 – Transportation and Handling of Materials and Equipment and Section 01661 – Storage of Materials and Equipment.

_____ _____

CONTRACTOR'S SIGNATURE Date

Form 01752-A

EQUIPMENT TEST REPORT FORM

NOTE: This example equipment test report is provided for the benefit of CONTRACTOR and is not specific to any piece of equipment to be installed as a part of this project. The example is furnished as a means of illustrating the level of detail required for the preparation of equipment test report forms for this project.

_____
CONTRACTOR

EQUIPMENT/SYSTEM TEST REPORT

Equipment Name: _____
Equipment Number: _____
Specification Reference: _____
Location: _____
System: _____

	CONTRACTOR		ENGINEER	
	Verified	Date	Verified	Date
PRE-OPERATIONAL CHECKLIST				
Mechanical				
Lubrication	____	____	____	____
Alignment	____	____	____	____
Anchor Bolts	____	____	____	____
Seal Water System Operational	____	____	____	____
Equipment Rotates Freely	____	____	____	____
Safety Guards	____	____	____	____
Valves Operational	____	____	____	____
Hopper Purge Systems Operational	____	____	____	____
Sedimentation Tank/Hopper Clean	____	____	____	____
O&M Manual Information Complete	____	____	____	____
Manufacturer's Installation Certificate	____	____	____	____

	CONTRACTOR Verified	CONTRACTOR Date	ENGINEER Verified	ENGINEER Date
Electrical (Circuit and High-Pot Tests)				
Circuits:				
Power to MCC	_____	_____	_____	_____
Control to HOA	_____	_____	_____	_____
Indicators:				
Red (Running)	_____	_____	_____	_____
Green (Stop)	_____	_____	_____	_____
Other	_____	_____	_____	_____
Misc. Local Control Panel:				
Wiring Labels Complete	_____	_____	_____	_____
Nameplates	_____	_____	_____	_____
Other	_____	_____	_____	_____
Equipment Bumped for Rotation	_____	_____	_____	_____
Piping Systems				
Cleaned and Flushed:				
Suction	_____	_____	_____	_____
Discharge	_____	_____	_____	_____
Pressure Tests	_____	_____	_____	_____
Temporary Piping Screens in Place	_____	_____	_____	_____
Instrumentation and Controls				
List Instruments:				
Instrument:_____	_____	_____	_____	_____

	CONTRACTOR Verified	CONTRACTOR Date	ENGINEER Verified	ENGINEER Date

EQUIPMENT/SYSTEM PERFORMANCE TESTS (Section 01752)

Mechanical

Motor Operating Temperature	_____	_____	_____	_____
Pump Operating Temperature	_____	_____	_____	_____
Unusual Noise, etc?	_____	_____	_____	_____
Pump operation: gpm/psig	_____	_____	_____	_____

Measurement:

Flow _____

Pressure _____Test Gauge Number _____

Alignment Hot	_____	_____	_____	_____
Dowelled in	_____	_____	_____	_____

Remarks: _____

_____

_____

Electrical

Local switch function:

Runs in *HAND*	_____	_____	_____	_____
No Control Power in *OFF*	_____	_____	_____	_____
Timer control in *AUTO*	_____	_____	_____	_____

Overpressure protection switch

PS_____ functional in both *HAND* and *AUTO*	_____	_____	_____	_____
PS_____ set at ___ psig	_____	_____	_____	_____

Equipment/System Performance Test Completed

Contractor _____Date _____

Equipment/System Performance Test Accepted

Engineer _____Date _____

CITY OF PHOENIX WSD:
PROJECT NAME:
PROJECT NUMBER:

DATE:
REV BY:
JOA#
JOC#
PREP BY:

O&M TITLE:
FACILITY:
PROCESS AREA:
SPECIFICATION #
EQUIP MAN:

OPERATING & MAINTENANCE DATA REVIEW CHECKLIST

Form 01781-A

REQUIRED DATA		Item Complete	Item Incomplete	Comment No.	Applicable Page(s)
GENERAL FORMAT					
Paper Quality	*01781-1.2.A.1*	☐	☐		
Typed/Printed Originals	*01781-1.2.A.2*	☐	☐		
D-Ring Binder/Triple Post	*01781-1.2.A.3*	☐	☐		
Binder Identification	*01781-1.2.A.4*	☐	☐		
Index Tabs - Hard & Soft PDF/CD Indexed & OCR	*01781-1.2.A.5*	☐	☐		
Dividers	*01781-1.2.A.6*	☐	☐		
Table of Contents	*01781-1.2.A.7*	☐	☐		
Full Equipment Names/Identification In Table of Contents & Each Section	*01781-1.2.A.8*	☐	☐		
Equipment Component Identification on Catalog Pages	*01781-1.2.A.9*	☐	☐		
OPERATIONS & MAINTENANCE DATA					
Checklist Form 01781-A	*01781-1.2.C.1* *01331 Form 01781-A*	☐	☐		
Copy of Applicable Product/Equipment Specification Section	*01781-1.2.C.2*	☐	☐		

REQUIRED DATA	Item Complete	Item Incomplete	Comment No.	Applicable Page(s)
Manufacturer/Vendor/Installer & Equipment Information Forms *01781.1.2.C.3 & 4* *01331 Forms 01600-A & C*	☐	☐		
Equipment, System Startup, Performance Testing / *Spec 01752* *01781.1.2.C.5*	☐	☐		
CMMS Tag Number Reference *Spec 01630* *01781.1.2.C.6*	☐	☐		
Warranty Bond & Service Contract *General Conditions Guaranty-Warranty Spec 01600* *01781-1.2.C.7* *Form 01600-B* *01331 Form 01620-A*	☐	☐		
Record Documents – Name Plate *"As Built, Diagrams etc." Information Spec 01782* *01781-1.2.C.8*	☐	☐		
CAD Drawings - CD & Hard (in Sleeves) *01781-1.2.C.9* AutoCAD Version 2017 or Newer / Spec 17260	☐	☐		
Written Product/Equipment Operating Instructions, Conditions, Characteristics *01781-1.2.C10*	☐	☐		
Preventive Maintenance Instructions *01781-1.2.C.11* *Spec 01785* *01331 Form 01785-A*	☐	☐		
Personnel Maintenance Lesson/Training Plan / *Spec 01821* *01781-1.2.C.12* *Form 01821-A* *01331 Form 01821-B*	☐	☐		
Spare Parts, Lists/Supply Sources *01781-1.2.C.13*	☐	☐		
Written Explanations - Safety Precautions /Maintenance Procedures *01781-1.2.C.14*	☐	☐		
Safety Data Sheets (S.D.S) and Volume for all fluids, oils, chemicals *01781-1.2.C.15*	☐	☐		
Installation Data / *Spec 01731* *01781-1.2.C.16*	☐	☐		
Final Test Data *01781-1.2.C.17* *01781-1.2.D.1 & 2*	☐	☐		
Checklist Form 01781-B *01781-1.4.A*	☐	☐		

Contractor / Document Manager **Date**

PRINT

CITY OF PHOENIX WSD:
PROJECT NAME:
PROJECT NUMBER:

OPERATING & MAINTENANCE MANUAL REVIEW CHECKLIST *Form 01781-B*

O&M Manual Title: _____

JOC / JOA #: _____ Engineering Firm: _____

Manufacturer: _____ Specification No.: _____

ITEM	REVIEW DESCRIPTION	ENGINEER			CITY PROJECT MANAGER		
		Yes	No	N/A	Yes	No	N/A
1	Uniform Binder Formatting and Identification (Cover, Spine, Title Page and Table of Contents, CD - Templates)	☐	☐	☐	☐	☐	☐
2	Equipment Name/Component Identification on Catalog Pages	☐	☐	☐	☐	☐	☐
3	Completed/Signed Checklist Form 01781-A	☐	☐	☐	☐	☐	☐
4	Copy of Product/Equipment Specification	☐	☐	☐	☐	☐	☐
5	Information Form 01600-A	☐	☐	☐	☐	☐	☐
6	Equipment Manufacturer/Vendor/Installer Form 01600-C	☐	☐	☐	☐	☐	☐
7	Equipment/Startup/Performance Testing per Spec 01752	☐	☐	☐	☐	☐	☐
8	Written Reference to CMMS Tag Number per Spec 01630	☐	☐	☐	☐	☐	☐
9	Warranty Bond/Service Contract and Information Spec 01600	☐	☐	☐	☐	☐	☐
10	Unit of Responsibility Certification Form 01600-B	☐	☐	☐	☐	☐	☐
11	Manufacturer's Installation Certification Form 01620-A	☐	☐	☐	☐	☐	☐
12	As Built, Control Panel and Wiring Diagrams, Drawings, hard and electronic in AutoCAD version 2017 or newer per Spec 17260	☐	☐	☐	☐	☐	☐
13	Written Operating Characteristics, Startup, Limiting, Normal and Emergency Conditions, Regulation & Control, Shutdown	☐	☐	☐	☐	☐	☐
14	Preventive Maintenance Instructions per Spec 01785	☐	☐	☐	☐	☐	☐
15	Preventive Maintenance Data Submittal Form 01785-A	☐	☐	☐	☐	☐	☐
16	Personnel Maintenance Lesson/Training Plan Spec 01821	☐	☐	☐	☐	☐	☐
17	Manufacturer's Instruction Certification Forms 01821-A & B	☐	☐	☐	☐	☐	☐
18	Identify Parts, Spare Parts, Supply List and Local Source	☐	☐	☐	☐	☐	☐
19	Written Safety Precautions and Maintenance Procedures	☐	☐	☐	☐	☐	☐
20	S.D.S. Sheets and volume of each for all fluids, oils, chemicals	☐	☐	☐	☐	☐	☐
21	Installation Data per Spec 01731	☐	☐	☐	☐	☐	☐
22	Final Test Data per Spec 01781-1.2.C.1, 01781-1.2.D.1 & 2	☐	☐	☐	☐	☐	☐

ENGINEERS'S SIGNATURE/DATE:

PROJECT MGR'S SIGNATURE/DATE:

RESET

OPERATING & MAINTENANCE MANUAL REVIEW
CHECKLIST Form 01781-B

NOTES

OPERATING AND MAINTENANCE BINDER SPINE INSTRUCTIONS

1. Select spine width.
2. Update form in indicated fields.
3. Insert logo.
4. Print current page.
5. Use crop marks as cutting guide.
6. Insert spine in binder.

1" Spine

1.5" Spine

2" Spine

3" Spine

1" BINDER SPINE

PROJECT WS No.

WS No 1

SPEC No.

Spec No 1

WTP / WWTP Facility Name 1

Prod / Equip Title 1

Project Name 1

OPERATING AND MAINTENANCE INSTRUCTIONS

Volume 1

PRINT

RESET

1.5"
BINDER
SPINE

PRINT

RESET

OPERATING AND
MAINTENANCE
INSTRUCTIONS

WTP/WWTP Facility Name 1.5

Prod/Equip Title 1.5

Project Name (Do Not Repeat Facility Name) 1.5

PROJECT WS No.

Project No 1.5

SPEC No.

Spec No. 1.5

Volume 1.5

2"
BINDER
SPINE

PRINT

RESET

OPERATING AND
MAINTENANCE
INSTRUCTIONS

WTP/WWTP Facility Name 2

Prod/Equip Title 2

Project Name (Do Not Repeat Facility Name) 2

PROJECT WS No.

WS/Project No 2

SPEC No.

Spec No 1.5

Volume 1.5

3"
BINDER
SPINE

PRINT

RESET

OPERATING AND MAINTENANCE INSTRUCTIONS

WTP/WWTP Facility Name 3

Prod/Equip Title 3

Project Name (Do Not Repeat Facility Name) 3

Project WS No.

WS/Project No 3

Spec No.

Spec Number 3

Volume (if applicable) 3

City of Phoenix, Water Services Department

Enter WTP/WWTP Facility Name **Enter WS Project No.**

Enter Project Name (DO NOT Repeat Facility Name)

Enter Contract# if App. or N/A **Enter JOA#**

City "Approval" Stamp

OPERATING AND MAINTENANCE INSTRUCTIONS

Enter O&M Product/Equipment Title

Enter Spec Section No.

PRINT

Enter Volume # of # (blank if none)

RESET

Contractor

Contractor Company Name
Contractor Street Address
Contractor City, ST, Zip
Contractor Phone/Fax Number
Contractor Web Address

Engineer

Engineer Company Name
Engineer Street Address
Engineer City, ST, Zip
Engineer Phone/Fax Number
Engineer Web Address

Manufacturer

Manufacturer Company Name
Manufacturer Street Address
Manufacturer City, ST, Zip
Manufacturer Phone/Fax Number
Manufacturer Web Address

Installer

Installer Company Name
Installer Street Address
Installer City, ST, Zip
Installer Phone/Fax Number
Installer Web Address

City of Phoenix, Water Services Department

Enter WTP/WWTP Facility Name Enter WS Project No.

Enter Project Name (DO NOT Repeat Facility Name)

Enter Contract# if App. or N/A Enter JOA#

PRINT

Enter O&M Product/Equipment Title

RESET

Enter Spec Section No.

TABLE OF CONTENTS

Tabs: Section Titles	Page Numbers
1. **Equipment Component Identification/Catalog Pages** Enter Notes 1	Page No. [# thru #] 1
2. **Checklist Form 01781-A** Enter Notes 2	Page No. [# thru #] 2
3. **Copy of Product/Equipment Specification Section** Enter Notes 3	Page No. [# thru #] 3
4. **Information Forms 01600-A & 01600-C** Enter Notes 4	Page No. [# thru #] 4
5. **Equipment, System Startup, Performance Testing** Enter Notes 5	Page No. [# thru #] 5
6. **CMMS Tag Number Reference** Enter Notes 6	Page No. [# thru #] 6
7. **Warranty Bond/Service Contract and Forms** Enter Notes 7	Page No. [# thru #] 7
8. **Record Documents AND CAD Drawings** Enter Notes 9	Page No. [# thru #] 8
9. **Operating Instructions, Conditions, Characteristics** Enter Notes 9	Page No. [# thru #] 9
10. **Preventative Maintenance Instruction** Enter Notes 10	Page No. [# thru #] 10
11. **Personnel Maintenance, Lesson / Training Plan** Enter Notes 11	Page No. [# thru #] 11
12. **Spare Parts, Lists / Supply Sources** Enter Notes 12	Page No. [# thru #] 12
13. **Safety Precautions / Maintenance Procedures** Enter Notes 13	Page No. [# thru #] 13
14. **S.D.S & Volume for all Fluids, Oils and Chemicals** Enter Notes 14	Page No. [# thru #] 14
15. **Installation Data** Enter Notes 15	Page No. [# thru #] 15
16. **Final Test Data** Enter Notes 16	Page No. [# thru #] 16
17. **Checklist Form 01781-B** Enter Notes 17	Page No. [# thru #] 17

OPERATING AND MAINTENANCE INSTRUCTIONS

Prod / Equip Title

PROJECT WS No.
Enter Project N

SPEC No.
Spec No.

Vol if app

WTP / WWTP Facility Name

Project Name

RESET

PRINT

OPERATING AND MAINTENANCE INSTRUCTIONS

Prod / Equip Title 1

PROJECT WS No.
Project No.

SPEC No.
Spec No.

Vol if app

WTP / WWTP Facility Name

Project Name

01783-A
SPARE PARTS RECEIVER FORM

CONTRACTOR TO FILL OUT:

MANUFACTURER:_____

ITEM DESCRIPTION:_____

COST: _____ PART NUMBER: _____

VENDOR/SUPPLIER NAME:_____

ADDRESS:_____

TELEPHONE NUMBER:_____

FAX NUMBER:_____

PART TO BE USED ON
WHAT EQUIPMENT:_____

EQUIPMENT NUMBER: _____ SPECIFICATION SECTION:_____

****

_____
_____
CONTRACTOR REP DATE CITY REP DATE

_____
ENGINEER REP DATE

Form 01785-A

PREVENTIVE MAINTENANCE DATA SUBMITTAL FORM

Project Name:	**City Project #** **WS----------**
Engineer:	**Contractor:**
Asset Type:	**Asset Manufacturer:**

	Preventive Maintenance Task Description	**Class**	**Category**	**Task Duration (Hrs)**	**Est. Staff**	**Freq.**	**Freq. Unit (Run-Time Hrs or Calendar Days)**	**Preventive Maintenance Procedure MS WORD File Name**
1.								
2.								
3.								

Assets IDs	**Asset Description**	**Max. Life (yrs)**	**Warranty**			**Copy of Warranty Certificate File Name**
			Start Date	**End Date**	**Duration (Months)**	

Form 01821-A

MANUFACTURER'S INSTRUCTION CERTIFICATION FORM

Contract No:_____Specification Section: _____ Equipment Name: _____

_____

CONTRACTOR: _____

Manufacturer of equipment item: _____

The undersigned manufacturer certifies that a service engineer has instructed the Plant operating personnel in the proper maintenance and operation of the equipment designated herein.

Operations Check List (check appropriate spaces)

Start-up procedure reviewed.	_____
Shutdown procedure reviewed.	_____
Normal operation procedure reviewed.	_____
Others: _____	_____
_____	_____

Maintenance Check List (check appropriate spaces)

Described normal oil changes (frequency).	_____
Described special tools required.	_____
Described normal items to be reviewed for wear.	_____
Described preventive maintenance instructions.	_____
Described greasing frequency.	_____
Others: _____	_____
_____	_____

_____ _____
Date Manufacturer

_____
Signature of Authorized Representative

_____ _____
Date Signature of OWNER'S Representative

_____ _____
Date Signature of CONTRACTOR'S
Representative

Form 01821-B

TRAINING REQUEST FORM

SPECIFICATION SECTION 01821
INSTRUCTION OF OPERATIONS AND MAINTENANCE PERSONNEL

Equipment Name:_____

Equipment Tag Number: _____

Equipment Description: _____

Specification Section: _____

Operations and Maintenance Data Submitted/Approved: _____

Start-up and Testing Complete/Date: _____

Lesson Plan Submitted/Approved: _____

Training Aids Submitted/Approved: _____

Hands-on Demonstration: _____

Training Schedule (Dates, Time, No. of Sessions): _____

_____

_____

_____

_____

_____

Form 11000-A

MOTOR DATA FORM:

Equipment Name_____

Equipment No.(s) _____

Site Location _____

Nameplate Markings

Mfr _____ Mfr Model _____
Frame _____ HP_____
Volts _____ Phase _____
RPM _____ Service Factor _____
FLA _____ LRA _____
Freq _____ Amb Temp Rating _____degrees C
Time Rating _____ (NEMA MG1-10.35) Design letter _____ (NEMA MG-1.16)
KVA Code Letter _____ Insulation Class _____

The following information is required for explosion proof motors only:

A. Approved by UL for installation in Class _____, Div _____

B. UL Frame Temp. Code_____ (NEC Tables 500-2 and 500-2(b)) Group _____ Atmosphere

The following information is required for all motors 1/2 horsepower and larger:

A. Guaranteed Minimum Efficiency _____ (Section 11000)

B. Nameplate or Nominal Efficiency _____

Data Not Necessarily Marked on Nameplate

Type of Enclosure _____ Enclosure Material_____

Temp Rise _____degrees C (NEMA MG1-12.41,42)

Space heater included? _____Yes _____ No; if Yes, _____watts _____volts

Type of motor winding over-temperature protection, if specified: _____

Use the space below to provide additional information on other motor modifications, if specified:

_____

_____

Form 16000-A

WIRE AND CABLE RESISTANCE TEST DATA FORM

Conduit No.	Circuit Number/Feeder No.	Volts/Phase/ Cycles	Phase "A" to Phase "B"	Phase "A" to Phase "C"	Phase "B" to Phase "C"	Phase "A" to Neutral	Phase "B" to Neutral	Phase "C" to Neutral	Phase "A" to Ground Conductor	Phase "B" to Ground Conductor	Phase "C" to Ground Conductor

CERTIFIED _____ Date_____
CONTRACTOR'S Representative

WITNESSED _____ Date_____
OWNER'S Representative

Form 16000-B

CONDUIT AND WIRE TERMINATION SHEET

CONDUIT NO.: _____ No. of Wires: _____ Size: _____
Process Area: _____

Wire No.	Terminal No.	From	Via	Via	To	Terminal No.	Service Description	DWG No.(s)

Form 16000-B

INSTALLED MOTOR TEST DATA FORM

Motor Equipment Number _____ Date of test _____

Equipment Driven _____

MCC Location _____ Ambient temp _____°F

Resistance:

Insulation resistance phase-to-ground megohms:

Phase A _____, Phase B _____, Phase C _____

Current at Full Load:

Phase _____ Current, amps _____

Phase _____ Current, amps _____

Phase _____ Current, amps _____

Thermal Overload Device: Manufacturer/catalog # _____ Amperes _____

Circuit breaker (MCP) setting: _____

Motor Nameplate Markings:

Mfr _____ Mfr type _____ Frame _____ HP_____

Volts _____ Phase _____ RPM _____ **Service factor _____

Amps _____ Freq _____ Ambient temp rating _____ °C

Time rating _____ **Design letter _____
(NEMA 1-10.35) (NEMA MG-1.16)

Code letter _____ Insulation class _____

**Required for 3-phase squirrel cage induction motors only.

CERTIFIED _____ Date_____
CONTRACTOR'S Representative

WITNESSED _____ Date_____
OWNER'S Representative

Form 16215-A

POWER SYSTEM / ARC FLASH ANALYSIS SIGN-OFF FORM

COMPANY NAME DATE:

STREET ADDRESS
CITY, STATE ZIP
TELEPHONE
FAX

Project Title:	Analysis Firm:
Plant/Site:	City of Phoenix Project #: WS

Per Specification 16215 – POWER SYSTEM / ARC FLASH ANALYSIS
Breaker settings, arc flash / voltage labels, single line diagrams, load summaries and panel schedules are incorporated on the equipment to the satisfaction of the CONTRACTOR, ANALYSIS FIRM and ENGINEER.

_____ Date _____
CONTRACTOR (Print Name & Sign)

_____ Date _____
ANALYSIS FIRM (Print Name & Sign)

_____ Date _____
ENGINEER (Print Name & Sign)

CITY OF PHOENIX: Water Services Department
PROJECT NAME: Lift Station 76 Phase II Expansion
PROJECT NUMBER: WS90400067

Form 17001-C

FUNCTIONAL ACCEPTANCE TEST

System:			P&ID No.:
Loop No.:			Page of
Factory Acceptance Test:			
Tag Number:			
Loop Description:			
Instrument Location:			
Manufacturer:			
Model Number/Serial Number:			
Adjustable Range:			
Calibrated Range:			
Remarks:			
Installation Per Manufacturer's Requirements?		Yes:	No:
Installation Per Contract Documents?		Yes:	No:
If "No," E:xplain:			

Calibration Test:								**Switch Test:**			
%	Calibration Signal	Instrument Indication	Error %	4-20 ma Output	CCS Indication	Error %		Set Point	Setting	Switch Point Increasing	Switch Point Decreasing
0								1			
25								2			
50								3			
75								4			
100								5			

Form 17260-A

FACTORY ACCEPTANCE TEST REPORT

PROJECT TITLE

Witnessing Firm(s):
Testing Date:
Witnessed by:

Equipment Name:
Manufacturer:
Location of Test:

REVIEW CHECKLIST

REVIEW ITEMS	ITEM COMPLETE	ITEM INCOMPLETE	COMMENT NO.
PRIOR TO FACTORY ACCEPTANCE TEST			
Control Panels Shall Be Furnished In Accordance With The Requirements As Shown On The Drawings And As Specified In Specification 16050, 17051, 17052, 17053, 17226 and 17260.			
Was The System Internally Tested By Manufacturer.			
Approved Submittal Available			
Panel Construction Fully Completed And Panel Clean Of Debris			
Programming Of All Devices And Logic Controllers Completed, Installed And Printed Program Copies Available			
Panel Drawings As-Built And Per Specifications			
Operations & Maintenance Manual Completed			
MECHANICAL INSPECTION			
Manufacturers UL 508 Label Installed			
Enclosure is NEMA Rated Per Specification 16050			
Enclosure Door Seals, Gaskets, Alignment, Latches And Locking Mechanisms Installed And Functioning Properly			
Panel Painted Per Specifications			

REVIEW ITEMS	ITEM COMPLETE	ITEM INCOMPLETE	COMMENT NO.
Front Panel Nameplates And Components Installed Per Specifications And NEMA Rated For Application			
Arc Flash Labels Installed			
Internal Components Mounted Securely And Locations Are As Per Approved Submittal			
Component Fasteners Constructed Of Stainless Steel			
Panels And Shelves Constructed Of Minimum 12 Gage Steel			
Wireways Covered And Wire Fill Limits Per Specifications			
All Wires Are Terminated And Labeled Per Specifications			
Spare Free Space Capacity Percentage Per Specifications			
Conduit Entry Points Free Space Per Specifications			
Steel Print Pocket With White Enamel Finish Provided			
Enclosure Mounting And Lifting Supports Provided			
Air Conditioner and Drain Line Installed and Functioning			
Sunshade Structure Per Specifications			
Shipping Container and Preparations Reviewed			
PANEL COMPONENTS			
Components Are Per Bill Of Materials And Specifications			
Components Are UL Listed			
Light Fixture And Operation Switch Installed			
Grounding Studs And Bars For The Door, Backplane And Controls Installed For AC And DC Circuits			
Air Conditioner, Heat Exchanger, Ventilation Fan Or Heater Installed			
Thermostat And Panel High Temperature Switch Installed			
All Internal Components Labeled Per Specification			
Fuses Labeled on the Backplane with Fuse Number and Fuse Size			

REVIEW ITEMS	ITEM COMPLETE	ITEM INCOMPLETE	COMMENT NO.
Wire Type, Colors, Size, Labeling, Routing And Terminations Per Specifications			
Panel Front Nameplate #1 As Per Specifications			
Panel Incoming Power Terminated To PTB			
Spare Parts Provided			
PANEL TESTING			
List Test Equipment Used For The Factory Acceptance Test			
List All Personal Protective Equipment Utilized For Factory Acceptance Test			
Verify Panel Is Grounded and Test All Panel Grounds			
Verify All Circuit Breaker And Fuse Sizes			
Verify Safety Circuits Are Fail Safe Including From The Panel To the Field Device			
Power On Verification Test			
Measure Panel Power Consumption – Test Total System Current With System In Non-Loaded State. Current Measured: _____			
Circuit Breaker And Disconnect Switch - Power On/Off/Lock-out Test			
Lamp Test			
Test All Power Supply(s) Voltages Power Measured: _____			
Test All Panel Start/Stop Controls And Computer Generated Controls			
Test Emergency Stop Controls			
Verify All Starters, Relays And Contactors Activate As Required			
Simulate All I/O As Near As Possible To The Installed System Configuration			
Simulate All Analog Signals Including Field Devices Inputs and Computer Control Inputs By Varying The Analog Inputs Between 4 – 20 mA's DC - 0 To 100% Ranges.			
Verify All Calibrations And Set Points Of Panel Components			

REVIEW ITEMS	ITEM COMPLETE	ITEM INCOMPLETE	COMMENT NO.
Test All Programmable Logic Controller Serial Ports			
Test Programmable Logic Controller Retentative Memory			
Test Programmable Logic Controller Power Failure			
Test All Start Up And Shut Down Sequence Procedures			
Test All Alarms			

Comments:

SECTION 01332

SHOP DRAWING PROCEDURES

PART 1 - GENERAL

1.1 DESCRIPTION

A. The submittal of Shop Drawings shall conform to requirements of General Conditions and procedures described in this Section. A separate transmittal form shall be used for each specific item or class of material or equipment for which a submittal is required. Transmittal of Shop Drawings on various items using a single transmittal form shall be permitted only when the items taken together constitute a manufacturer's "package" or are so functionally related that expediency indicates review of the group or package as a whole.

B. The term "Shop Drawings" as used herein shall be understood to include detailed design calculations, fabrication and installation drawings, lists, graphs, test data, operating instructions, preventive maintenance tasks instructions, and other items which shall include, but are not necessarily limited to:
   1. Drawings and catalog information and cuts.
   2. Specifications, parts list, suggested spare parts lists, and equipment drawings.
   3. Wiring diagrams of systems and equipment.
   4. Complete lubrication, preventive maintenance and operation instructions, including initial startup instructions as described in Section 01785, Preventive Maintenance Data and Section 01821, Instruction of Operations and Maintenance Personnel.
   5. Applicable certifications.
   6. Anchor bolt templates, mounting instructions and mounting design calculations as required.
   7. Required maintenance operations to allow all installed equipment to remain idle for a period of time not to exceed 24 months.
   8. Other technical, installation, and maintenance data as applicable.
   9. Unloading and handling methods and storage requirements.
   10. Note, highlight, and explain proposed changes to the Contract Documents.
   11. Paint submittal showing type of paint and the mils thickness of coating system used. The coating system shall be the approved system as submitted under Division 9, Finishes.
   12. Drawings showing CONTRACTOR field verifications illustrating all field dimensions. CONTRACTOR shall field verify all dimensions and existing materials shown on the Drawings. Any modifications required shall be at CONTRACTOR'S expense.

C. Preliminary Submittal Schedule: CONTRACTOR, within fourteen (14) days after the Notice to Proceed, shall prepare and submit to the ENGINEER a Preliminary Submittal Schedule. Identify on his Preliminary Submittal Schedule all of the submittal items required by the Contract Documents governing the Work.

D. Submittal Schedule: CONTRACTOR, within thirty (30) days after the Notice to Proceed, shall prepare and submit to the ENGINEER a comprehensive Submittal Schedule. Identify on his Submittal Schedule all of the submittal items required by the Contract Documents governing his Work. Indicate, for each submittal item on his Submittal Schedule the following:

1. The date by which that item will be submitted to the ENGINEER.
2. Whether the submittal is for a substitute or "equal" item. Complete submittal for all substitute or "equal" items shall be made to the ENGINEER, in accordance with the Contract requirements. Identification by the CONTRACTOR of substitute or "equal" items does not relieve CONTRACTOR of his responsibility to furnish equipment and materials that meet all the requirements of the Contract Documents. Items of manufacturers' equipment listed with CONTRACTOR'S Bid Proposal shall not be replaced with any substitute or "equal" items as part of this Submittal Schedule process. Procedure for substitutions is specified under the General Conditions.
3. Whether the submittal is for review or "for record only".
4. The date by which response is required.
5. The date by which the material or equipment must be on site in order not to delay the progress of the Work.

E. In preparing his Submittal Schedule, consider the nature and complexity of each submittal item and shall allow ample time for review, revision or correction. Submittal will normally be returned to CONTRACTOR within fourteen (14) calendar days following receipt of the submittal. Complex submittals, for example, Instrumentation and Control Systems, Variable Frequency Drives and other such submittals may require additional review time. Identify submittal(s) for which long review periods are anticipated.

F. Hereby notified that the project electric motor requirements, specified in Section 11000, Electric Motors, do not allow standard "off the shelf" motors. Make provisions in the Submittal Schedule to account for longer manufacturing and delivery lead times for the motors and equipment requiring electric motors under this Project.

G. The ENGINEER will review CONTRACTOR'S Submittal Schedule to determine its completeness and compatibility with the Progress Schedule. A Submittal Schedule which is incompatible with the Progress Schedule or a review schedule which places extraordinary manpower demands on the ENGINEER will be sufficient reason(s) to reject the Submittal Schedule. It shall be understood that certain submittals will take longer than fourteen (14) days to review and that these particular submittals will be

identified during the review of the Submittal Schedule, by the ENGINEER to allow for very complex submittal reviews. Also, identify submittal for which he anticipates long review periods.

H. CONTRACTOR'S Submittal Schedule shall be consistent with the Progress Schedule as described in Section 01320, Progress Schedule.

I. Approval of the Submittal Schedule shall be required prior to processing of the first progress payment.

1.2 PROCEDURE

A. Submit Shop Drawings to: Fernando Sarmiento, PE, Greeley and Hansen, LLC

B. A letter of transmittal shall accompany each submittal. If data for more than one Section of the Specifications is submitted, a separate transmittal letter shall accompany the data submitted for each Section.

C. All letters of transmittal shall be submitted in duplicate.

D. At the beginning of each letter of transmittal, provide a reference heading indicating the following:
   1. OWNER'S Name _____
   2. Project Name _____
   3. Contract No. _____
   4. Transmittal No. _____
   5. Section No. _____

E. If a Shop Drawing deviates from the requirements of the Contract Documents, specifically note each variation in his letter of transmittal.

F. All Shop Drawings submitted for approval shall have a title block with complete identifying information satisfactory to ENGINEER.

G. All Shop Drawings submitted shall bear the stamp of approval and signature of CONTRACTOR as evidence that they have been reviewed and verified to the completeness of the submittal by CONTRACTOR. Submittal without this stamp of approval will not be reviewed by ENGINEER and will be returned to CONTRACTOR. CONTRACTOR'S stamp contain the following minimum information:

Project Name: _____

CONTRACTOR'S Name: _____

Date: _____

----------Reference----------

Item: _____

Specifications:

Section: _____

Page No.: _____

Para. No.: _____

Drawing No.: _____ of _____

Location: _____

Submittal No.: _____

Approved By: _____

H. In order to identify and track all submittals as separate and unique items, utilize the submittal identification numbering system as follows:

1. The Submittal Number shall be a separate and unique number correlating to each individual submittal that is required to be tracked as a separate and unique item. The Submittal Number shall be a two-part, eight-character, alpha/numeric number assigned by CONTRACTOR in the following manner:
   a. The first part of the Submittal Number shall consist of five characters that pertain to the applicable Specification Section number.
   b. The second part of the Submittal Number shall consist of three digits (numbers 001 to 999) to number each separate and unique submittal submitted under each Specification Section.
   c. A dash shall separate the two parts of the Submittal Number.
   d. A typical Submittal Number for the third Working Drawing submitted under Section 15101, Ductile Iron Pipe, would be 15101-003.

2. The Review Cycle shall be a three-digit number indicating the initial submission or resubmission of the same submittal. For example:

   001 = First (initial) submission
   002 = Second submission (first resubmission)
   003 = Third submission (second resubmission)

3. An example of the typical submittal identification numbers for the first submission of the third submittal submitted under Section 15101, Ductile Iron Pipe is:

Submittal Number	Review Cycle
15101-003	001

An example of the typical submittal identification numbers for the second submission of the third submittal submitted under Section 15101, Ductile Iron Pipe is:

Submittal Number	Review Cycle
15101-003	002

I. Initially submit to ENGINEER a minimum of five (5) HARD copies and one (1) Electronic PDF format copies.

J. After ENGINEER completes his review, Shop Drawings will be affixed with a stamp and marked with one of the following notations:
   1. Approved.
   2. Approved as Corrected.
   3. Approved as Corrected, Resubmit.
   4. Revise and Resubmit.
   5. Not Approved.
   6. Not Reviewed.
   7. For Information Only.

K. If a submittal is acceptable, the ENGINEER will mark it “Approved” or “Approved as Corrected” and will forward five (5) hard copies and one (1) electronic PDF format of the submittal to the OWNER for review and comment. The OWNERS review process will begin when all required copies of a specific submittal are received. After the OWNERS review is complete, the ENGINEERS and OWNERS comments will be combined and one (1) print or copy of the submittal will be returned to CONTRACTOR.

L. Upon return of a submittal marked "Approved" or "Approved as Corrected", CONTRACTOR may order, ship or fabricate the materials included on the submittal, provided it is in accordance with the corrections indicated.

M. If a Shop Drawing marked "Approved as Corrected" has extensive corrections or corrections affecting other Shop Drawings or Work, ENGINEER may require that CONTRACTOR make the corrections indicated thereon and resubmit the Shop Drawings for record purposes. Such Shop Drawings will have the notation, "Approved as Corrected - Resubmit." The corrected Shop Drawing shall be a pre-condition for payment for the work item of the Shop Drawing.

N. If a submittal is unacceptable, one (1) electronic copy will be returned to CONTRACTOR with one of the following notations:
   1. "Revise and Resubmit"
   2. "Not Approved"

O. Upon return of a submittal marked "Revise and Resubmit", make the corrections indicated and repeat the initial approval procedure. The "Not Approved" notation is used to indicate material or equipment that is not acceptable. Upon return of a submittal so marked, repeat the initial approval procedure utilizing acceptable material or equipment.

P. Any related Work performed, or equipment installed without an "Approved" or "Approved as Corrected" Shop Drawing will be at the sole responsibility of CONTRACTOR.

Q. Shop Drawings shall be submitted well in advance of the need for the material or equipment for construction and with ample allowance for the time required to make delivery of material or equipment after data covering such is approved. Assume the risk for all materials or equipment which are fabricated or delivered prior to the approval of Shop Drawings. Materials or equipment will not be included in periodic progress payments until approval thereof has been obtained in the specified manner.

R. ENGINEER will review and process all submittals promptly; a reasonable time shall be allowed for this, for the Shop Drawings being revised and resubmitted, and for time required to return the approved Shop Drawings to CONTRACTOR.

S. Responsibility belongs to CONTRACTOR to review submittals made by his suppliers and subcontractors before transmitting them to the ENGINEER to assure proper coordination of the Work and to determine that each submittal is in accordance with CONTRACTOR'S desires and that there is sufficient information about materials and equipment for ENGINEER to determine compliance with the Contract Documents. Incomplete or inadequate submittals will be returned for revision without review.

T. Furnish required submittals with complete information and accuracy in order to achieve required approval of an item within one submittal. Backcharges for resubmittals that account for a number greater than 20 percent of the total number of first-time submittals and will be backcharged for all third submittals. The number of first-time submittals shall be equal to the number of submittals agreed to by ENGINEER and CONTRACTOR in accordance with Section 01330.1.2.A.2. All costs to ENGINEER involved with subsequent submittal of Shop Drawings, Samples or other items requiring approval will be backcharged to CONTRACTOR at the rate of 3.0 times direct technical labor cost by deducting such costs from payments due CONTRACTOR for Work completed. In the event that CONTRACTOR requests a substitution for a previously approved item, all of ENGINEER'S costs in the reviewing and approval of the substitution will be backcharged to CONTRACTOR, unless the need for such substitution is beyond the control of CONTRACTOR.

U. The OWNER reserves the right to withhold monies, identified in the General Conditions, for Shop Drawing reviews beyond those described herein.

V. The ENGINEER will implement, if requested by CONTRACTOR, one special Shop Drawing Review Meeting. The purpose of the meeting is to expedite Shop Drawing reviews for the equipment and materials required for the first document of the Work. Requirements of this Section will not be waived but could be expedited.

W. Mark each page of a submittal and each individual component submitted with the specification number, paragraph, and subparagraph. Arrange submittal information presentation to appear in the sequence in the Specification Section.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01333

SAMPLES

PART 1 - GENERAL

1.1 DESCRIPTION

A. The submittal of Samples shall conform to the requirements of the General Conditions and to procedures described in this Section.

B. Samples and Shop Drawings which are related to the same unit of Work or Specification Section shall be submitted at the same time. If related Shop Drawings and Samples are submitted at different times, they cannot be reviewed until both are furnished to the ENGINEER.

1.2 PROCEDURE

A. Review, approve, and submit all Samples promptly. Samples shall be identified with correct reference to Specification Section, page, article and paragraph number, and Drawing Number, when applicable. Samples shall clearly illustrate functional characteristics of the product, all related parts and attachments, and full range of color, texture, pattern and material. Samples shall be furnished so as not to delay fabrication, allowing the ENGINEER reasonable time for the consideration of the Samples submitted.

B. Submit at least three Samples of each item required for the ENGINEER'S approval. Submission of Samples shall conform to all applicable provisions under Shop Drawing Submittal and Correspondence Procedure. Two of the Samples shall be delivered to the ENGINEER, unless otherwise authorized by the ENGINEER. The ENGINEER shall retain all samples. If CONTRACTOR requires a Sample for his use, he shall notify the ENGINEER, in writing.

C. Make all corrections required and shall resubmit the required number of new Samples, until approved.

1.3 JOB MOCK-UPS

A. Job mock-ups (sample panels) shall be constructed on site by CONTRACTOR and only one of each type will be required. Mock-ups shall be constructed only after the individual Samples and components used in the mock-up have been approved by the ENGINEER. If a mock-up is not approved, construct additional ones until approval is received.

B. Store and protect large Samples and mock-ups until the Work is complete or until a time approved by ENGINEER.

1.4 SAMPLES FOR TESTS

A. Furnish such Samples of material as may be required for examination and tests. All Samples of materials for tests shall be taken according to standard methods and as required by the Contract Documents.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01412

STORMWATER POLLUTION PREVENTION PLAN AND PERMIT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Comply with the terms and conditions of the Lift Station 76 Arizona Pollutant Discharge Elimination System (AZPDES) requirements under the Arizona Department of Environmental Quality (ADEQ) General Permit. Under provisions of that permit, CONTRACTOR is designated as permittee and responsible for providing necessary material and for taking appropriate measures to minimize pollutants in stormwater runoff from the Project. Obtain a DeMinimus discharge permit from ADEQ for any discharge that is to Waters of the U.S. and comply with the requirements of the permit.

B. The Contract Price shall include all material, labor and other permits and incidental costs related to:
   1. Preparing, updating and revising the Stormwater Construction Pollution Prevention Plan (SWPPP).
   2. Installing and maintaining all structural and non-structural items chosen by CONTRACTOR to comply with the construction SWPPP.
   3. Clean-up and disposal costs associated with clean-up and repair following storm events or CONTRACTOR caused spills on the Project.
   4. Implementing and maintaining Best Management Practices to comply with the OWNER'S stormwater code.
   5. Preparing the Notice of Intent and Notice of Termination shall be covered by the AZPDES General Permit for Arizona.
   6. Obtain and comply with DeMinimus permit, if such permit is required.

C. Coordinate the requirements under this Section with Section 02315, Excavation and Backfill, permit requirements. All necessary SWPPP controls and practices must be implemented prior to commencement of any construction activity.

1.2 SUBMITTALS

A. Submit, at least two days prior to the initial start of construction on the project; completed and signed Notice of Intent forms to the State of Arizona at the following addresses:

1. Stormwater Program – Water Permits Section / NOI
   Arizona Department of Environmental Quality
   1110 West Washington, 5415B-3
   Phoenix, AZ 85007

B. Submit to the OWNER, no later than fourteen (14) days before submitting to the State agency the following:
   1. Notice of Intent (NOI) to be covered by the AZPDES General Permit for Arizona, including certifications of signature.
   2. SWPPP for the Project, including certification of signature. Stormwater Plan shall include CONTRACTOR'S proposed temporary means for stormwater control during all phases of construction and include stormwater pumping/retention plans. This submittal shall be coordinated with CONTRACTOR'S Excavation Plan submittal, specified in Section 02315, Excavation and Backfill.
   3. A manual has been prepared by the Maricopa County Flood Control District to aid in CONTRACTOR'S preparation of the SWPPP. This manual, "Drainage Design Manual for Maricopa County Arizona, Volume III, Erosion Control" is available at the Flood Control District Office, 2801 West Durango Street, Phoenix, Arizona. The complete Construction General Permit is in the December 8, 1999, Federal Register available at local libraries and is also available from the ADEQ website at www.adeq.state.az.us/environ/water/ permits/download/constgp.pdf.

C. Submit to the OWNER, as part of the Construction SWPPP a construction site inspection report that includes the following:
   1. Inspection scope.
   2. Inspector qualifications.
   3. Observations of SWPPP non-compliance and corrective steps taken.
   4. Certificate of Compliance with SWPPP and the AZPDES General Permit for Stormwater Discharge in the event of no incidents. Reports shall be submitted each quarter, at a minimum, throughout the Contract duration.

D. Submit to the OWNER, upon project completion the Notice of Termination (NOT) of coverage under AZPDES General Permit.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01414

EARTHMOVING AND DUST CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Obtain all earthmoving permits and any other permits required for earthmoving and dust generating operations related to the Work as required by the Maricopa County Air Pollution Control Regulations.

B. Not cause or allow any dust generating operation, earthmoving operation, use of property, or any other operation which causes fugitive dust emissions that exceed the 20 percent visible emission opacity limit in Rule 300 of Maricopa County's Air Pollution Control Regulations.

C. If requested by the OWNER, ENGINEER, or Maricopa County representative, shall conduct opacity observations for visible emissions of fugitive dust in accordance with techniques specified in USEPA Reference Method 9.

D. In addition to earthmoving permits, obtain an approved Dust Control Plan from Maricopa County. At a minimum, the Dust Control Plan shall include the following information:
   1. Name(s), address(es) and phone number(s) of the person(s) responsible for the preparation, submittal, and implementation of the Dust Control Plan and responsible for the dust generating operations.
   2. A site plan that describes the total area of land surface to be disturbed (in acres); the operations and activities to be performed on the site; actual and potential sources of fugitive dust emissions; and the delivery, transportation, and storage areas for the site (including types of materials stored and appropriate size of material stock piles).
   3. Description of the Reasonably Available Control Measures (RACM) to be applied during all periods of dust generating operations at all actual and potential sources of fugitive dust.
   4. Description of dust suppressants to be applied including product specifications; method, frequency, and intensity of application; type, number, and capacity of application equipment; and certifications related to the suppressant's appropriate and safe use.
   5. Description of specific surface treatment(s) or RACM used to control material track-out where unpaved or access points join paved surfaces.
   6. Description of at least one alternative RACM for each actual and potential fugitive dust source shall be designated as a contingency measure.

E. Post a copy of all earthmoving permits as well as the approved Dust Control Plan in a conspicuous location at the worksite and provide a copy of each to the ENGINEER.

F. Maintain a daily written log that records the actual application or implementation of the RACMS described in the approved Dust Control Plan. Maintain this written log and supporting documentation on site and shall make available for review on request by ENGINEER, OWNER, or Maricopa County representative. Retain copies of the Dust Control Plan, RACM implementation records, and all supporting documentations for a minimum of three years.

G. At a minimum, provide all necessary equipment and materials to apply sufficient dust suppressants (e.g., water, etc.), properly clean (sweep, etc.) all track-out areas, and provide adequate physical stabilizations (e.g., gravel, recycled asphalt, etc.) to meet all requirements of the earthmoving permit and approved Dust Control Plan. Use these methods to control fugitive dust generation from all CONTRACTOR operations on all CONTRACTOR areas including, but not limited to:
   1. Construction areas.
   2. Vehicle and equipment parking areas.
   3. Material storage areas.
   4. Office and trailer areas.
   5. Haul and access roadways.
   6. Track-out areas.
   7. All other areas where CONTRACTOR work, storing, or parking of vehicles, equipment, and materials.

H. Pay all fines issued to the OWNER by the USEPA, ADEQ, or Maricopa County due to violation of CONTRACTOR'S earthmoving permit and Dust Control Plan.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01415

CONFINED SPACE ENTRY PLAN

PART 1 - GENERAL

1.1 DESCRIPTION

A. OWNER has determined that portions of the Work site may constitute "confined spaces" as defined in 29 CFR §1926.21(b)(2) and 1910.146. Accordingly, incorporate into its Safety Plan for the Work site appropriate measures to protect the health and safety of all persons on the Work site or who may be affected by the Work, including, without limitation thereby, employees and representatives of CONTRACTOR, any subcontractor, OWNER, or ENGINEER while they are present and engaged in the performance of their duties on the Work site.

B. Comply with all local, State and Federal rules and regulations related to the protection of persons working or entering into confined spaces including, but not limited to the following:
   1. 29 United States Code §654.
   2. Title 29 Code of Federal Regulations Parts 1910 and 1926, Occupational Safety and Health.
   3. Ariz. Rev. Stat. §23-403.
   4. City of Phoenix, Confined Space Program

C. To assure OWNER that CONTRACTOR is complying with the intent of the regulations stated in Paragraph 1.1.A, above, as they relate to the protection of all persons on the Work site, CONTRACTOR'S Safety Plan, at a minimum, respond to the following requirements as they relate to Work in confined spaces:
   1. Conducting a Site-specific hazard assessment to identify confined spaces that should be characterized as "Permit Required Confined Spaces" within the meaning of 29 CFR §1926.21 (b)(6)(i) and 29 CFR §1910.146.
   2. Adopting as an element of its Safety Plan appropriate requirements for safeguarding access to "Permit Required Confined Spaces".
   3. Providing training, personal protective or safety equipment and personnel as needed to perform the Safety Plan's requirements for "Permit Required Confined Spaces."
   4. Performing all record-keeping required for "Permit Required Confined Spaces", including the required permits and confined space data sheets located in Section 01331, Reference Forms.

1.2 CONFINED SPACES SAFETY PLAN REQUIREMENTS

A. For purposes of the Safety Plan requirements listed in Article 1.1, above, "confined

spaces" are those areas on or about the Work site that fall within OSHA's definition as "any space having limited means of egress, which is subject to the accumulation of toxic or flammable contaminants or has an oxygen deficient atmosphere. Confined or enclosed spaces include, but are not limited to, storage tanks, process vessels, bins, boilers, ventilation or exhaust ducts, sewers, underground utility vaults, tunnels, pipelines, and open top spaces more than four feet in depth such as pits, tubs, vaults, and vessels."

B. Ensure that those persons who are required to enter a confined space are trained according to OSHA requirements set forth in 29 CFR §1926.21 (b)(6)(i).

C. If the confined space is a "Permit Required Confined Space", then comply with the standards set forth in 29 CFR §1910.146. and the City of Phoenix, Confined Space Program.

D. "Permit Required Confined Space" means a confined space that has one or more of the following characteristics:
   1. Contains or has the potential to contain a hazardous atmosphere.
   2. Contains a material that has the potential for engulfing an entrant.
   3. Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or floors, or by a floor that slopes downward and tapers to a smaller cross-section.
   4. Contains any other recognized serious safety or health hazard.

1.3 SUBMITTALS

A. Prepare and submit a site-specific Confined Space Entry Plan as a portion of the CONTRACTOR'S site-specific Health and Safety Plan.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01416

SPECIAL INSPECTIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The following types of Work will be subject to Special Inspections, which may be performed by the ENGINEER or the Resident Project Representative, or by such other special inspector as the OWNER may employ:
   1. High-Strength Bolting: During all bolt installations and tightening operations.
      a. Exceptions:
         1) The special inspector need not be present during the entire installation and tightening operation, provided he has:
            a) Inspected the surfaces and bolt type for conformance to plans and specifications prior to start of bolting, and "will, upon completion of all bolting, verify the minimum specified bolt tension for ten percent of the bolts for each connection, with a minimum of two bolts per connection".
         2) In bearing-type connections when threads are not required by design to be excluded from the shear plane, inspection prior to or during installation will not be required.
   2. Concrete.
   3. Reinforcing Steel.
   4. Structural Welding.
   5. Structural masonry.
   6. Epoxy Anchors.
   7. Electrical Inspections.
   8. Polyvinyl chloride liner for concrete.

1.2 SPECIAL INSPECTOR

A. The special inspector shall be a qualified person who shall demonstrate his competence to the satisfaction of the regulatory authorities for inspection of the particular type of construction or operation requiring special inspection.

1.3 DUTIES AND RESPONSIBILITIES OF SPECIAL INSPECTOR

A. The special inspector shall observe the Work assigned to be certain it conforms to the Contract Documents.

B. The special inspector shall furnish inspection reports to the regulatory authorities, the ENGINEER and other designated persons. All discrepancies shall be brought to the immediate attention of CONTRACTOR for correction, then, if uncorrected, to the ENGINEER and regulatory authorities.

C. The special inspector shall submit a final signed report stating whether the Work requiring special inspection was, to the best of his knowledge, in conformance with the Contract Documents and the applicable workmanship provision of these codes.

1.4 PERIODIC SPECIAL INSPECTIONS

A. Some inspections may be made on a periodic basis and satisfy the requirements of continuous inspection, provided this periodic scheduled inspection is performed as outlined in the Contract Documents and approved by the regulatory authorities.

PART 2PRODUCTS (NOT USED)

PART 3EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01420

REFERENCES

PART 1 - GENERAL

1.1 DEFINITIONS

A. General: Definitions of basic Contract terms are included in the General Conditions.

B. Definitions of terms commonly found in the Specifications are as follows:
   1. Indicated: The term indicated refers to graphic representations, notes, or schedules on the Drawings, or to other paragraphs or schedules in the Specifications and similar locations in the other Contract Documents. Terms such as “shown”, “noted”, “scheduled”, and “specified” are used to help the user locate the reference. There is no limitation on the location.
   2. Installer (or applicator, or erector): An installer is CONTRACTOR or another entity engaged by CONTRACTOR, either as an employee or subcontractor to perform a particular construction activity, including installation, erection, application or similar operations. Installers are required to be experienced in the operations they are engaged to perform.
      a. The term “experienced”, when used with the term “installer”, means having successfully completed a minimum of five previous projects similar in size and scope to this Project; being familiar with the special requirements indicated; and having complied with the requirements of authorities having jurisdiction and of the Supplier of the product being installed.
   3. Trades: Use of a term such as “carpentry” does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as “carpenter”. It also does not imply that requirements specified apply exclusively to trades persons of the corresponding generic name.
   4. Assigned Specialists: Certain Sections of the Specifications require that specific construction activities shall be performed by specialists who are recognized experts in those operations. Said specialists shall be engaged for those activities, and their engagement is a requirement over which CONTRACTOR has no option. These requirements shall not be interpreted to conflict with the enforcement of building codes and similar regulations governing the Work. Also, they are not intended to interfere with local trade-union jurisdictional settlements and similar conventions. Such assignments shall not relieve CONTRACTOR of its responsibility for fulfilling the requirements of the Contract Documents.

5. Equipment Identification: Several terms define the information attached to equipment.
   a. The term "CMMS Tag" means information attached to equipment pertaining to the City of Phoenix Water Services Department Computerized Maintenance Management System. CMMS Tags shall be provided by the CONTRACTOR. Refer to Section 01630, Equipment Identification Tag System for specifications regarding CMMS Tags.
   b. The term "Manufacturer Nameplate" means information attached to equipment by the manufacturer pertaining to equipment criteria, such as capacity, power supply requirement, model number, etc.

1.2 ABBREVIATIONS

A. Common abbreviations, which may be found in the Specifications, are:

alternating current		AC
Ampere		A
ante meridiem		am
Average		avg.
biochemical oxygen demand		BOD
brake horsepower		BHP
British thermal unit		BTU
Centigrade		C
Company		Co.
cubic inch		cu. in.
cubic foot		cu. ft.
cubic yard		cu. yd.
cubic feet per minute		cfm
cubic feet per second		cfs
Decibel		DB
degree Centigrade (or Celsius)	(Say)	20°C
degree Fahrenheit	(Say)	68°F
Diameter		dia.

direct current	DC
Dollars	$
Each	ea
Efficiency	eff
Fahrenheit	F
feet per hour	fph
Feet	ft.
feet per minute	fpm
feet per second	fps
Figure	Fig.
Flange	flg
foot-pound	ft-lb
gallon	gal
gallons per minute	gpm
gallons per second	gps
gram	g
Hertz	Hz
horsepower	hp
hour	hr
inch	in.
inch-pound	in.-lb
inside diameter	id
kilovolt-ampere	kva
kilowatt	KW
kilowatt-hour	kwhr
linear foot	lin. ft.
liter	l

maximum	max.
mercury	Hg
milligram	mg
milligrams per liter	mg/l
milliliter	ml
millimeter	mm
million gallons per day	mgd
million gallon	mil
minimum	min.
National Pipe Threads	NPT
net positive suction head	npsh
number	No.
ounce	oz
outside diameter	OD
parts per million	ppm
post meridiem	pm
pound	lb
pounds per square inch	psi
pounds per square inch absolute	psia
pounds per square inch gage	psig
pounds per square foot	psf
revolutions per minute	rpm
second	sec.
specific gravity	sp gr
square	sq
square foot	sq ft
square inch	sq in
square yard	sq yd

standard	std
standard cubic feet per minute	scfm
total dynamic head	tdh
totally-enclosed-fan-cooled	tefc
volt	V

1.3 APPLICABLE CODES

A. When a reference standard is specified, comply with requirements and recommendations stated in that standard, except when they are modified by the Contract Documents, or when applicable laws, ordinances, rules, regulations or codes establish stricter standards. The latest provisions of applicable standards shall apply to the Work, unless otherwise specified. Reference standards include, but are not necessarily limited to, the following:

1. American Association of State Highway and Transportation Officials (AASHTO).
2. American Concrete Institute (ACI).
3. American Gear Manufacturers Association (AGMA).
4. American Institute of Steel Construction (AISC).
5. American Iron and Steel Institute (AISI).
6. American National Standards Institute (ANSI).
7. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
8. American Society of Mechanical Engineers (ASME).
9. American Society for Testing and Materials (ASTM).
10. American Water Works Association (AWWA).
11. American Welding Society (AWS).
12. Concrete Reinforcing Steel Institute (CRSI).
13. Factory Mutual (FM).
14. Institute of Electrical and Electronics Engineers (IEEE).
15. National Electrical Manufacturer's Association (NEMA).
16. National Electrical Code (NEC) current adoption.
17. City of Phoenix – Amendments to the National Electric Code.
18. Occupational Safety and Health Administration (OSHA).
19. National Fire Protection Association (NFPA).
20. Prestressed Concrete Institute (PCI).
21. Underwriters' Laboratories, Inc. (UL).
22. All other applicable standards listed in the Specifications and the standards of utility service companies, where applicable.
23. Maricopa Association of Governments (MAG), Uniform Standard Specifications for Public Works Construction, as supplemented by the City of Phoenix. References to MAG Standard Details refer to the "Uniform Arizona.

24. International Building Code, with City of Phoenix Amendments.
25. National Electric Code – NFPA 70, with City of Phoenix Amendments.
26. American Petroleum Institute (API).
27. Uniform Building Code as supplemented by the City of Phoenix, Building Construction Code.
28. International Energy Conservation Code, with City of Phoenix Amendments.
29. Phoenix Fire Code.
30. International Fuel and Gas Code, with City of Phoenix Amendments.
31. International Mechanical Code, with City of Phoenix Amendments.
32. Uniform Plumbing Code, with City of Phoenix Amendments.
33. National Sanitation Foundation (NSF-61) and Arizona Administration Code (AAC # 18-4-213)
    a. Incorporate the requirements NSF-61, Drinking Water System Components Health Effects and AAC # 18-4-213, Standards for Additives, Materials and Equipment on all potable water systems, water treatment facilities and water distribution facilities.

B. To ensure consistent application of standards and codes the following terminology definitions shall be applicable throughout the contract documents.

Term	Definition
Phoenix Building Code	International Building Code with City of Phoenix Amendments
Phoenix Electrical Code	National Electric Code – NFPA 70 with City of Phoenix Amendments
Phoenix Energy Conservation Code	International Energy Conservation Code with City of Phoenix Amendments
Phoenix Fire Code	Phoenix Fire Code based on International Fire Code
Phoenix Fuel and Gas Code	International Fuel and Gas Code with City of Phoenix Amendments
Phoenix Mechanical Code	International Mechanical Code with City of Phoenix Amendments
Phoenix Plumbing Code	Uniform Plumbing Code with City of Phoenix Amendments
Phoenix Construction Code	All of the Codes Listed Above

1.4 OWNER'S REFERENCE SPECIFICATIONS

A. The Work, as may be otherwise specified, shall conform to the following Reference Specifications:
   1. Maricopa Association of Governments (MAG) Uniform Standard Specifications and Details for Public Works Construction, 2022
   2. City of Phoenix Supplement to 2015 MAG Uniform Standard Specifications

B. Maintain a complete copy of the Reference Specifications on the site.

1.5 INDUSTRY STANDARDS

A. Applicability of Standards: Except where the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: For applicable publication dates, refer to General Conditions.

C. Conflicting Requirements: Where compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, refer to ENGINEER for a decision before proceeding.

D. Copies of Standards: Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents. Where standards are required to perform a required construction activity, obtain copies of same from the publication source.

E. Abbreviations and Names: Whenever in these Specifications or the other Contract Documents references are made to the standards, specifications, or other published data of international, national, regional, or local organizations, such organizations may be referred to by their acronym or abbreviation only. The following acronyms or abbreviations, which may appear in the Specifications, shall have the meanings indicated herein.

1.	AA	Aluminium Association
2.	AABC	Associated Air Balance Council
3.	AAMA	American Architectural Manufacturers Association

4.	AASHTO	American Association of State Highway and Transportation Officials
5.	ACI	American Concrete Institute
6.	ACS	American Chemical Society
7.	AFBMA	Anti-Friction Bearing Manufacturers' Association
8.	AGMA	American Gear Manufacturers Association
9.	AI	Asphalt Institute
10.	AIChE	American Institute of Chemical Engineers
11.	AISC	American Institute of Steel Construction
12.	AISI	American Iron and Steel Institute
13.	AITC	American Institute of Timber Construction
14.	ALS	American Lumber Standards
15.	AMA	Acoustical Materials Association
16.	AMCA	Air Movement and Control Association
17.	ANSI	American National Standards Institute
18.	APA	American Plywood Association
19.	API	American Petroleum Institute
20.	APHA	American Public Health Association
21.	AREA	American Railway Engineering Association
22.	ARI	Air Conditioning and Refrigeration Institute
23.	ASA	American Standards Association
24.	ASAE	American Society of Agricultural Engineers
25.	ASTM	American Society for Testing and Materials
26.	ASCE	American Society of Civil Engineers
27.	ASHRAE	American Society of Heating, Refrigerating and Air Conditioning
28.	ASME	American Society of Mechanical Engineers
29.	AWI	Architectural Woodwork Institute
30.	AWPA	American Wood Preservers' Association
31.	AWPB	American Wood Preservers Bureau

32.	AWPI	American Wood Preservers' Institute
33.	AWS	American Welding Society
34.	AWWA	American Water Works Associations
35.	BHMA	Builders Hardware Manufacturers' Association
36.	CBMA	Certified Ballast Manufacturers' Association
37.	CDA	Copper Development Association
38.	CGA	Compressed Gas Association
39.	CISPI	Cast Iron Soil Pipe Institute
40.	CMAA	Crane Manufacturers' Association of America
41.	CRSI	Concrete Reinforcing Steel Institute
42.	EPA	Environmental Protection Agency
43.	ETL	Engineering Test Laboratories
44.	FCC	Federal Communications Commission
45.	FEMA	Federal Emergency Management Agency
46.	FGMA	Flat Glass Marketing Association
47.	FM	Factory Mutual Association
48.	FS	Federal Specification
49.	GA	Gypsum Association
50.	HEW	Department of Health, Education and Welfare
51.	HI	Hydraulic Institute
52.	HMI	Hoist Manufacturers' Institute
53.	HUD	Department of Housing and Urban Development
54.	ICBO	International Conference of Building Officials
55.	ICEA	Insulated Cable Engineers' Association
56.	IEEE	Institute of Electrical and Electronic Engineers
57.	IES	Illuminating Engineering Society
58.	IFI	Industrial Fasteners Institute
59.	IRI	Industrial Risk Insurers

60.	ISA	The Instrumentation Systems and Automation Society
61.	ISO	Insurance Services Office
62.	MAG	Maricopa Association of Governments
63.	MIA	Marble Institute of America
64.	MS	Military Specifications
65.	MMA	Monorail Manufacturers' Association
66.	NAAMM	National Association of Architectural Metal Manufacturers
67.	NACE	National Association of Corrosion Engineers
68.	NARUC	National Association of Railroad and Utilities Commissioners
69.	NBHA	National Builders Hardware Association
70.	NEC	National Electrical Code
71.	NEMA	National Electrical Manufacturers Association
72.	NESC	National Electrical Safety Code
73.	NFPA	National Fire Protection Association
74.	NHLA	National Hardwood Lumber Association
75.	NHPMA	Northern Hardwood and Pine Manufacturer's Association
76.	NLMA	National Lumber Manufacturers' Association
77.	NRCA	National Roofing Contractors Association
78.	NSF	National Sanitation Foundation
79.	NTMA	National Terrazzo and Mosaic Association
80.	NWWDA	National Wood Window and Door Association
81.	OECI	Overhead Electrical Crane Institute
82.	OSHA	Occupational Safety and Health Administration
83.	PCI	Precast Concrete Institute
84.	PEI	Porcelain Enamel Institute
85.	PPI	Plastic Pipe Institute
86.	PS	Product Standards Section-U.S. Department of Commerce
87.	RMA	Rubber Manufacturers' Association

88.	SAE	Society of Automotive Engineers
89.	SCPRF	Structural Clay Products Research Foundation
90.	SDI	Steel Deck Institute
91.	SDI	Steel Door Institute
92.	SIGMA	Sealed Insulating Glass Manufacturing Association
93.	SJI	Steel Joist Institute
94.	SMACNA	Sheet Metal and Air Conditioning National Association
95.	SPI	Society of the Plastics Industry
96.	SSPC	The Society for Protective Coatings
97.	SWI	Steel Window Institute
98.	TEMA	Tubular Exchanger Manufacturers' Association
99.	TCA	Tile Council of America
100.	UL	Underwriters' Laboratories, Inc.
101.	USGS	United States Geological Survey
102.	USPHS	United States Public Health Service
103.	WCLIB	West Coast Lumber Inspection Bureau
104.	WWEMA	Water and Wastewater Equipment Manufacturers Association
105.	WWPA	Western Wood Products Association

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01452

TESTING LABORATORY SERVICES FURNISHED BY CONTRACTOR

PART 1 - GENERAL

1.1 DESCRIPTION

A. Employ and pay for an independent testing laboratory to perform the specified services. Laboratory selected shall be subject to approval by the ENGINEER.

1.2 QUALIFICATIONS OF LABORATORY

A. Where applicable, meet "Recommended Requirements for Independent Laboratory Qualification," latest edition, published by American Council of Independent Laboratories and the basic requirements of ASTM E 329, "Standards of Recommended Practice for Inspection and Testing Agencies for Concrete and Steel as Used in Construction." Laboratory shall be authorized to operate in the State of Arizona.

B. Submit five copies of report of inspection of facilities made by Materials Reference Laboratory of National Bureau of Standards, for the most recent tour of inspection, with memorandum of remedies of any deficiencies reported by inspection.

C. Testing Equipment:
   1. Calibrated, at maximum 12-month intervals by devices of accuracy traceable to either National Bureau of Standards or accepted values of natural physical constants.
   2. Submit copy of certificate of calibration made by an accredited calibration agency.

1.3 LABORATORY DUTIES

A. Cooperate with ENGINEER and provide qualified personnel promptly on notice.

B. Perform specified inspections, sampling and testing of materials and methods of construction; comply with applicable standards; and ascertain compliance with requirements of Contract Documents.

C. Promptly notify ENGINEER and CONTRACTOR of any irregularities or deficiencies of Work that are observed during performance of services.

D. Promptly submit five copies of reports of inspections and tests to ENGINEER, including:
   1. Date issued.
   2. Project title and number.

3. Testing laboratory name and address.
4. Name and signature of inspector.
5. Date of inspection or sampling.
6. Record of temperature and weather.
7. Date of test.
8. Identification of product and Specification Section.
9. Location in Work.
10. Type of inspection or test.
11. Results of tests and observations regarding compliance with Contract Documents.

E. Perform additional tests and services as required to ensure compliance with the Contract Documents.

1.4 CONTRACTOR'S COORDINATION WITH LABORATORY

A. Cooperate with laboratory personnel and provide access to Work and to manufacturer's operations.

B. Provide to laboratory representative samples of materials to be tested, in quantities required by the laboratory for testing.

C. Furnish labor and facilities:
1. To provide access to Work to be tested.
2. To obtain and handle samples at the site.
3. To facilitate inspections and tests.
4. For laboratory's exclusive use for storage and curing of test samples.
5. Forms for preparing concrete test beams and cylinders.

D. Notify laboratory and ENGINEER sufficiently in advance of operations to allow for assignment of personnel and scheduling of tests.

E. Arrange with laboratory and pay for, additional samples and tests required for CONTRACTOR'S convenience.

1.5 PRODUCT TEST REPORTS

A. Furnish copies of product test reports where required by the Specifications or requested by ENGINEER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01510

TEMPORARY CONSTRUCTION FACILITIES

PART 1 - GENERAL

1.1 GENERAL

A. Responsible for all temporary construction facilities required for the Work. Make all arrangements with utility service companies for temporary services and shall pay all costs associated therewith.

B. Temporary construction facilities include:
   1. Water.
   2. Electricity and Lighting.
   3. Telephone.
   4. Heat, Weather Protection and Ventilation.
   5. Fire Protection.
   6. Sanitary and First Aid Facilities.

C. Abide by all rules and regulations of the utility service company or authority having jurisdiction.

D. Sufficient temporary heat and ventilation shall be provided to assure safe working conditions and that no damage will occur to any of the Work. In addition, all enclosed areas shall be maintained at a minimum of 50° F, unless otherwise specifically accepted in the Specifications.

E. Provide all materials, equipment and power required for temporary electricity and lighting. Include continuous power for construction site offices. Provide all outlets with circuit breaker protection and comply with ground fault protection requirements of NEC. Minimum lighting shall be five-foot candles for open areas, ten-foot candles for stairs and shops. Provide minimum of one 30- watt lamp each 20 feet in Work areas.

F. Suitably enclosed chemical or self-contained toilets shall be provided for the use of general employees. Toilets shall be located near the Work site and secluded from observation insofar as possible. Toilets shall be serviced at regular intervals, kept clean and supplied throughout the course of the Work.

G. Furnish and maintain a safe drinking water supply readily available to all workers.

H. Responsible for all utility service costs until Final Acceptance of the Work. Included are all fuel, power, light, heat, and other utility services necessary for execution, completion, testing and initial operation of the Work.

I. CONTRACTOR:
   1. Comply with applicable requirements specified in Division 15, Mechanical, and Division 16, Electrical.
   2. Maintain and operate systems to assure continuous service.
   3. Modify and extend systems as Work progress requires.
   4. Completely remove temporary materials and equipment when their use is no longer required.
   5. Clean and repair damage caused by temporary installations or use of temporary facilities.
   6. Restore existing facilities used for temporary services to the specified, or to original condition.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01511

TEMPORARY ELECTRICITY

PART 1 - GENERAL

1.1 DESCRIPTION

A. Temporary electrical service shall be provided by CONTRACTOR until Final Acceptance of the Work, unless otherwise agreed by ENGINEER.

B. All costs, including the charge for power consumed, shall be assumed by CONTRACTOR. Also, provide power for testing, initial start-up, and commissioning of equipment.

C. The temporary service shall conform to applicable provisions of Division 16, Electrical.

D. Materials and equipment may be new or used; however, they shall be in first class, fully serviceable condition and shall not create unsafe conditions or violate requirements of applicable codes.

E. Service is required for lighting, power tools, construction trailers, dewatering equipment, and similar usages. Electric space heaters and large welding machines are not included herein.

F. All temporary service required beyond the specified locations shall be the responsibility of CONTRACTOR requiring such power, who shall furnish his own portable generator or other means.

1.2 POWER SOURCE AND SERVICE REQUIRED

A. A temporary power service is available from SRP.

B. System shall be 240/120-volt, single phase, 60 Hz with sufficient capacity to provide service for construction use by all trades and with the following minimum facilities:
   1. 600 ampere frame with 600 ampere trip primary circuit breaker.
   2. Two pole safety switch, and a 240/120 volt, single phase, 3 wire distribution panel.

C. Service shall be provided and maintained so that power can be secured at any desired point with no more than a 50-foot extension.

D. One power center, minimum, shall be provided on each floor.

E. Provide each outlet with circuit breaker protection and comply with ground fault protective requirements of NEC.

F. Work hours are specified under the General Conditions.

G. Provide continuous power for construction site offices.

H. Provide power to maintain continuous operation of existing facilities during changeover of electrical equipment.

I. Provide power for testing, checking, initial start-up of equipment and commissioning.

1.3 INSTALLATION

A. Install temporary work in a neat orderly manner and make structurally and electrically sound throughout.

B. Maintain installation throughout construction period to provide continuous service and to provide safe working conditions.

C. Modify service and rearrange wiring as Work progress requires.

D. Locate all facilities to avoid interference with hoisting, materials handling, storage, traffic areas, existing operable facilities, and Work under other contracts.

E. Assume responsibility for and return to original condition any part of the permanent electrical system that is used for construction purposes.

1.4 REMOVAL

A. Completely remove temporary materials and equipment after permanent installation is in use.

B. Repair damage caused by the temporary service or its removal and restore to specified or original condition.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01512

TEMPORARY LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Temporary lighting shall be provided by CONTRACTOR.

1.2 DEFINITIONS

A. Work Lighting: That required to provide adequate illumination for Work being performed.

B. Safety Lighting: That required to provide:
   1. Adequate illumination for safe movement of authorized persons throughout project.
   2. Adequate illumination for public safety.
   3. Special warning lighting for hazardous conditions.

C. Security Lighting: That required in protection of Work from unauthorized entry.

1.3 DESCRIPTION OF SYSTEM

A. Furnish and install temporary lighting that is required for:
   1. Construction needs.
   2. Safe and adequate working conditions throughout the Work.
   3. Public safety.
   4. Security lighting.
   5. Lighting for temporary office, storage and construction buildings.

B. Lighting Intervals:
   1. Work Lighting:
      a. General: Five-foot candles.
      b. All stairs: Ten-foot candles.
      c. Construction Plant and Shops: Ten-foot candles.
      d. For Detail and Finishing Work: Twenty-foot candles.
      e. For Detailed Testing and Inspection: Thirty-foot candles.
      f. For First Aid Stations: Thirty-foot candles.
      g. Operating areas: One 300-watt lamp per 15 feet on centers.
   2. Safety Lighting:
      a. General: Five-foot candles, minimum.
      b. For Hazardous Conditions: As required by applicable codes.
   3. Night Security Lighting: Provide over area within 50 feet of any portion of construction

C. Periods of Service:
   1. Work Lighting: Continuous from 15 minutes prior to 15 minutes past scheduled Work hours on scheduled Workdays.
   2. Safety Lighting:
      a. Within Project site: At all times authorized personnel are present.
      b. Public areas: At all times.
   3. Security Lighting: All hours of darkness.

D. Maintain strict supervision of use of temporary lighting. Enforce conformance with applicable standards and safe practices and prevent abuse of services.

1.4 POWER

A. As specified in Section 01511, Temporary Electricity.

1.5 COSTS OF INSTALLATION AND OPERATION

A. Electrical contractor shall pay costs of Temporary Lighting, including costs of installation, maintenance, and removal.

B. Power Costs: As specified in Section 01511, Temporary Electricity.

1.6 REQUIREMENTS OF REGULATORY AGENCIES

A. Comply with National Electrical Code (NEC) current adoption, and City of Phoenix – Amendments to the National Electrical Code.

1.7 USE OF OWNER'S EXISTING SYSTEM

A. Existing systems cannot be used for temporary lighting.

1.8 USE OF PERMANENT SYSTEM

A. Secure OWNER'S written permission for use of system, indicating conditions of use.

B. Furnish and install temporary lamps for temporary lighting.

C. Lamps used shall be replaced upon Final Acceptance of the Work

1.9 MATERIALS

A. Comply with applicable provisions of Division 16, Electrical.

B. Materials and equipment may be new or used, but must be adequate for purposes intended and must not create unsafe conditions or violate requirements of applicable codes.

C. Provide all required facilities, including wiring, switches, accessories and supports.

D. At CONTRACTOR'S option, patented specialty products may be used, if UL approved.

1.10 RECEPTACLES, FIXTURES

A. Standard products, meeting UL requirements.

B. Provide heavy-duty guards on fixtures.

C. Provide appropriate types of fixtures for environment in which used, in accordance with NEC and NEMA standards.

1.11 INSTALLATION

A. Install temporary work in neat and orderly manner and make structurally and electrically sound throughout.

B. Maintain throughout construction period to give continuous service and to provide safe working conditions.

C. Modify and extend lighting as Work progress requires.

D. Locate to avoid interference with or hazards to:
   1. Work or movement of personnel.
   2. Traffic areas.
   3. Materials handling.
   4. Storage areas.
   5. Work for other contracts.

E. Install lighting switches at entrance to each area, or successive areas, so that progress to all areas of the Work may be made through lighted areas.

F. Install exterior security lighting.
   1. Illuminate entire Work site.
   2. Control lighting by photo-electric cell.

1.12 REMOVAL

A. Completely remove temporary materials and equipment after permanent lighting is in use.

B. Repair damage caused by temporary service and restore surfaces to specified, or original condition.

C. Immediately prior to completion of the Work, remove temporary lamps and install new lamps throughout.

PART 2 - PRODUCTS (NOT USED)

PART 3 -EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01514

TEMPORARY WATER

PART 1 - GENERAL

1.1 DESCRIPTION

A. Temporary water shall be provided by CONTRACTOR, as specified in the paragraphs below.

1.2 DESCRIPTION OF SYSTEM

A. Furnish and install temporary water service for entire Project for use throughout construction period.

B. Provide water hoses from hose bibbs to point of operations.

C. Also, provide water for sanitary facilities, first aid facilities, fire protection, field offices, cleaning, disinfection and testing.

D. Maintain adequate volume of water for all purposes.

E. Potable Water Source:
   1. Supplier: Provide water source by connecting to existing utility mains at locations designated by OWNER. Provide backflow preventers, where required. Hydrants cannot be taken out of service.
   2. Provide minimum 2-inch supply service and supply and install meter satisfactory to water utility.
   3. Permission shall be obtained from OWNER for water from hydrants.

F. Maintain strict supervision of use of temporary services:
   1. Enforce conformance with applicable codes and standards.
   2. Enforce sanitary practices.
   3. Prevent abuse of services.
   4. Prevent wasteful use of water.
   5. Protect system from freezing.

1.3 COSTS OF INSTALLATION AND OPERATION

A. Pay costs of temporary water service, including costs of installation, maintenance and removal of pipe and equipment.

B. Pay costs for water used by all trades.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

A. Obtain and pay for permits, fees, deposits required by governing authorities.

B. Obtain and pay for temporary easements required across property, other than that of OWNER.

C. Comply with federal, state and local laws, ordinances, rules and regulations and standards, and with utility service company regulations.

1.5 USE OF OWNER'S EXISTING SYSTEM

A. Use existing system for temporary water for construction.

B. Modify and extend system as necessary to meet temporary water requirements.

C. Upon completion of Work, restore existing system to specified, or original condition.

1.6 MATERIALS

A. Comply with applicable provisions of Division 15, Mechanical.

B. Materials may be new or used, but must be adequate for purpose required, sanitary, and must not violate requirements of applicable codes.

C. Provide all required facilities, including piping, valves, pumps, pressure regulators, tanks and other appurtenances.

1.7 INSTALLATION

A. Install Work in a neat and orderly manner and make structurally and mechanically sound throughout.

B. Maintain to provide continuous service.

C. Modify and extend service as Work progress requires.

D. Locate piping and outlets to provide service convenient to work stations and to avoid interference with traffic and work areas, materials handling equipment, storage area, and work under other contracts.

E. Do not run piping on floor or on ground.

F. Provide drip pan under each hose bibb located within building and connect drain to sewer.

G. Provide insulation, or other means, to prevent pipes from freezing.

H. When necessary to maintain pressure, provide temporary pumps, tanks and compressors.

I. Disinfect temporary or permanent potable water piping prior to use in accordance with City, State and Maricopa Association of Governments (MAG) requirements and as supplemented by the City of Phoenix.

1.8 REMOVAL

A. Completely remove temporary materials and equipment upon completion of construction.

B. Clean, repair damage caused by installation, and restore to specified or original condition.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01515

TEMPORARY SANITARY AND FIRST AID FACILITIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Temporary sanitary and first aid facilities shall be provided by CONTRACTOR.

B. Provide temporary sanitary and first aid facilities for use throughout the Contract including:
   1. Potable water and sanitary drinking cups.
   2. Sanitary drinking fountains, where feasible.
   3. Enclosed toilet facilities.
   4. Suitable general employee washing facilities.
   5. First aid stations at or immediately adjacent to all major Work areas and in the temporary field offices.
   6. Post telephone numbers of physicians, hospitals and ambulance services by each telephone at the Project site.
   7. At least one person thoroughly trained in first aid procedures shall be present on the site, whenever Work is in progress. These persons must have a certificate indicating that they have completed a first aid training course conducted by the American Red Cross or other approved agency. Submit the certificates to the ENGINEER.

C. Provide facilities and fixtures in compliance with all applicable federal, state, and local laws, ordinances, standards, and regulations.

D. Maintain strict supervision of use of facilities.

E. Maintain, service and clean facilities and keep them supplied continuously with soap, towels, paper and all other required supplies.

F. Enforce proper use of sanitary facilities, including preventing the committing of nuisances in buildings on the site.

G. Dispose of all wastes in conformance with applicable regulations.

1.2 COSTS OF INSTALLATION AND OPERATION

A. Pay all cost including installation, maintenance, and removal.

1.3 USE OF EXISTING SYSTEM

A. Existing facilities may not be used, unless an agreement is obtained in writing from the OWNER stating the conditions of use.

1.4 USE OF PERMANENT FACILITIES

A. Permanent facilities shall not be used by construction personnel.

1.5 INSTALLATION AND REMOVAL

A. Temporary flush toilets or portable toilets may be used.

B. Comply with all applicable provisions of Division 15, Mechanical.

C. Completely remove temporary materials and equipment upon completion of construction and restore all damaged facilities to original condition.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01516

TEMPORARY FIRE PROTECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Conform to the fire protection and prevention requirements specified herein as well as those which may be established by federal, state or local governmental agencies.

B. Comply with all applicable provisions of NFPA Standard No. 241, Safeguarding Building Construction and Demolition Operations.

C. Facilities specified herein shall be provided by CONTRACTOR, but all other contractors shall conform to the provisions of this Section and all applicable laws, ordinances, rules and regulations.

1.2 REQUIRED FIRE FIGHTING EQUIPMENT

A. Provide portable fire extinguishers, rated not less than 2A or 5B in accordance with NFPA Standard No. 10, Portable Fire Extinguishers, for each temporary building and for every 3000 square feet of floor area under construction.

B. Locate portable fire extinguishers 50 feet maximum from any point in the protection area.

1.3 FIRE PREVENTION AND SAFETY MEASURES

A. Prohibit smoking in all hazardous areas and in all of the OWNER'S buildings. Post suitable warning signs in areas which are continuously or intermittently hazardous.

B. Use metal safety containers for storage and handling of flammable and combustible liquids.

C. Do not store flammable or combustible liquids in or near stairways or exits.

D. Maintain clear exits from all points in the Work site.

1.4 COSTS OF INSTALLATION

A. Pay all costs including installation, maintenance, and removal.

1.5 HAZARDOUS MATERIALS RELEASE EVACUATION

A. Be familiarized with the OWNER'S hazardous materials release evacuation plan and shall have the Work force prepared to evacuate should the emergency occur.

B. The OWNER will conduct a training session for CONTRACTOR'S supervisory staff, which would be responsible to train all of CONTRACTOR'S employees, all Subcontractors' employees or any other personnel who are on site.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01550

ACCESS ROADS AND PARKING AREAS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide all temporary construction roads, walks and parking areas required during the construction and for use of emergency vehicles. Temporary roads and parking areas shall be designed and maintained by CONTRACTOR so as to be fully usable in all weather conditions.

B. Prevent interference with traffic and the OWNER'S operations on existing roads. Indemnify and save harmless the OWNER from any expenses caused by CONTRACTOR'S operations over these roads.

C. Roadway damage shall be restored to the original condition by CONTRACTOR subject to approval of the OWNER or ENGINEER.

D. Temporary roads, walks and parking areas shall be removed by CONTRACTOR, prior to Final Acceptance, and the ground returned to its original condition, unless otherwise required by the Contract Documents.

1.2 DESIGNATED PARKING

A. All CONTRACTOR'S employee vehicles shall park in an area specifically designated for that purpose, as more fully described in Section 01561, Security.

1.3 MAINTENANCE OF ROADS

A. At all times maintain approved access for trucks to loading areas of the plant and parking facilities for plant personnel. All parking of construction vehicles shall be in approved lots.

B. Have all paved roads swept by mechanical sweeper, a minimum seven (7) times a week or as directed by the ENGINEER. Keep roads serviceable at all times. Specific roads include:
   1. All roads within the limits of this Contract.
   2. Lift Station 76 access roads from entrance to work parking and work sites.

C. Dust resulting from construction shall be controlled by CONTRACTOR to prevent a nuisance on the site or in adjacent areas. Apply water or use other methods subject to the ENGINEER'S approval, which will keep dust in the air to a minimum. Use of

water will not be permitted when it results in hazardous or objectionable conditions such as ice, mud, ponds and pollution, refer to Section 01414, Earthmoving and Dust Control.

D. Provide temporary heavy duty steel roadway plates to protect existing manholes, handholes, valve boxes and vaults.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01561

SECURITY

PART 1 - GENERAL

1.1 DESCRIPTION

A. Safely guard all Work, materials, equipment and property from loss, theft, damage and vandalism. CONTRACTOR'S duty to safely guard property shall include the OWNER'S property and other private property from injury or loss in connection with the performance of the Work.

B. Employ watchmen as required to provide the required security and prevent unauthorized entry.

C. Make no claim against the OWNER for damage or injury resulting from trespass.

D. Responsible for security and shall make good all damage to property of OWNER and others arising from failure to provide adequate security. The standard for security shall be, at a minimum, equivalent to the owner's standards.

E. If the existing fencing or barriers are breached or removed for purposes of construction, provide and maintain temporary security fencing equal to the existing in a manner satisfactory to the ENGINEER and OWNER. Provide additional security staff, if required, to maintain the security of the facility.

F. Security measures taken shall be at least equal to those usually provided by OWNER to protect his existing facilities during normal operation.

G. Maintain security program throughout the Work until OWNER'S acceptance and occupancy precludes need for CONTRACTOR'S security program.

H. Comply with all aspects of OWNER'S site-specific Security Guard Protocol. This shall include background checks equivalent to those conducted by the owner.

I. All costs for security as specified in this Section shall be borne by CONTRACTOR.

1.2 CONTRACTOR'S ACCESS TO THE SITE

A. Access to the Lift Station 76 site for CONTRACTOR'S employees, material, tools and equipment shall be from the designated construction entrance only.

B. Ensure that each of his employees, representatives, delivery persons, suppliers and others acting for CONTRACTOR, shall be subject to the following regulations:
   1. CONTRACTOR'S subcontractor's, suppliers and manufacturer's employees shall not park anywhere other than CONTRACTOR Employee's Parking Area. The Area shall be designated by the ENGINEER. Prepare and maintain this area, as required.
   2. All CONTRACTOR employees shall wear a laminated photograph identification and badge bearing CONTRACTOR'S name, employee's name, and employee number at all times when the employee is on the site. Badge and Background Check Data form shall be completed by CONTRACTOR and approved by OWNER prior to CONTRACTOR personnel entering the site.
   3. Turn over the identification badge to the OWNER upon the individual's completion of the participation on the project or project completion.
   4. OWNER reserves all rights to the approval of all CONTRACTOR, subcontractor, suppliers, and manufacturers employees receiving an identification badge.
   5. All vehicles, including those belonging to CONTRACTOR, his employees and subcontractors, delivery persons and suppliers entering the plant site shall conform to all security and safety regulations in force at the site. All vehicles entering and leaving the facility are subject to search.
   6. Personal vehicles shall not be allowed outside CONTRACTOR'S Employee Parking Area.
   7. Delivery vehicles shall access the site from the designated construction entrance road stated in Paragraph 1.2 A. above.
   8. Access to the Lift Station 76 site from any other entrance is strictly prohibited unless prior approval is obtained from the owner. Violators shall be banned from the site.
   9. Firearms are not allowed on City property.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01570

TEMPORARY CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide and maintain methods, equipment, and temporary construction, as necessary to provide controls over environmental conditions at the construction site and adjacent areas. Remove physical evidence of temporary facilities at completion of Work.

B. Obtain all City, County and State permits required for the construction of all Work, including Hazardous Material Management, Earth Moving/ Dust Control and Stormwater/Stormwater Pollution Prevention Permits.

1.2 NOISE CONTROL

A. CONTRACTOR'S vehicles and equipment shall be such as to minimize noise to the greatest degree practicable. Noise levels shall conform to the latest OSHA standards and in no case will noise levels be permitted which interfere with the Work of the OWNER or others.

1.3 PEST AND RODENT CONTROL

A. Provide rodent and pest control as necessary to prevent infestation of construction or storage areas.
   1. Employ methods and use materials that will not adversely affect conditions at the site or on adjoining properties.

1.4 WATER CONTROL

A. Provide methods to control surface water and water from excavations and structures to prevent damage to the Work, the site, or adjoining properties.
   1. Control fill, grading and ditching to direct water away from excavations, pits, tunnels, and other construction areas and to direct drainage to proper runoff courses so as to prevent any erosion, damage, or nuisance.

1.5 EROSION CONTROL

A. Plan and execute construction and earth work by methods to control surface drainage from cuts and fills, and from borrow and waste disposal areas, to prevent erosion and sedimentation.
   1. Hold the areas of bare soil exposed at one time to a minimum.
   2. Provide temporary control measures such as berms, dikes and drains.

B. Construct fills and waste areas by selective placement to eliminate surface silts or clays which will erode.

C. Periodically inspect earthwork to detect any evidence of the start of erosion; apply corrective measures as required to control erosion.

D. Coordinate erosion control requirements with the requirements of Article 1.4, above.

1.6 AIR POLLUTION CONTROL

A. The CONTRACTOR shall not discharge smoke, dust, equipment exhaust, or any other air contaminants into the atmosphere in such quantity as will violate any Federal, State, or local regulations. The CONTRACTOR shall also abate dust nuisance by cleaning, sweeping and spraying with water, or other means as necessary.

B. Air pollution control shall comply with Section 01414, Earthmoving and Dust Control.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01580

PROJECT IDENTIFICATION AND SIGNS

PART 1 GENERAL

1.1 DESCRIPTION

A. Furnish, install and maintain temporary project identification and informational signs.

B. The following signs shall be provided:
1. Provide one (1) project construction sign no larger than W = 8'-0" by H = 4'-0" with the following text and formatting:
   - 6-inch, RomanS Bold

2022
LIFT STATION 76 PHASE II EXPANSION
COP NO. WS90400067-4
OWNER: COP WATER SERVICES DEPT.
ENGINEER: GREELEY AND HANSEN
CONTRACTOR:
PROJECT HOTLINE: (602) XXX-XXXX
EST. COMPLETION: XX/XX/2024

C. No signs, except those specified, shall be displayed, unless approved by OWNER.

1.2 SUBMITTALS

A. Submit for approval the following:
1. Type of grade of materials.
2. Layout, size, trim, framing, supports and coatings.
3. Size and style of lettering.
4. Samples of colors.

1.3 CONSTRUCTION

A. Use 3/4-inch exterior grade plywood, unless shown otherwise.

B. Use, trim, mitered on all edges.

C. Design signs and supports to withstand 75 mile per hour wind.

D. Paint with exterior gloss-finish enamel. Sign painter shall be a professional in the type work required.

1.4 INSTALLATION AND MAINTENANCE

A. Location of signs shall be as shown or directed by ENGINEER.

B. Maintain signs so they are clean, legible, and upright. Keep grass and weeds cut away from signs.

C. Repair and repaint damaged signs. Relocate signs as required by progress of the Work.

D. Remove signs when project is completed or when directed by ENGINEER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01600

GENERAL EQUIPMENT PROVISIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. These General Equipment Provisions apply, to all equipment furnished under this Contract including equipment specified in Division 11, Equipment, Division 13, Special Construction, Division 14, Conveying Systems, Division 15, Mechanical, Division 16, Electrical, and Division 17, Instrumentation. These General Provisions shall supplement the Detailed Equipment Specifications, but in case of conflict the Detailed Equipment Specifications shall govern.

B. Environmental Conditions :
   1. All equipment and appurtenances specified in the scope of this Section shall be designed and configured for installation and operation in a corrosive environment.
   2. Equipment shown or specified for exterior locations shall be designed for continuous operation in a dusty environment, with normal ambient air temperatures of 120°F, and exposed to air that contains corrosive compounds.

1.2 QUALITY ASSURANCE

A. Arrangement:
   1. The arrangement of equipment shown on the Drawings is based upon information available to the ENGINEER at the time of design and is not intended to show exact dimensions peculiar to a specific manufacturer. The Drawings are, in part, diagrammatic, and some features of the illustrated equipment installation may require coordination to meet actual equipment installation requirements. Structural supports, foundations, connected piping, valves, and electrical conduit specified may have to be coordinated to accommodate the equipment provided. No additional payment will be made for the coordination.

B. Unit Responsibility:
   1. Equipment systems made up of two or more components shall be manufactured and assembled as a unit by the responsible manufacturer. The responsible manufacturer shall select all components of the system to assure compatibility, ease of construction and efficient maintenance. The responsible manufacturer shall coordinate selection and design of all system components, such that all equipment furnished under the specification for the equipment system,

including equipment specified elsewhere, but referenced in the specification, is compatible and operates properly to achieve the performance requirements specified. Unless otherwise specified, the responsible manufacturer shall be the manufacturer of the driven equipment. Agents, representatives or other entities that are not a direct component of the manufacturing corporation will not be acceptable as a substitute for the manufacturer's corporation in conforming to this requirement. This requirement for unit responsibility shall in no way relive CONTRACTOR of his responsibility to the OWNER for performance of all systems.

2. Assure that all equipment systems provided for the Project are products for which unit responsibility has been accepted by the responsible manufacturer. Where the detailed specification requires a certificate from the Unit Responsibility Manufacturer, coordinate delivery of such certificates. Certificates shall conform to the content, form and style of Form 01600-B specified in Section 01331, Reference Forms, shall be signed by an officer of the manufacturer's corporation and shall be notarized. No other submittal material will be processed until a Certificate of Unit Responsibility has been received and has been found to be satisfactory. Failure to provide acceptable proof that the unit responsibility requirement has been satisfied will result in withholding approval of progress payments for the subject equipment even though the equipment may have been installed in the Work.

1.3 WORKMANSHIP AND MATERIALS

A. All equipment shall be designed, fabricated and assembled in accordance with the best modern engineering and shop practice and in accordance with applicable standards. Individual parts shall be manufactured to standard sizes and gauges so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required for tests.

B. In various Sections of the Specification, manufacturer's names have been used for clarity and to establish minimum product standards only. Responsibility for selection and coordination of all materials required for construction belongs to CONTRACTOR.

C. All parts and components of mechanical equipment shall be designed for satisfactory service under continuous duty and under the specified and indicated operating conditions. Any part of mechanical equipment that shows excessive wear or fails due to wear, under normal operating conditions, within the warranty period shall be considered as evidence of defective material or defective workmanship, and it shall be replaced by CONTRACTOR with equipment or parts to meet the specified requirements, at no additional cost to the OWNER.

D. Bronze which shall be in contact with water or any liquid, used in the manufacture of any equipment shall not contain aluminum or more than six percent zinc, and shall conform to ASTM B62, or equivalent.

E. Tolerances and clearances shall be as indicated on the Shop Drawings, and these tolerances and clearances shall be closely followed to secure proper operation of the equipment.

F. All flanges on equipment and equipment appurtenances furnished shall conform in dimensions and drilling to ANSI B16.1, Class 150, unless otherwise noted.

1.4 MANUFACTURER'S NAMES

A. Manufacturer's name and catalog numbers are for the convenience of CONTRACTOR. The detailed Contract Documents shall apply in the event of a conflict. If detailed Contract Documents have not been given, the manufacturer's name and catalog number shall determine the design criteria for comparison should an equal be submitted.

1.5 REGULATIONS AND CODES

A. Electrical and Instrumentation Work, furnished with equipment supplied under Division 11, Equipment, Division 13, Special Construction, Division 14, Conveying Systems, and Division 15, Mechanical, including connection to electrical equipment integral with mechanical equipment, shall be performed in accordance with the requirements of Division 16, Electrical, and Division 17, Instrumentation. When applicable, the material used in the performance of the electrical Work shall be approved by the Underwriter's Laboratories, Inc. (UL) for the class of service for which they are intended.

1.6 BEARINGS

A. Unless otherwise specified, all equipment bearings shall be oil or grease lubricated and ball or roller antifriction type of standard manufacture. Bearings shall be conservatively designed to withstand all stresses of the service specified. Each bearing, except as otherwise noted, shall be rated in accordance with the latest revisions of Anti-Friction Bearing Manufacturer's Association's (AFBMA) Methods of Evaluating Load Ratings of Ball and Roller Bearings for B-10 rating life of 100,000 hours.

B. All grease lubricated bearings, except those specified to be factory sealed lubricated, shall be fitted with easily accessible grease supply, flush, drain, and relief fittings of the standard hydraulic type. Extension tubes shall be provided for easy access.

C. Oil-lubricated bearings shall be equipped with either a pressure lubricating system or a separate oil reservoir type system. Each oil lubrication system shall be of

sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 55°C and shall be equipped with a filler pipe and an external level gauge. Fittings for pressure lubrication shall be 1/4-inch straight type.

D. To avoid work hardening or "Brinelling" damage from vibration, bearings shall be separately packed or otherwise suitably protected during transport.

1.7 LUBRICATION AND LUBRICATION FITTINGS

A. Equipment shall be adequately lubricated by systems that require attention no more often than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants. Lubricants of the type recommended by the equipment manufacturer shall be provided in sufficient quantity for consumption prior to completion of required testing and commissioning of equipment. Provide the ENGINEER at Substantial Completion of the Project or portion of the Project, three (3) copies of a list showing the proper lubricants for each item of mechanical equipment, approximate quantities needed per year of continuous operation, and recommended lubrication intervals. Wherever possible, the types of lubricants shall be consolidated with the manufacturer's approval to minimize the number of different lubricants required for plant maintenance.

B. Equipment and bearing lubrication fittings shall be extended with piping beyond obstructions, such as guards or covers, to provide ease of lubrication without disassembly of the unit.

C. All lubrication fittings shall be constructed of Type 304L stainless steel and shall be brought to the outside of all equipment, so they are readily accessible from the outside without the necessity of removing covers, plates, housing, or guards. Fittings shall be of button head type. Lubrication fittings shall be mounted together wherever possible and shall be made of factory-mounted multiple fitting assemblies. Fittings shall not be individual fittings field-mounted together.

D. Lubrication: Food grade oil meeting NSF 61 for water applications or oil bath for wastewater applications.

1.8 EQUIPMENT BASES AND BEDPLATES

A. A heavy cast iron, FRP, or stainless-steel base shall be provided for each item of equipment that is to be installed on a concrete base, in accordance with the equipment manufacturer's requirements. Equipment assemblies, unless otherwise specified or shown on the Drawings, shall be mounted on a single, heavy, cast iron, FRP, or stainless-steel bedplate, in accordance with the equipment manufacturer's requirements. Bases and bedplates shall be provided with machined support pads,

tapered dowels for alignment of mating or adjacent items, adequate openings to facilitate grouting, and openings for electrical conduits. Seams and contact edges between stainless steel plates and shapes shall be continuously welded and ground smooth. Bedplate drain fittings shall be piped to the nearest sump or designated drainage area.

B. After assembly and installation on the concrete base, each unit shall be leveled, using a precision level, and aligned in place but not grouted until after the initial fitting and alignment of connecting piping. Each unit shall then be grouted to the concrete base. Each base and bedplate shall be completely filled with grout, where applicable. The grout shall extend to the edge of each base or bedplate and shall be beveled at 45 degrees all around the unit. Grout exposed at horizontal surfaces shall be rounded to provide drainage to appropriate points. After grout has set, jacking screws shall be removed, and nuts on anchor bolts shall be tightened followed by an overall check on leveling and alignment. Should equipment not meet tolerances of leveling and alignment, as recommended by the manufacturer, corrective measures shall be taken to obtain the tolerances required. Reciprocating equipment shall be grouted with non-shrinking epoxy grout, as specified under Section 03600, Grout.

1.9 EQUIPMENT GUARDS

A. Belt or chain drives, fan blades, couplings, exposed shafts, and other moving or rotating parts shall be covered on all sides by guards conforming with the General Industry Safety Orders of the Arizona Division of Industrial Safety. The guards shall be fabricated from 15 USS gauge or heavier aluminum or Type 316 stainless steel. Each guard shall be designed for easy installation and removal. Necessary supports and accessories shall be provided for each guard. Guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water. Drawings of the guards shall be submitted to the ENGINEER for approval prior to fabrication or delivery.

B. Secure guards in position by aluminum or Type 316 stainless steel braces or straps, securely fastened to floor, wall, or frame of the equipment. Fastenings shall permit easy removal for servicing the equipment.

1.10 EQUIPMENT DATA NAMEPLATES

A. Manufacturers nameplates shall meet requirements as stated in individual equipment specifications. Manufacturers equipment data nameplates shall be stamped on Type 316 stainless steel and fastened to the equipment in an accessible location with No. 4 or larger oval head Type 316 stainless steel screws or drive pins. The nameplate shall include manufacturer’s name, equipment model number, serial number, drive speed, motor horsepower, and rated capacity etc. Manufacturers nameplates for pumps shall also include, at a minimum, rated total dynamic head, impeller size and capacity, where applicable.

B. All storage tanks (steel, fiberglass and polyethylene), shall include a second sign with the description of the contents. The lettering on the sign shall be visible from at least ten feet.

C. Refer to Section 01630 for CMMS Tag requirements.

1.11 WARNING SIGNS

A. Furnish and install permanent warning signs at all mechanical equipment, prior to startup, that may be started automatically or from remote locations. Signs shall be located near the equipment, in accordance with safety regulations, and shall be suitable for exterior use.

B. Warning signs shall be colored yellow with black letters, on not less than 18-gauge vitreous enameling stock. Copy shall read:

CAUTION:
THIS EQUIPMENT STARTS
AUTOMATICALLY

C. Each sign shall be clearly readable from a distance of 20 feet.

D. Additional warning sign requirements are specified in Section 10400, Identification Devices.

1.12 EQUIPMENT PAINTING/COATINGS

A. Surfaces requiring painting or coating for corrosion protection shall be smooth, free from sharp edges, burrs, and projections and shall have all welds ground smooth and all edges and corners of structural members rounded. Non-conformance shall be grounds for rejection of equipment, as determined by the ENGINEER.

B. Equipment shall be shop-primed prior to delivery to the Work site, unless otherwise specified, in accordance with Section 09900, Painting.

C. Surfaces of equipment, which will be inaccessible after assembly, shall be painted or otherwise protected before assembly by a method that provides protection for the life of the equipment. Furnish equipment to replace any equipment that the ENGINEER determines to be damaged beyond repair by rust or mishandling, etc., while in storage or during installation by CONTRACTOR.

D. Manufacturers equipment or motor data nameplates shall not be painted.

E. The equipment supplier shall certify, by a letter included with the equipment submittal, confirming that the proposed primer and finish coating used is compatible with the approved Division 9, Finishes, painting scheme. After delivery to the Work site, the equipment finished surfaces shall be inspected and evaluated. A final coat of paint shall be applied to all equipment in the field.

F. Machined, polished, and other ferrous and non-ferrous surfaces that are not to be painted shall be coated with rust preventative compound, Dearborn Chemical "NO-Ox-Id", Houghton "Rust Veto 344," Rust-oleum "R9," or approved equal. Should rust occur during shipment or storage, responsibility for correction, as determined by the ENGINEER, belongs to CONTRACTOR.

G. Copper, bronze, chromium plate, nickel, stainless steel, aluminum, monel metal, lead, lead coated copper, brass, and plastic are not to be painted or finished, unless otherwise specified or recommended by the manufacturer.

H. All metallic surfaces requiring a shop applied primer shall be primed with an approved priming system that has been certified, by letter, as being compatible with the Division 9, Finishes, coating systems proposed and shall be applied in accordance with the recommendations of the paint manufacturer. Submittal for equipment shall include:
   1. Coating manufacturer's "Cut-sheet" describing components, surface preparation requirements, recommended mil thicknesses, and application procedures for the proposed primer.
   2. A letter from the equipment supplier stating that he has confirmed that the proposed primers are compatible, and that the primer will be applied in accordance with the coating manufacturer's requirements. In addition, the letter shall certify that the appropriate surface preparations will be made prior to primer application.

I. After delivery to the Work site, equipment surfaces shall be inspected and evaluated by the ENGINEER. Touch-up or complete removal of shop priming, by sandblasting or other approved method, may be required as determined by the ENGINEER based on the condition of the equipment primer prior to final, in place, finish coat application.

J. Field touch-up, final surface preparation, and final finish coatings shall be applied by CONTRACTOR.

1.13 FACTORY TEST AND CERTIFICATION

A. All equipment, devices, and systems requiring factory test and certification, as specified in these Specifications, may be witnessed by the OWNER. Notify the ENGINEER, in writing, at least 30 calendar days in advance of all equipment, devices and system testing. The written notifications shall specify the exact date and location of the tests that will be conducted and shall define the test procedures to be

utilized. Testing procedure shall be scheduled and performed during normal working hours and shall be subject to review by the ENGINEER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01620

INSTALLATION OF EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section describes Work necessary to install equipment and materials to be incorporated into this Project. It supplements the Specification requirements in Division 2, Sitework, through Division 17, Instrumentation.

B. Shop Drawings, installation drawings and instructions furnished by the manufacturers shall be used by CONTRACTOR in the installation of the equipment and materials.

1.2 ANCHOR BOLTS AND GROUT

A. Anchors and adhesive anchors shall be furnished by CONTRACTOR, as specified and required. Use adhesive anchors only where shown or approved by ENGINEER or required by the manufacturer. Anchors and adhesive anchors shall be of specified materials with heavy hexhead nuts. Anchorage items shall conform to the applicable requirements of Section 05051, Anchor Bolts, Expansion Anchors, Toggle Bolts and Concrete Inserts.

B. Grouting shall be in accordance with Section 03600, Grout, and Section 01600, General Equipment Provisions.

1.3 TRANSPORTING, HANDLING AND INSTALLING EQUIPMENT AND MATERIALS

A. Conform to requirements of Section 01600, General Equipment Provisions, and Section 01651, Transportation and Handling of Equipment and Materials.

B. Employ competent mechanics experienced in the installation of the types of equipment and materials to be furnished and shall ensure that all equipment and materials are installed in accordance with the recommendations of the manufacturers.

1.4 EQUIPMENT ERECTION

A. General: Conform to the following as a minimum:

1. Use only mechanics, machinists, or mill wrights skilled in the handling, setting, aligning, leveling and adjusting of the type of equipment and materials furnished.

2. Use only an oil bath heater to expand couplings, gears, etc. Do not force or drive them on equipment shafts, nor subject them to an open flame or torch.
3. Wedging shall not be permitted. Use the least number of flat shims possible in leveling equipment. Shims shall be clean and free of slags. Provide all shims, filling pieces, keys, packing, red or white lead grout, or other materials necessary to properly align, level and secure apparatus in place. When requested by ENGINEER, demonstrate that all elements so required are level and plumb. Grind as necessary to bring parts to proper bearing after erection.
4. Use proper tools in the assembly of equipment and materials to prevent deforming or marring the surface of shafts, nuts or other parts.
5. Tighten connections requiring gaskets evenly all around to ensure uniform stress over the entire gasket area.
6. Equipment and materials shall not be altered or repaired, and no burning or welding shall be permitted on any parts having machined surfaces, except by written permission of ENGINEER.
7. No rigging shall be done from any structure without the permission of ENGINEER. Responsibility for any damage to the structure resulting from this operation, belongs to CONTRACTOR.
8. Use tools, equipment and materials that shall not damage the structure or equipment.
9. Furnish and install plugs in lubrication holes to prevent entry of foreign material.
10. Electrical work, testing, lubricating and painting shall all comply with requirements of the applicable Section.

B. Setting and Erection:
1. All units shall be carefully set and aligned on their foundations, by qualified millwrights, after their sole plates have been shimmed to true alignment at the anchor bolts. Anchor bolts shall be set in place and the nuts tightened against the shims. Bedplates or wing feet of the equipment shall be further checked after securing to the foundations and, after confirmation of all alignments, the sole plates shall be finally grouted in place. Be responsible for the correct alignment of equipment with its associated piping. “Pipe springing” shall not be allowed.
2. Misaligned holes shall be reamed. “Driving” of bolts or keys shall not be permitted.

C. Jacking Screws and Anchor Bolts:
1. All equipment shall be anchored to supporting members by bolts or other connections to accommodate all operating forces and satisfy the seismic

restraint requirements of the Phoenix Building Code for Zone 1 Seismic Area. Anchors shall provide resistance to a lateral force of at least 0.30 times the weight of the equipment, including its contents.

2. Jacking screws shall be provided in the heavy equipment bases and bedplates, and where required elsewhere, to aid in leveling during installation.
3. Anchor bolt setting drawings shall be delivered sufficiently early to permit setting the anchor bolts when the structural steel support frame is fabricated by others.
4. All anchor bolts and anchoring hardware shall be of Type 316 stainless steel. Adhesive anchors shall only be used where permitted by the ENGINEER and shall be Type 316 stainless steel. Alternate methods of anchoring to those shown on the Contract Documents shall meet the requirements of this Section and shall be submitted to the ENGINEER for review.

D. Alignment and Leveling:
1. Field check all shafts, couplings and sheaves for alignment and adjust to manufacturer's specifications where necessary.
2. Couplings shall be aligned while the equipment is free from all external loads.
3. Angular and parallel alignment shall be checked, and the actual alignment shall be recorded and submitted to ENGINEER. Alignment shall be within manufacturer's recommended tolerance.
4. Dial indicators shall be used for the checking of angular and parallel alignment. During rotation of the half couplings in performance of this test, they shall be maintained in the same relative position, and the dial indicator readings shall be taken at the same place on the circumference of the coupling.

E. Threaded Connections:
1. Apply a molybdenum disulfide, anti-seize compound to all threads in mechanical connections such as bolts, studs, cap screws, tubing, etc., unless otherwise specified.

F. Equipment Drive Guards:
1. Unless shown or specified otherwise, provide all equipment driven by open shafts, belts, chains, pulleys, sheaves, or gears with all-metal guards conforming to the requirements of Section 01600, General Equipment Provisions.

1.5 EQUIPMENT INSTALLATION

A. Obtain installation instruction booklets or other recommendations from the equipment manufacturers as to procedures for, sequence of, and tolerances allowed in equipment installation. In particular, the manufacturer's recommendations as to grout spaces required, type of grout to be used, and tolerances for level and alignment, both vertical and horizontal, shall be obtained and followed. One copy of this material shall be given to the ENGINEER prior to the installation of the equipment.

B. Whenever applicable, obtain the services of a manufacturer's representative specifically trained in erection of his equipment to supervise the installation. Be responsible for the proper alignment of all installed driven equipment and drives in accordance with the tolerance recommendation of the manufacturers for both OWNER furnished and CONTRACTOR furnished equipment. Within 14 calendar days after installation, submit to the ENGINEER a letter from the manufacturer, on the manufacturer's letterhead, stating all equipment and components are installed in accordance with the manufacturer's requirements and installation instructions as described in these Specifications.

C. Skilled craftsmen experienced in installation of the equipment or similar equipment shall be used. Applicable specialized tools and equipment, such as precision machinist levels, dial indicators, and gauges shall be utilized as required in the installations. The Work shall be accomplished in a workmanlike manner to produce satisfactory equipment installation free of vibration or other defects.

D. Install all OWNER furnished equipment in accordance with the installation instructions, Shop Drawings and submittals provided by the equipment manufacturers and available at the OWNER'S offices for CONTRACTOR'S use.

E. Prior to installation of equipment, all sacking and concrete preparation shall be completed, and the Work area shall be maintained in a broom-clean condition during the equipment installation.

F. No equipment and materials shall be altered or repaired, and no burning or welding shall be permitted on any parts having machined surfaces, except by written permission of the ENGINEER.

G. No rigging shall be done from any structure without the permission of the ENGINEER. Responsibility for any damage to the structure resulting from this operation, belongs to CONTRACTOR.

H. Only such equipment and materials as will not damage the structure or equipment and materials shall be used on the Work.

1.6 SPECIAL TOOLS

A. All special tools that are required to assemble, disassemble, repair, and maintain any item of equipment furnished under the terms of this Contract shall be furnished with the equipment. When special tools are provided, they shall be marked or labeled and a list of such tools shall be included with the maintenance and operation instructions for the equipment.

1.7 COORDINATION

A. Take all measurements for Work at the installation sites, verify all subcontractor's and manufacturer's drawings, shall be responsible for the proper installation within

the available space of the apparatus specified and shown on the Drawings and shall inform the ENGINEER of any variations and shall submit all proposed changes for review before making any changes.

1.8 SERVICES OF MANUFACTURERS' REPRESENTATIVE

A. Equipment furnished under Divisions 11, 13, 14, 15, 16 and 17 shall include the cost of competent, qualified representatives of manufacturers of all equipment to supervise the installation, adjustment and testing of the equipment and to instruct the OWNER'S operating personnel on operation and maintenance. The training time and additional requirements for furnishing services of manufacturers' representatives are specified in the appropriate Sections. If no time is specified, the training time shall be at least one day. Supervision may be divided into two or more time periods as required by CONTRACTOR'S schedule or as directed by ENGINEER.

B. Upon completion of the equipment installation, submit "Equipment Information Form", Form 01600-A located in Section 01331, Reference Forms. The completed form shall also be included in the individual Operation and Maintenance Manuals.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01630

COMPUTERIZED MAINTENANCE MANGEMENT SYSTEM TAGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals, as shown on the Drawings, specified and required to furnish and install the Computerized Maintenance Management System (CMMS) tag system.
   2. The extent of the CMMS tag system is specified herein and shown on the Drawings.
   3. The CMMS tag system includes, but is not necessarily limited to, the following:
      a. CMMS tags.
      b. Miscellaneous mechanical fasteners.

B. CMMS Tags:
   1. Provide sufficient quantity of identification tags for each piece of equipment listed in table 3.3.A. below.

1.2 QUALITY ASSURANCE

A. Source Quality Control: All CMMS tags shall be the product of a single manufacturer.

1.3 SUBMITTALS

A. Samples: Submit for approval samples for color, materials and accessories required for the CMMS tag system. ENGINEER'S review of samples will be for color, material, and fastener only. Compliance with all other requirements is the exclusive responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
   1. Fasteners and accessory items.
   2. Samples of actual equipment identification tags for five devices.

C. CMMS Tag List: Submit for approval the following:
   1. Submit the finalized list of all CMMS tags including any alterations to the list that occur during construction. The list shall be provided on a compact disc in Microsoft Excel format (latest version) and shall include columns as shown under 3.3.A, CMMS Tag Information

PART 2 - PRODUCTS

2.1 CMMS TAG

A. Material of Construction:
   1. Material: Aluminum
   2. Thickness: 0.020 inches
   3. Coating: Black enamel
   4. Size: 2-inches wide by 2-inches high
   5. Shape: Square with rounded corners
   6. Holes: One (1) 3/16-inch hole centered on one end of the tag

B. Engraving:
   1. Text location: CMMS tags shall be engraved with text centered on the tag.
   2. Lettering: Engraved Arial font 1/8-inch-high characters. Stamped CMMS tags are not acceptable.
   4. Text quantity: CMMS tags shall accommodate at minimum five (5) lines of engraved text with a minimum of twenty (20) characters per line.
   5. CMMS Tag information:
      a. See Table 3.3.A., CMMS Tag Information
         1) After CONTRACTOR receives approved submittals from the ENGINEER or OWNER. ENGINEER or OWNER will provide the Asset ID for the equipment requiring a tag.

C. Fastener:
   1. Fasteners: 48-mil, stainless steel wire
   2. Fastener Clamp: Zinc double ferrule wire clamp.
   3. Alternate fasteners must be approved by ENGINEER.

D. Layout:
   1. Refer to article 3.3.B, below for an example of the CMMS tag layout.

E. Manufacturer and Model:
   1. Brady, Model 87637
   2. Seton
   3. Or equal

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer shall examine the substrates and conditions under which the CMMS tags are to be installed and notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. Install CMMS tags and components at the locations shown on the Drawings or, if not shown, at the nearest control point of the corresponding equipment, i.e. the local control panel, near a manual actuator, on the equipment itself, at the electrical disconnect, etc. The CMMS tag shall not interfere with the normal operation of the equipment. Where the location of the CMMS tag is such that it is not easily visible or the association between the CMMS tag and the corresponding equipment is not obvious install tags as directed by the ENGINEER.

B. For submersible or below ground equipment at a facility or plant, install the tag above grade next to motor disconnect or attach to the underside of the valve box cover with adhesive epoxy.

C. Repair or replace damaged units as directed by ENGINEER.

3.3 EQUIPMENT INFORMATION

A. CMMS Tag Information:

Service Description	Equipment Name	Serial Key	Asset ID	Initial Installed or Purchased Year
(--*1*--)	(--*2*--)	(--*3*--)	(--*4*--)	(--*5*--)
"Filter-to-Waste"	*"Valve Actuator"*	*"SK:1234567"*	*"A-ID:9876543"*	*"2024"*

B. Example CMMS Tag Layout:

+ + END OF SECTION + +

SECTION 01651

TRANSPORTATION AND HANDLING OF MATERIALS AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Make all arrangements for transportation, delivery and handling of equipment and materials required for prosecution and completion of the Work.

B. Shipments of materials to CONTRACTOR or subcontractors shall be delivered to the site only during regular working hours and shall conform to the requirements of Section 01413, CONTRACTOR'S Hazardous Materials Management Program. Shipments shall be addressed and consigned to the proper party giving name of Project, street number and city. Shipments shall not be delivered to OWNER, except where otherwise directed.

C. If necessary to move stored materials and equipment during construction, move materials and equipment without any additional compensation.

1.2 PREPARATION FOR SHIPMENT

A. When practical, factory assemble products. Matchmark or tag separate parts and assemblies to facilitate field assembly. Cover machined and unpainted parts that may be damaged by the elements with a strippable protective coating.

B. Package products to facilitate handling and protect from damage during shipping, handling, and storage. Mark or label outside of each package or crate to indicate its purchase order number, bill of lading number, contents by name, OWNER'S contract name and number, CONTRACTOR, equipment number, and approximate weight. Include complete packing lists and bills of materials with each shipment.

C. Protect products from exposure to the elements and keep thoroughly dry and dust free at all times. Protect painted surfaces against impact, abrasion, discoloration, or other damage. Grease or oil all bearings and similar items.

D. Advance Notice to ENGINEER of Shipments: Upon receipt of manufacturer's advance notice of shipment, provide ENGINEER seven-day advance notice of anticipated date and place of arrival of the following:
   1. Temporary Standby Generator.
   2. 18-inch VCP Piping.
   3. Precast Polymer Manhole.
   4. 14-inch DIP Piping and Appurtenances.

5. 6-inch DIP Piping and Appurtenances.
6. Vertical Submersible Pumps
7. 8'x16' Wet Well.
8. Biofilter Media.
9. Biofilter Blower and Ventilation Pipe and Appurtenances
10. Irrigation System Components and Monitoring Equipment
11. Decomposed Granite.
12. Additional fill and needed materials

E. Do not have products shipped until:
   1. Related Shop Drawings have been approved by ENGINEER.
   2. Related factory test results, required in the individual Specification Sections, have been reviewed and accepted by ENGINEER.
   3. Required storage facilities have been provided.

F. Items shall be supported, packaged and stored in such a way so as not to impose undue stress/forces to couplings, connections, supports, valves, equipment and instruments.

1.3 DELIVERY

A. Arrange, with the United States Postal Service, a special address for the Project. All deliveries shall be made to that address.

B. Arrange deliveries of products in accordance with construction schedules and in ample time to facilitate inspection prior to installation.

C. Coordinate deliveries to avoid conflict with Work and conditions on site and to accommodate the following:
   1. Work of other contractors, or OWNER.
   2. Limitations of storage space.
   3. Availability of equipment and personnel for handling products.
   4. OWNER'S use of premises.

D. Do not have products delivered to Project site until related Shop Drawings have been approved by the ENGINEER.

E. Do not have products delivered to Project site until required storage facilities have been provided.

F. Have products delivered to site in manufacturer's original, unopened, labeled containers. Keep ENGINEER informed of delivery of all equipment to be incorporated in the Work.

G. Partial deliveries of component parts of equipment shall be clearly marked to identify the equipment, to permit easy accumulation of parts and to facilitate assembly.

H. Immediately on delivery, inspect shipment to assure:
   1. Product complies with requirements of Contract Documents and reviewed submittal.
   2. Quantities are correct.
   3. Containers and packages are intact, and labels are legible.
   4. Products are properly protected and undamaged.
   5. Verify that the accelerometer recordings were made during shipment.

I. Promptly remove damaged products from the Project site and expedite delivery of new undamaged products, and remedy incomplete or lost products to provide that specified, so as not to delay progress of the Work.

1.4 PRODUCT HANDLING

A. Provide equipment and personnel necessary to handle products, including those provided by OWNER, by methods to prevent soiling or damage to products or packaging.

B. Provide additional protection during handling as necessary to prevent scraping, marring or otherwise damaging products or surrounding surfaces.

C. Handle products by methods to prevent bending or overstressing.

D. Lift heavy components only at designated lifting points.

E. Materials and equipment shall at all times be handled in a safe manner and as recommended by manufacturer or supplier so that no damage will occur to them. Do not drop, roll or skid products off delivery vehicles. Hand carry or use suitable materials handling equipment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01661

STORAGE OF MATERIALS AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Store and protect materials in accordance with manufacturer's recommendations and requirements of Specifications.

B. Make all arrangements and provisions necessary for the storage of materials and equipment. All excavated materials, construction equipment, and materials and equipment to be incorporated into the Work shall be placed so as not to injure any part of the Work or existing facilities and so that free access can be maintained at all times to all parts of the Work and to all public utility installations in the vicinity of the Work. Materials and equipment shall be kept neatly and compactly stored in locations that will cause a minimum of inconvenience to other contractors, public travel, adjoining owners, tenants and occupants. Arrange storage in a manner to provide easy access for inspection.

C. Areas available on the site for storage of materials and equipment shall be as shown or approved by the ENGINEER.

D. Materials and equipment, which are to become the property of the OWNER, shall be stored to facilitate their inspection and ensure preservation of the quality and fitness of the Work, including proper protection against damage by freezing, moisture and summer temperatures with ambient temperatures as high as 120°F. They shall be placed in inside climate storage areas, unless otherwise acceptable to OWNER. When placing orders to suppliers for equipment and controls containing computer chips, electronics and solid-state devices, request and coordinate specific temperature limitations on equipment since cabinets and components stored in the summer can approach temperatures of 200°F.

E. Be fully responsible for loss or damage, including theft, to stored materials and equipment.

F. Do not open manufacturer's containers until time of installation, unless recommended by the manufacturer or otherwise specified.

G. Do not store products in the structures being constructed, unless approved in writing by the ENGINEER.

H. Lawns, grass plots or other private property shall not be used for storage purposes without written permission of the OWNER or other person in possession or control of such premises.

1.2 PROTECTION

A. Equipment shall be boxed, crated or otherwise completely enclosed and protected during shipment, handling and storage. Each container or piece of equipment shall be clearly marked with CONTRACTOR'S name, project name and location. Equipment shall be stored on raised supports protected from exposure to the elements and shall be kept thoroughly dry at all times. Pumps, motors, drives, electrical equipment, instrumentation equipment (controls, devices, panels, etc.) and other equipment having anti-friction or sleeve bearings shall be stored in weathertight storage facilities, such as warehouses. Covering with visquine or similar material shall not be considered as a weathertight enclosure.

B. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted equipment surfaces, which are damaged prior to acceptance, shall be repainted in entirety to the satisfaction of the ENGINEER.

C. Electrical equipment, controls, and instrumentation shall be protected against moisture, water damage, heat or dust. Space heaters provided in the equipment shall be connected and operating at all times until equipment is placed in operation.

D. Items shall be stored in such a way so as not to impose undue stress/forces to couplings, connections, supports, valves, equipment, and instruments.

1.3 UNCOVERED STORAGE

A. The following types of materials may be stored outdoors without cover:
   1. Reinforcing steel.
   2. Structural steel.
   3. Piping, except PVC.
   4. Precast concrete items.
   5. Castings.

B. Store the above materials on wood blocking so there is no contact with the ground.

1.4 COVERED STORAGE

A. The following types of materials may be stored outdoors if covered with material impervious to water:
   1. Rough lumber.
   2. Handrailing.
   3. PVC Piping.
   4. Filter Media.

B. Tie down covers with rope and slope to prevent accumulation of water on covers.

C. Store materials on wood blocking or skids.

D. Store loose granular materials, covered with materials impervious to water, in a well-drained area or solid surfaces to prevent mixing with foreign matter.

1.5 FULLY PROTECTED STORAGE

A. Store all products not named above in buildings or trailers which have a concrete or wooden floor, a roof, and fully closed walls on all sides.

B. Provide heated storage space for materials which could be damaged by freezing.

C. Provide air-conditioned storage space for materials that could be damaged by Arizona's severe high temperatures.

D. Protect mechanical and electrical equipment from being contaminated by dust, dirt and moisture.

E. Maintain humidity at levels recommended by manufacturers for electrical and electronic equipment.

1.6 HAZARDOUS PRODUCTS

A. Prevent contamination of personnel, the storage area and the site. Comply with the requirements of the Specification Section 01413, CONTRACTOR'S Hazardous Materials Management Program, codes and manufacturer's instructions.

1.7 MAINTENANCE OF STORAGE

A. Maintain periodic system of inspection of stored products on a scheduled basis to assure that:
   1. State of storage facilities is adequate to provide required conditions.
   2. Required environmental conditions are maintained on a continuing basis.
   3. Products exposed to elements are not adversely affected.

B. Mechanical and electrical equipment which require long term storage shall have complete manufacturer's instructions for servicing each item with notice of enclosed instructions shown on exterior of package.
   1. Comply with manufacturer's instructions on a scheduled basis.
   2. Space heaters which are part of electrical equipment shall be connected and operated continuously until equipment is placed in service.

1.8 PANEL AND INSTRUMENTATION STORAGE

A. All panels, microprocessor-based equipment and all other devices subject to damage or useful life decrease, because of temperatures below 40°F or above 100°F, relative humidity above 90 percent, or exposure to rain or exposure to blowing dust shall not be stored on site.

B. Storage shall be in an insured, climate-controlled warehouse within Maricopa County. The OWNER shall have the right to inspect the equipment during normal working hours. Placed inside each panel or device shall be a desiccant, volatile corrosion inhibitor blocks (VCI), a moisture indicator and maximum minimum indicating thermometer. The panels and equipment shall be checked once per month. The desiccant, VCI and moisture indicator shall be replaced as often as required or every six months, whichever occurs first. A certified record of the daily maximum and minimum temperature and humidity in the warehouse shall be available for inspection by the OWNER. A certified record of the monthly inspection, noting maximum and minimum temperature for the month, condition of desiccant, VIC and moisture indicator, shall also be available for inspection by the OWNER.

C. All costs for the storage shall be at no additional cost to the OWNER. Any panel or device which has been damaged by any cause or for which the storage temperatures or humidity range has been exceeded shall be replaced at no additional cost to the OWNER and shall not be cause for a delay in Contract completion.

D. The panels and equipment shall not be shipped to the site until field conditions are ready for installation, including all slabs, walls, roofs, and environmental controls. The failure to have the site ready for installation shall not relieve CONTRACTOR from conforming to all of the Contract requirements.

1.9 RECORDS

A. Keep running account of products in storage to facilitate preparation of progress payments, if Agreement provides for payment for products delivered, but not installed in the Work.

B. A record shall be kept of the storage requirements and a continuous maintenance log for all stored equipment. A tag shall be applied to each piece of equipment showing all service dates and who did the service.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01721

PROTECTION OF THE WORK AND PROPERTY

PART 1 - GENERAL

1.1 DESCRIPTION

A. Be responsible for taking all precautions, providing all programs, and taking all actions necessary to protect the Work and all public and private property and facilities from damage as specified in the General Conditions and herein.

B. In order to prevent damage, injury or loss, CONTRACTOR'S actions shall include, but not be limited to, the following:
   1. Store apparatus, materials, supplies, and equipment in an orderly, safe manner that will not unduly interfere with the progress of the Work or the work of any other contractor or utility service company.
   2. Provide suitable storage facilities for all materials which are subject to injury by exposure to weather, theft, breakage, or otherwise.
   3. Place upon the Work or any part thereof only such loads as are consistent with the safety of that portion of the Work.
   4. Clean up frequently all refuse, rubbish, scrap materials, and debris caused by his operations, to the end that at all times the site of the Work shall present a safe, orderly and workmanlike appearance.
   5. Provide barricades and guard rails around openings, for scaffolding, for temporary stairs and ramps, around excavations, elevated walkways and other hazardous areas.

C. Shall not, except after written consent from proper parties, enter or occupy privately-owned land with personnel, tools, materials, or equipment, except on easements provided herein.

D. Assume full responsibility for the preservation of all public and private property or facility on or adjacent to the site. If any direct or indirect damage is done by or on account of any act, omission, neglect or misconduct in the execution of the Work by CONTRACTOR, it shall be restored by CONTRACTOR, at his expense, to a condition equal to that existing before the damage was done.

E. CONTRACTOR shall be responsible for any staking/roping needed to identify the contractual limits of construction activities.

1.2 BARRICADES AND WARNING SIGNALS

A. Where Work is performed on or adjacent to any roadway, right-of-way, or public place, provide barricades, fences, lights, warning signs, danger signals, watchmen, and shall take other precautionary measures for the protection of persons or property and of the Work. Barricades shall be painted to be visible at night. From sunset to sunrise, furnish and maintain at least one light at each barricade. Sufficient barricades shall be erected to keep vehicles from being driven on or into Work under construction. Furnish watchmen in sufficient numbers to protect the Work. CONTRACTOR'S responsibility for the maintenance of barricades, signs, lights, and for providing watchmen shall continue until the Project is accepted by OWNER.

1.3 TREE AND PLANT PROTECTION

A. Protect existing trees, shrubs, and plants on or adjacent to the site that are shown or designated to remain in place against unnecessary cutting, breaking or skinning of trunk, branches, bark or roots.

B. Materials or equipment shall not be stored or parked within the drip line.

C. Temporary fences or barricades shall be installed to protect trees and plants in areas subject to traffic.

D. Fires shall not be permitted.

E. Within the limits of the Work, water trees and plants that are to remain, in order to maintain their health during construction operations.

F. Cover all exposed roots with burlap which shall be kept continuously wet. Cover all exposed roots with earth as soon as possible. Protect root systems from mechanical damage and damage by erosion, flooding, run-off or noxious materials in solution.

G. If branches or trunks are damaged, prune branches immediately and protect the cut or damaged areas with emulsified asphalt compounded specifically for horticultural use in a manner approved by the ENGINEER.

H. All damaged trees and plants that die or suffer permanent injury shall be removed and disposed of off-site when ordered by the ENGINEER and replaced by a specimen of equal or better quality.

I. Coordinate Work in this Section with requirements of Section 02220, Demolition, and Section 02230, Clearing.

J. Erect and maintain temporary construction fence as required by the OWNER to protect area from construction traffic and activities.

1.4 PROTECTION OF EXISTING STRUCTURES

A. Underground Structures:
   1. Underground structures are defined to include, but are not limited to, all sewer, water, gas, and other piping, and manholes, chambers, electrical conduits, tunnels and other existing subsurface work located within or adjacent to the limits of the Work.
   2. All underground structures known to ENGINEER, except water, gas, sewer, electric, and telephone service connections, are shown. This information is shown for the assistance of CONTRACTOR, in accordance with the best information available, but is not guaranteed to be correct or complete.
   3. Explore ahead of trenching and excavation Work and shall uncover all obstructing underground structures sufficiently to determine their location, to prevent damage to them and to prevent interruption to the services which such structures provide. If CONTRACTOR damages an underground structure, he shall restore it to original condition at his expense.
   4. Necessary changes in the location of the Work may be made by ENGINEER to avoid unanticipated underground structures.
   5. If permanent relocation of an existing underground structure or other subsurface facility is required and is not otherwise provided for in the Contract Documents, ENGINEER will direct CONTRACTOR, in writing, to perform the Work, which shall be paid for under the provisions of the General Conditions.

B. Surface Structures:
   1. Surface structures are defined as all existing buildings, structures, and other facilities above the ground surface. Included with such structures are their foundations or any extension below the surface. Surface structures include, but are not limited to, buildings, tanks, walls, bridges, roads, dams, channels, open drainage, piping, poles, wires, posts, signs, markers, curbs, walks and all other facilities that are visible above the ground surface.

C. Protection of Underground and Surface Structures:
   1. Sustain in their places and protect from direct or indirect injury all underground and surface structures located within or adjacent to the limits of the Work. Such sustaining and supporting shall be done carefully and as required by the party owning or controlling such structure. Before proceeding with the Work of sustaining and supporting such structure, satisfy the ENGINEER that the methods and procedures to be used have been approved by the party owning same.
   2. Assume all risks attending the presence or proximity of all underground and surface structures within or adjacent to the limits of the Work. Be responsible for all damage and expense for direct or indirect injury caused by his Work to

any structure. Repair immediately all damage caused by his Work, to the satisfaction of the owner of the damaged structure.

D. All other existing surface facilities, including but not limited to, guard rails, posts, guard cables, signs, poles, markers, and curbs, which are temporarily removed to facilitate installation of the Work, shall be replaced and restored to their original condition at CONTRACTOR'S expense.

1.5 PROTECTION OF FLOORS AND ROOFS

A. Protect floors and roofs during entire construction period.

B. Proper protective covering shall be used when moving heavy equipment, handling materials or other loads, when painting, handling mortar and grout and when cleaning walls and ceilings.

C. Use metal pans to collect all oil and cuttings from pipe, conduit, or rod threading machines and under all metal cutting machines.

D. Concrete floors less than 28 days old shall not be loaded without written permission of the ENGINEER. No floor, roof or slab shall be loaded in excess of its design loading.

E. Roofs shall not be loaded without written permission of the ENGINEER.

F. Restrict access to roofs and keep clear of existing roofs, except as required by the Work.

G. If access to roofs is required, roofing, parapets, openings and all other construction on or adjacent to roof shall be protected with suitable plywood or other approved means.

1.6 PROTECTION OF INSTALLED PRODUCTS AND LANDSCAPING

A. Provide protection of installed products to prevent damage from subsequent operations. Remove protection facilities when no longer needed prior to completion of Work.

B. Control traffic to prevent damage to equipment, materials and surfaces.

C. Provide coverings to protect equipment and materials from damage.
   1. Cover projections, wall corners and jambs, sills and soffits of openings, in areas used for traffic and for passage of products in subsequent work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01723

CUTTING AND PATCHING

PART 1 - GENERAL

1.1DESCRIPTION

A. This Section includes administrative and procedural requirements for the cutting and coring, and rough and finish patching of holes and openings in existing construction.

B. All cutting, coring and rough patching shall be performed by CONTRACTOR requiring the opening. Finish patching shall be the responsibility of CONTRACTOR and shall be performed by the trade associated with the application of the particular finish.

C. Provide cutting, coring, fitting and patching, including attendant excavation and backfill required to complete the Work, or to:
   1. Remove and replace defective Work or Work not conforming to requirements of the Contract Documents.
   2. Remove samples of installed Work as specified or required for testing.
   3. Remove all constructions required to provide for specified alterations or addition to existing work.
   4. Uncover Work to provide for ENGINEER'S observation of covered Work or observation by regulatory agencies having jurisdiction.
   5. Connect to completed Work that was not accomplished in the proper sequence.
   6. Remove or relocate existing utilities and pipes that obstruct the Work in locations where connections must be made.
   7. Make connections or alterations to existing or new facilities.

D. Coordinate the requirements of the Work in this Section along with the requirements of the Sections listed below which includes Work that is directly related to this Section.
   1. Division 2, Site Work, through 17, Instrumentation, Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.

1.2QUALITY ASSURANCE

A. Structural Work: Do not cut or patch structural elements in a manner that would change their load-carrying capacity as load-deflection ratio.

B. Operating Elements: Do not cut or patch operating elements in a manner that would result in reducing their capacity to perform as intended. Do not cut or patch operating elements or related components in a manner that would result in increased maintenance or decreased operational life or safety.

1.3SUBMITTALS

A. Submit a written request to ENGINEER well in advance of executing any cutting or alteration which affects:
   1. Design function or intent of Project.
   2. Work of OWNER or any other contractor.
   3. Structural value or integrity of any element of the Project.
   4. Integrity or effectiveness of weather-exposed or moisture-resistant elements or systems.
   5. Efficiency, operational life, maintenance, or safety of operational elements.
   6. Visual qualities of sight-exposed elements.

B. Request shall include:
   1. Identification of Project.
   2. Description of affected Work of CONTRACTOR and work of others.
   3. Necessity for cutting.
   4. Effect on work of OWNER or any other contractor, or on structural or weatherproof integrity of Project.
   5. Description of proposed Work, describing:
      a. Scope of cutting and patching.
      b. Trades who will be executing the Work.
      c. Products proposed to be used.
      d. Extent of refinishing.
      e. Schedule of operations.
   6. Alternatives to cutting and patching, if any.
   7. Designation of party responsible for cost of cutting and patching, when applicable.
   8. Written permission of any other contractor whose work will be affected.

C. Should conditions of Work, or schedule, indicate a change of materials or methods, submit written recommendation to ENGINEER, including:
   1. Conditions indicating change.
   2. Recommendations for alternative materials or methods.
   3. Submittals as required for substitutions.

D. Submit written notice to ENGINEER, designating time Work will be uncovered, to provide for observation. Do not begin cutting or patching operations until authorized by ENGINEER.

E. Conform to all applicable specifications for application and installation of materials used for patching.

1.4WARRANTY

A. Replace, patch and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials in such a manner as to not void required or existing warranties.

PART 2 - PRODUCTS

2.1MATERIALS, GENERAL

A. Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to fullest extent possible. If identical materials are unavailable or cannot be used, use materials whose installed performance will equal or surpass that of existing materials.

PART 3 - EXECUTION

3.1GENERAL

A. Perform all cutting and coring in such a manner as to limit the extent of patching.

B. Core drill all holes to be cut through concrete and masonry walls, slabs, or arches, unless otherwise approved by the ENGINEER.

3.2INSPECTION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed before cutting.

B. Report unsatisfactory or questionable conditions to ENGINEER, in writing. Do not proceed with Work until the ENGINEER has provided further instructions.

3.3PREPARATION

A. Provide temporary support as required to maintain structural integrity of Project, to protect adjacent Work from damage during cutting, and to support the Work to be cut.

B. Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project that will be exposed during cutting and patching operations.
   1. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
   2. Do not cut existing pipe, conduit or ductwork serving facilities scheduled to be removed or relocated until provisions have been made to bypass them.

3.4CORING

A. Perform coring with a non-impact rotary tool using diamond core drills. Size holes for pipe, conduit, sleeves, equipment or mechanical seals, as required.

B. Protect existing equipment, utilities and adjacent areas from water and other damage covered by drilling operations.

C. Vacuum or otherwise remove slurry or tailings from the Work area following drilling.

3.5CUTTING

A. Cut existing construction using methods least likely to damage elements retained or adjoining construction and that will provide proper surfaces to receive installation or repair.
   1. In general, use hand or small power tools designed for sawing or grinding, not hammering and chopping.
   2. Cut through concrete and masonry using a concrete wall saw with diamond saw blades.
      a. Provide for control, on both sides of walls, of slurry generated by sawing.

B. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Provide temporary covering over openings where not in use.

C. To avoid marring existing finished surfaces, cut or drill from exposed or finished side into concealed side.

D. Provide adequate bracing of area to be cut prior to start of cutting.

E. Provide equipment of adequate size to remove cut panel.

3.6PATCHING

A. Patch construction by filling, repairing, refinishing, closing-up and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified, in other Sections of these Specifications.

B. Where feasible, test patched areas to demonstrate integrity of installation.

C. Fit Work airtight to pipes, sleeves, ducts, conduit and other penetrations through surfaces.

D. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
   1. For continuous surfaces, refinish to nearest intersection.
   2. For an assembly, refinish entire unit.

E. Patch, repair or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

3.7CLEANING

A. Clean areas and spaces where cutting, coring and patching are performed. Clean piping, conduit or similar constructions before applying paint or other finishing materials. Restore damaged pipe covering to original condition.

+ + END OF SECTION + +

SECTION 01724

CONNECTIONS TO EXISTING FACILITIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Perform all construction necessary to complete connections and tie-ins to existing facilities.

B. Keep existing facilities in operation unless otherwise specifically permitted in these Specifications or approved by OWNER.

C. Perform all construction activities so as to avoid interference with operations of the facility and the work of others.

1.2 BYPASSING

A. Bypassing of flow will be permitted only for brief intermittent periods necessary to make the connections, as outlined below:
   1. Bringing the new Lift Station 76 Wet Well Pumps online in order to demolish the existing Lift Station 76 Wet Well Piping, and Appurtenances.

1.3 SEQUENCING AND OPERATIONS

A. All operations of existing valves and gates required for the Work shall be done by OWNER.

B. Insofar as possible, all equipment shall be tested and in operating condition before the final tie-ins are made to connect equipment to the existing facility.

C. Carefully coordinate all Work and schedules and provide OWNER written notice at least 48 hours before shut-downs or by-passes are required.

D. Work Sequence: Sequence of Work and Schedule of Completion is specified under Section 01111, Schedule of Completion, Section 01143, Coordination with OWNER'S Operations, and shown on the Construction Sequence Diagrams included in the Drawings.

1.4 ELECTRICAL INSTALLATION

A. A temporary standby generator shall be brought onsite to provide temporary standby power to the site during construction.

1.5 SUBMITTALS

A. For any tie-ins/connections or required shutdowns to existing mains and systems, the CONTRACTOR shall submit a shutdown/tie-in plan to Water Distribution personnel and Engineering and shall be approved at least two weeks prior to the start of the event. The plan shall include dates, durations, procedures, staffing, and any other information pertinent to shutting down the system and connecting to a new system.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01731

INSTALLATION DATA

PART 1 - GENERAL

1.1DESCRIPTION

A. Installation data is defined as written instructions; drawings; illustrative, wiring, and schematic diagrams; diagrams identifying external connections, terminal block numbers and internal wiring; and all other such information pertaining to installation of materials and equipment that is not furnished with Shop Drawings. Included are all printed manufacturers installation instructions, including those that may be attached to equipment and for which approval by the ENGINEER is not required.

1.2SUBMITTALS

A. Submit four copies of all such data to the ENGINEER for each piece of equipment which he furnishes and for all other construction products for which such information is available from manufacturer. Data shall be acceptably identified and accompanied with a letter of transmittal. Three copies shall be transmitted to the ENGINEER, in accordance with Section 01332, Shop Drawings Procedures, and one copy shall be transmitted to the ENGINEER at the Engineer's Field office. Copies shall be transmitted at least two weeks prior to the start of the equipment installation.

B. A copy of the installation data shall be provided in each copy of the Operation and Maintenance Manuals for the covered materials and equipment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01740

CLEANING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Execute cleaning, during progress of the Work, at completion of the Work, and as required by General Conditions. If CONTRACTOR fails to clean areas as specified in this Section, the OWNER will have the areas cleaned and backcharge CONTRACTOR.

1.2 REQUIREMENTS OF REGULATORY AGENCIES:

A. In addition to the requirements herein, maintain the cleanliness of the Work and surrounding premises within the Work limits so as to comply with federal, state, and local fire and safety laws, ordinances, codes, and regulations.

B. Comply with all federal, state and local anti-pollution laws, ordinances, codes and regulations when disposing of waste materials, debris and rubbish.

1.3 PROGRESS CLEANING:

A. General: Clean the Site, Work areas and other areas CONTRACTOR is permitted to occupy by Laws and Regulations at least weekly. Dispose of materials lawfully according to Laws and Regulations:
   1. Comply with requirements in NFPA 241, Standard for Safeguarding Construction, Alteration and Demolition Operations, for removal of combustible waste materials and debris.
   2. Do not hold other materials more than three days if the temperature is expected to rise above 80° F.
   3. Provide suitable containers for storage of waste materials and debris.
   4. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately.

B. Project:
   1. Maintain Project free of waste materials and debris.
   2. Keep exterior dust generating areas wetted down.
   3. Paved roads: Comply with the requirements of Section 01550, Access roads and Parking Areas.

C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work.
   1. Remove liquid spills promptly and report spills to the OWNER and ENGINEER immediately.
   2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire Work area, as appropriate.

D. Installed Work: Keep installed Work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove all debris from concealed spaces before enclosing the space.

F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Cutting and Patching: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.
   1. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.

H. Waste Disposal:
   1. Properly dispose of all waste materials, surplus materials, debris and rubbish off the Project site.
   2. Do not burn or bury rubbish and waste materials on the Project site.
   3. Do not dispose of volatile or hazardous wastes such as mineral spirits, oil, or paint thinner in storm or sanitary drains.
   4. Do not discharge wastes into streams or waterways.
   5. Sole responsibility for complying with any federal, state, and local environmental and regulations in disposing of waste, belongs to CONTRACTOR.

I. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

J. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

1.4 FINAL CLEANING

A. General: Provide final cleaning.
   1. Complete the following cleaning and waste-removal operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
      a. Clean and remove from the Project rubbish, waste material, debris, and other foreign substances.
      b. Mechanical sweeping of paved areas. Remove petrochemical spills, stains, and other foreign deposits.
      c. Hose clean sidewalks and loading areas.
      d. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
      e. Leave water courses, gutters, and ditches open and clean.
      f. Repair pavement, roads, sod, and all other areas affected by construction operations and restore them to original condition or to minimum condition specified.
      g. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of spatter, grease, stains, fingerprints, films, and similar foreign substances.
      h. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, and similar spaces.
      i. Sweep concrete floors broom clean in unoccupied spaces.
      j. Remove tags and labels that are not permanent.
      k. Touch up and otherwise repair and restore chipped, scratched, dented or otherwise marred surfaces to specified finish and match adjacent surfaces.
         1) Do not paint over “UL” or similar labels, including manufacturer mechanical and electrical nameplates.
      l. Wipe surfaces of mechanical and electrical equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
      m. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
      n. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
      o. Maintain the cleaning until OWNER occupies the Project or portion thereof.
      p. Leave Project clean and in a neat and orderly condition satisfactory to ENGINEER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01751

STARTING AND PLACING EQUIPMENT IN OPERATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Initially start-up and place all equipment installed into successful operation according to manufacturer's written instructions and as instructed by manufacturer's field representative. Provide all material, labor, tools, equipment, chemicals, lubricants, and expendables required to complete start-up.

B. No system or subsystem shall be started up for continuous operation unless all components of that system or subsystem, including instrumentation, have been tested and proven to be operable as intended by the Contract Documents.

C. General Activities Include:
   1. Cleaning.
   2. Removing temporary protective coatings.
   3. Flushing and replacing greases and lubricants, where required by manufacturer.
   4. Lubrication.
   5. Check shaft and coupling alignments and reset where needed.
   6. Check and set motor, pump and other equipment rotation, safety interlocks, and belt tensions.
   7. Check and correct if necessary leveling plates, grout, bearing plates, anchor bolts, fasteners, and alignment of piping which may put stress on pumping equipment connected to it.
   8. All adjustments required.

D. Provide chemicals and lubricants and all other required operating fluids.

E. Provide fuel, electricity, water, filters, and other expendables required for start-up of equipment, unless otherwise specified.

F. OWNER provide sufficient personnel to assist CONTRACTOR in the start-up, but the prime responsibility for proper mechanical operation shall belong to CONTRACTOR. Manufacturer's representatives shall be present during initial start-up and operation, unless otherwise acceptable to ENGINEER.

H. No system, unit process or any piece of equipment shall be started up for continuous operation without the approved Operation and Maintenance Manuals being turned over to the OWNER.

I. Training shall be provided prior to turning the operation of a system, unit process or piece of equipment over to the OWNER. Training shall be scheduled for with the OWNER. Training shall conform to the requirements of Section 01821, Instruction of Operations and Maintenance Personnel.

J. Completion of start-up shall be when the OWNER assumes responsibility for operation of the equipment. If the OWNER does not assume operational responsibility and in the opinion of the ENGINEER start-up tasks are completed, the ENGINEER will notify CONTRACTOR, in writing, of the completion of the start-up period.

1.2 MINIMUM START-UP REQUIREMENTS

A. Bearings and Shafting:
1. Inspect for cleanliness, and clean and remove all foreign materials.
2. Verify alignment.
3. Replace defective bearings and those which run rough or noisy.
4. Grease as necessary and in accord with manufacturer's recommendations.

B. Drives:
1. Adjust tension in V-belt drives and adjust varipitch sheaves and drives for proper equipment speed.
2. Adjust drives for alignment of sheaves and V-belts.
3. Clean and remove foreign materials before starting operation.

C. Motors:
1. Check each motor for comparison to amperage manufacturer nameplate value.
2. Correct conditions which produce excessive current flow and exist due to equipment malfunction.

D. Pumps:
1. Check glands and seals for cleanliness and adjustment before running pump.
2. Inspect shaft sleeves for scoring.
3. Inspect mechanical faces, chambers, and seal rings, and replace if defective.
4. Verify that piping system is free of dirt and scale before circulating liquid through the pump.

E. Valves:
1. Inspect both hand and automatic control valves, and clean bonnets and stems.
2. Tighten packing glands to assure no leakage but permit valve stems to operate without galling.
3. Replace packing in valves to retain maximum adjustment after system is determined to be complete.
4. Replace packing on any valve that continues to leak.
5. Remove and repair bonnets that leak.
6. Coat packing gland threads and valve stems with a surface preparation of "Moly-Cote" or "Fel-Pro" after cleaning.

F. Verify that control valve seats are free from foreign material and are properly positioned for intended service.

G. Tighten flanges and all other pipe joints after system has been placed in operation.
   1. Replace gaskets which show any sign of leakage after tightening.

H. Inspect all joints for leakage.
   1. Promptly remake each joint that appears to be faulty; do not wait for rust to form.
   2. Clean threads on both parts and apply compound and remake joints.

I. After system has been placed in operation, clean strainers, drives, pockets, orifices, valve seats and headers in fluid system to assure freedom from foreign materials.

J. Open steam traps and air vents, where used, and remove operating elements.
   1. Clean thoroughly, replace internal parts and put back into operation.

K. Remove rust, scale and foreign materials from equipment and renew defaced surfaces.

L. Set and calibrate draft gages of air filters and other equipment.

M. Inspect fan wheels for clearance and balance.
   1. Provide factory-authorized personnel for adjustment when needed.

N. Check each electrical control circuit to assure that operation complies with Specifications and requirements and to provide desired performance.

O. Inspect each pressure gage and thermometer for calibration.
   1. Replace items which are defaced, broken, or which read incorrectly.

P. Repair any damaged insulation.

Q. Vent gasses trapped in any part of systems.
   1. Verify that liquids are drained from all parts of gas or air systems.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01752

EQUIPMENT AND SYSTEM
STARTUP AND PERFORMANCE TESTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section contains requirements for CONTRACTOR'S performance in documenting testing Work required under this Contract. In addition, this Section contains requirements for CONTRACTOR'S performance testing during installed startup and performance testing of all mechanical, electrical, instrumentation, and HVAC equipment and systems. This Section supplements, but does not supersede specific testing requirements, found elsewhere in the Contract Documents.

B. Upon completion of design, CONTRACTOR and ENGINEER shall submit a testing, startup and commissioning plan, and schedule to the OWNER for review and approval prior to any system or equipment startup. There shall be at a minimum three (3), eight (8)-hour work sessions to work through the development of a thorough testing plan. A draft testing, startup and commissioning plan shall be submitted to the OWNER and ENGINEER for review and comment at 30 percent of project construction. A revised draft of the plan shall be submitted to the OWNER and ENGINEER for review and comment at 60 percent of project construction. A final plan shall be submitted at 90 percent of project construction.

C. Refer to the City of Phoenix Equipment Setup / System Testing Guidance Manual (Guidance Manual) to assist in development of a testing program that will fulfill the requirements of the specifications.

1.2 QUALITY ASSURANCE

A. CONTRACTOR'S Quality Assurance Manager: Appoint an operations engineer or equally qualified operations specialist as Quality Assurance Manager to manage, coordinate, and supervise CONTRACTOR'S Quality Assurance Program. The Quality Assurance Manager shall have at least five years of total experience, or experience on at least five separate projects, in managing the startup and performance testing of mechanical, electrical, instrumentation, HVAC, and piping systems. Operations engineers shall be graduates from a minimum four-year course in mechanical or civil engineering. Operations specialists shall have equivalent experience in plant operation and maintenance. The quality assurance program shall include:
   1. A testing plan setting forth the sequence in which all testing Work required under the Contract Documents will be implemented.
   2. A documentation program to record the results of all equipment and system tests.
   3. An installed startup and performance testing program for all mechanical,

electrical, instrumentation, and HVAC equipment and systems installed under this Contract.

4. A calibration program for all instruments, meters, monitors, gages, and thermometers installed under this Contract.
5. A calibration program for all instruments, gages, meters, and thermometers used for determining the performance of equipment and systems installed under this Contract.
6. A testing schedule conforming to the requirements specified in Paragraph 2.2 C., below.

B. For the purposes of this Section, a system shall include all required items of equipment, devices and appurtenances connected in such a fashion as their operation or function complements, protects or controls the operation or function of the others. The Quality Assurance Manager shall coordinate the activities of all subcontractors and suppliers to implement the requirements of this Section.

C. Calibration:

1. All test equipment (gages, meters, thermometers, analysis instruments, and other equipment) used for calibrating or verifying the performance of equipment installed under this Contract shall be calibrated and certified to within plus or minus two percent of actual value at full scale. Test equipment employed for individual test runs shall be selected so that expected values as indicated by the detailed performance specifications will fall between 60 and 85 percent of full scale. Pressure gages shall be calibrated in accordance with ANSI/ASME B40.1. Thermometers shall be calibrated in accordance with ASTM E77 and shall be furnished with a certified calibration curve.
2. Liquid flow meters, including meters installed in pipelines with diameters greater than 2-inches shall be calibrated insitu using either the total count or dye dilution methods, as approved by the ENGINEER. Gas flow meters installed in piping systems with diameters greater than 6-inches shall be calibrated insitu using the pitot tube velocity averaging method. Flow meter calibration work shall be performed by individuals skilled in the techniques to be employed. Calibration tests for flow metering systems shall be performed over a range of not less than 10 percent to at least 75 percent of system full scale. At least five confirmed valid data points shall be obtained within this range. Confirmed data points shall be validated by not less than three test runs with results which agree within plus or minus two percent.

D. References:

1. This Section contains references to the following documents. They are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or

otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

3. Equipment Setup / System Testing Guidance Manual should be used as a resource to assist with understanding the detail the OWNER is requiring to ensure all equipment and systems are operational with respect to the contract documents. The Guidance Manual shows how to assemble a systematic equipment and system testing program that will satisfy the contract requirement. The Guidance Manual shall be used as a tool to assist the development of an equipment setup, testing plans, and documentation binder. The Guidance Manual is not all encompassing requirements. Meaning there are project specification and equipment specific requirement that will need to be added to the document; plus modification to the type of project, refer to project specifications for additional information.

Reference	Title
ANSI/ASME B40.1	Gauges Pressure Indicating Dial Type--Elastic Element
ASTM E77	Method for Verification and Calibration of Liquid-in-Glass Thermometers
ASHRAE 41.8	Standard Methods of Measurement of Flow of Gas
City of Phoenix	Guidance Manual Equipment Setup / System Testing Plan

1.3 SUBMITTALS

A. Submit for approval the following:
   1. A complete description of CONTRACTOR'S plan for documenting the results from the test program in conformance with the requirements of Paragraph 2.2.A., below, including:
      a. Proposed plan for documenting the calibration of all test instruments.
      b. Proposed plan for calibration of all instrument systems, including flow /level meters and all temperature, pressure, weight, and analysis systems.
      c. Sample forms for documenting the results of field pressure and performance tests. CONTRACTOR shall request Forms from the OWNER.
      d. A list of all CMMS Tag numbers as provided in Section 01630, Computerized Maintenance Management System Tags.
   2. The credentials and certification of the testing laboratory proposed by CONTRACTOR for calibration of all test equipment.

3. Pre-startup check out procedures, reviewed and approved by the respective equipment manufacturers.
4. Detailed testing plans, setting forth step-by-step descriptions of the procedures proposed by CONTRACTOR for the systematic startup and performance testing of all equipment and systems installed under this Contract.
5. A schedule and subsequent updates, presenting CONTRACTOR'S plan for startup and performance testing the equipment and systems installed under this Contract.
6. A schedule establishing the expected time period (calendar dates) when CONTRACTOR plans to commence performance testing of the completed systems, along with a description of the temporary systems and installations planned to allow operational testing to take place.
7. A summary of the Quality Assurance Manager's qualifications, conforming to the requirements of Paragraph 1. 2. A, above.
8. All records produced during the startup and testing program.
9. Systems or unit process or any piece of equipment shall not be started up without the approved Operation and Maintenance Manuals being turned over to the OWNER.
10. Written notice to ENGINEER a minimum of 72 hours prior to beginning of any test.

1.4 ADJUSTMENTS

A. Until final tests are completed and approved, make all necessary changes, adjustments and replacements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Prepare test plans and documentation plans as specified in the following paragraphs. The OWNER and ENGINEER will not witness any test work for the purpose of acceptance until all test documentation and calibration plans and the specified system or equipment test plans have been submitted and approved.

2.2 DOCUMENTATION

A. Documentation Plans:
   1. Equipment Setup / System Testing Guidance Manual format shall be used to develop and document test plans.
   2. Develop a record keeping system to document compliance with the requirements of this Section. Calibration documentation shall include identification (by make, manufacturer, model, and serial number) of all test equipment, date of original calibration, subsequent calibrations, calibration method, and test laboratory.

3. Equipment and system documentation shall include date of test, equipment number or system name, nature of test, test objectives, test results, test instruments employed for the test and signature spaces for the OWNER'S and ENGINEER'S witnesses and CONTRACTOR'S Quality Assurance Manager. A separate file shall be established for each system and item of equipment. These files shall include the following information as a minimum:
   a. Metallurgical tests.
   b. Factory performance tests.
   c. Accelerometer recordings made during shipment.
   d. Field calibration tests[1].
   e. Field pressure tests[1].
   f. Field performance tests[1].
   g. Field operational tests[1].

   ([1]Each of these tests are required even though not specifically noted in detailed specification Section.)
4. Develop test documentation forms specific to each item of equipment and system installed under this Contract. Acceptable documentation forms for all systems and items of equipment shall be submitted for review by the OWNER and ENGINEER as a condition precedent to CONTRACTOR'S receipt of progress payments in excess of 50 percent of the Contract amount. Once the OWNER and ENGINEER has reviewed and approved the forms proposed by CONTRACTOR, produce sufficient forms, at his expense, to provide documentation of all testing work to be conducted as a part of this Contract.

B. Test Plans:
1. Develop test plans detailing the coordinated, sequential testing of each item of equipment and system installed under this Contract. Each test plan shall be specific to the item of equipment or system to be tested. Test plans shall identify by specific equipment or CMMS Tag number each device or control station to be manipulated or observed during the test procedure and the specific results to be observed or obtained. Test plans shall also be specific as to support systems required to complete the test work, temporary systems required during the test work, subcontractors and manufacturers' representatives to be present and expected test duration. As a minimum, the test plans shall include the following features:
   a. Step-by-step proving procedure for all control and electrical circuits by imposing low voltage currents and using appropriate indicators to affirm that the circuit is properly identified and connected to the proper device.
   b. Calibration of all analysis instruments and control sensors.
   c. Performance testing of each individual item of mechanical, electrical, and instrumentation equipment. Performance tests shall be selected to duplicate the operating conditions described in the Contract Documents.
   d. System performance tests designed to duplicate, as closely as possible, operating conditions described in the Contract Documents.
2. Test plans shall contain a complete description of the procedures to be employed to achieve the desired test environment.

3. As a condition precedent to receiving progress payments in excess of 75 percent of the Contract amount, or in any event, progress payments due to CONTRACTOR eight weeks in advance of the proposed date the CONTRACTOR intends to begin any testing work (whichever occurs earliest in the Project Schedule), have submitted all test plans required for the systematic field performance and operational tests for all equipment and systems installed under this Contract. Once the ENGINEER has reviewed and approved CONTRACTOR'S test plans, reproduce the plans in sufficient number for CONTRACTOR'S purposes and an additional ten copies for delivery to the ENGINEER. No test work shall begin until CONTRACTOR delivers the specified number of final test plans to the ENGINEER.
4. Test Plans shall be developed and formatted according to the Equipment Setup / System Testing Guidance Manual.

C. Testing Schedule: Provide a startup and testing schedule setting forth the sequence contemplated for performing the test work. The schedule shall be a CPM format, plotted against calendar time, shall detail the equipment and systems to be tested, and shall be coordinated with CONTRACTOR'S Progress Schedule specified in Section 01320, Progress Schedule. The schedule shall show the contemplated start date, duration of the test and completion of each test. The test schedule shall be submitted no later than four weeks in advance of the date testing is to begin. The ENGINEER will not witness any testing work for the purpose of acceptance until CONTRACTOR has submitted a test schedule and the ENGINEER approves. The test schedule shall be updated weekly, showing actual dates of test work, indicating systems and equipment testing completed satisfactorily and meeting the requirements of the Contract Documents.

D. Binder Format:
1. Prepare data in the format detailed in the forms provided, forms shall be modified with project specific details.
2. Binders: Commercial quality, 8-1/2 inch by 11 inch (size A4), three D side ring binders with durable plastic covers; 2 inch (50 millimeter) maximum ring size. Correlate data into related consistent groupings when multiple binders are used,
3. Cover: Identify each binder with typed project number and name and subject matter of the contents. Titles shall be placed both on the front and binder edge of the binder.
4. Provide tabbed card stock material for each separate section and subsection, with 1/2in extended tabs and typed description on the tabs for the main sections.
5. Text: Printed data or type written data on 20 pound, minimum, white punched paper. Computer generated data shall be printed by letter quality 150 dpi resolution printers unless approved otherwise.
6. Drawings: Provide with reinforced punched binder tab. Bind in with text; Reduce larger drawings and fold to size of text pages but not larger than 11-inches by 17-inches.

2.3 SYSTEM AND EQUIPMENT PERFORMANCE TESTS

A. Each item of mechanical, electrical, instrumentation and HVAC equipment installed under this Contract shall be tested to demonstrate compliance with the performance requirements of the Contract Documents. Each electrical, instrumentation, mechanical, piping, and HVAC system installed or modified under this Contract shall be tested in accordance with the requirements of the Contract Documents.

B. Once all equipment and systems have been tested individually, defined in the Guidance Manual as Contractor Testing. Proceed with performance testing in accordance with the requirements of Article 3.3, below, simulating actual operating conditions to the greatest extent possible. Install temporary connections, bulkheads and make other provisions to recirculate process fluids or otherwise simulate anticipated operating conditions. Performance testing is broken in (2) groups of testing in the Guidance Manual, Verification and Demonstration Testing. During the operational testing period, CONTRACTOR'S Quality Assurance Manager and testing team shall monitor the characteristics of each machine and system and report any unusual conditions to the ENGINEER.

PART 3 - EXECUTION

3.1 GENERAL

A. Quality Assurance Manager: Organize teams made up of qualified representatives of equipment suppliers, subcontractors, CONTRACTOR'S independent testing laboratory, and others, as appropriate, to efficiently and expeditiously calibrate and test the equipment and systems installed and constructed under this Contract. The objective of the testing program shall be to demonstrate, to the OWNER'S and ENGINEER'S complete satisfaction, that the structures, systems, and equipment constructed and installed under this Contract meets all performance requirements and the facility is Substantially Complete and ready for the commissioning process to commence. In addition, the testing program shall produce baseline-operating conditions for the OWNER to use in a Preventive Maintenance Program.

3.2 CALIBRATION OF FIXED INSTRUMENTS

A. Calibration of analysis instruments, sensors, gages, and meters installed under this Contract shall proceed on a system-by-system basis. No equipment or system performance test shall be performed until all instruments, gages, and meters to be installed in that particular system have been calibrated and the calibration work has been witnessed by the OWNER and ENGINEER.

3.3 EQUIPMENT SETUP / SYSTEM TESTING

A. General:

1. Supplier Equipment Setup, Calibration, and Checkout: shall consist of but not limited to Pressure or leakage tests, Electrical testing as specified in Division 16, Electrical, Wiring and piping, individual component, loop, loop commissioning and tuning testing, as specified in Division 17, Instrumentation, Pre-startup check out for all mechanical and HVAC equipment. Pre-startup check out procedures shall be reviewed and accepted by the respective equipment manufacturer. Supplier Equipment Setup, Calibration, and Checkout is further explained in the Guidance Manual.
2 Contractor testing: shall consists of but not limited to the individual and system tests of all mechanical, electrical, HVAC, and instrumentation equipment and systems shall demonstrate compliance with the performance requirements of the Contract Documents to the CONTRACTOR. Contractor testing is further explained in the Guidance Manual.
3. Verification Testing: To verify to the Owners Representative that all equipment and systems will function as designed. The Verification Testing is to be designed to duplicate, as closely as possible, the operating design. Verification testing is further explained in the Guidance Manual.
4. Demonstration Testing: To show the Owner all equipment as a system will function as designed. The testing will simulate various operating conditions to allow the system as a whole to react. The plan will clearly show the system works in various conditions as described in the Control descriptions and detailed in the Process and Instrumentation drawings. Demonstration testing is further explained in the Guidance Manual.

B. Testing for any individual system shall be performed in the order listed above. The order may be altered only on the specific written authorization of the ENGINEER after receipt of a written request, complete with justification for the change in sequence.

C. Pressure and Leakage Tests: Pressure and leakage tests shall be conducted in accordance with applicable Sections. All acceptance tests shall be witnessed by the ENGINEER. Evidence of successful completion of the pressure and leakage tests shall be the ENGINEER'S signature on the test forms prepared by CONTRACTOR.

D. Equipment Checkout: Prior to energization (in the case of electrical systems and equipment), all circuits shall be rung out and tested for continuity and shielding in accordance with the requirements of Division 16, Electrical.

E. Component Calibration and Loop Testing: Prior to energization (in the case of instrumentation system and equipment), all loops and associated instruments shall be calibrated and tested, as specified in Division 17, Instrumentation.

F. Electrical Resistance: Electrical resistance testing shall be in accordance with the requirements of Division 16, Electrical.

G. Pre-Startup Tests: Pre-startup tests shall include the following:
1. Alignment of equipment using reverse dial indicator method.

2. Pre-operation lubrication.
3. Tests in accordance with the manufacturers' recommendations for pre-start preparation and pre-operational check out procedures.
4. Pre-Startup tests shall conform to the requirements of Section 01751, Starting and Placing Equipment in Operation.

H. System Performance Tests

1. System Performance Tests are broken in to (2) groups of tests, Verification and Demonstration testing. Refer to the Guidance Manual for further definition of how to develop System Performance Tests.
2. General: Once all affected equipment has been subjected to the required pre-operational check out procedures and the ENGINEER has witnessed and has not found deficiencies in that portion of the Work, individual items of equipment and systems may be started and operated under simulated operating conditions to determine, as nearly as possible, whether the equipment and systems meet the requirements of these specifications.
3. For each system performance test phase, the equipment shall be operated a sufficient period of time to determine machine operating characteristics, including noise, temperatures and vibration; to observe performance characteristics; and to permit initial adjustment of operating controls and shall last no less than 5 continuous days. When testing requires the availability of auxiliary systems such as looped piping, electrical power, compressed air, control air, or instrumentation which have not yet been placed in service, provide acceptable substitute sources, capable of meeting the requirements of the machine, device, or system, at no additional cost to the OWNER. Disposal methods for test media shall be subject to review and approval by the OWNER and ENGINEER. During the performance test period, obtain baseline-operating data on all equipment with motors greater than one horsepower to include amperage, bearing temperatures, and vibration. The baseline data shall be collected for the OWNER to enter in a Preventive Maintenance Program.
3. Test results shall be within the tolerances set forth in the detailed specification Sections of the Contract Documents. If no tolerances have been specified, test results shall conform to tolerances established by recognized industry practice. Where, in the case of an otherwise satisfactory performance test, any doubt, dispute, or difference should arise between the ENGINEER and CONTRACTOR regarding the test results or the methods or equipment used in the performance of such test, then the ENGINEER may order the test to be repeated. If the repeat test, using such modified methods or equipment as the ENGINEER may require, confirms the previous test, then all costs in connection with the repeat test will be paid by the OWNER. Otherwise, the costs shall be borne by CONTRACTOR. Where the results of any performance test fail to comply with the contract requirements for such test, then such repeat tests as may be necessary to achieve the contract requirements shall be made by CONTRACTOR at his expense.
4. Provide, at no expense to the OWNER, all power, fuel, compressed air supplies, water, and chemicals, all labor, temporary piping, heating, ventilating, and air conditioning for any areas where permanent facilities are not complete and operable at the time of functional tests, and all other items and work required to

complete the functional tests. Temporary facilities shall be maintained until permanent systems are in service.

5. Should the testing period be halted for any reason, the operational testing program shall be repeated, until the specified continuous period has been accomplished without interruption. All process units shall be brought to full operating conditions, including temperature, pressure, flow and level.
6. Record Documents shall conform to the requirements of Section 01782, Record Documents, of facilities involved shall be accepted and ready for turnover to the OWNER 72 hours prior to operational testing.
7. Phase Retesting: If under test, any portion of the Work should fail to fulfill the Contract requirements and is adjusted, altered, renewed, or replaced, tests on that portion when so adjusted, altered, removed, or replaced, together with all other portions of the Work as are affected thereby, shall, unless otherwise directed by the ENGINEER, be repeated within reasonable time and in accordance with the specified conditions. Pay to the OWNER all reasonable expenses incurred by the OWNER, including the costs of the ENGINEER, as a result of repeating such tests.
8. Post-Test Inspection: Once testing has been completed, all machines shall be rechecked for proper alignment and realigned, as required. All equipment shall be checked for loose connections, unusual movement, or other indications of improper operating characteristics. Any deficiencies shall be corrected to the satisfaction of the ENGINEER. All machines or devices which exhibit unusual or unacceptable operating characteristics shall be disassembled and inspected. Any defects found during the course of the inspection shall be repaired or the specific part or entire equipment item shall be replaced to the complete satisfaction of the ENGINEER, at no additional cost to the OWNER.
9. After the CONTRACTOR has demonstrated and proven to the ENGINEER that all system are functioning properly and has been documented in the approved testing and startup plan, then the CONTRACTOR shall demonstrate this reliability to the OWNER. The OWNER demonstration shall be executed as agreed upon and documented per the approved testing and startup plan.

I. Operational Availability Demonstration, defined as Commissioning in the Guidance Manual.

1. Operational Availability Demonstration (OAD) shall begin following completion of the integrated system field test as specified above and shall continue until a time frame has been achieved wherein the equipment, instrumentation and control system hardware availability meets or exceeds 99.7 percent for 14 consecutive days and no system failures have occurred which result in starting the OAD over again. During the OAD the system shall be available to plant operating personnel for use in normal operation of the Plant.
2. For the purpose of the Operational Availability Demonstration, the system shall be defined as consisting of the following systems and components:
   a. Lift Station 76 Wet Well.
   b. Lift Station 76 Biofilter
3. The conditions listed below shall constitute system failures which are considered critical to the operability and maintainability of the system. The

Operational Availability Demonstration shall be terminated if one or more of these conditions occur. Following correction of the problem, a new 5 consecutive day OAD shall begin.

a. Failure to repair a hardware or software problem within 120 consecutive hours from the time of notification of a system failure.
b. Recurrent hardware problems: If the same type of problem occurs three times or more.

4. The following conditions shall constitute a system failure in determining the system availability based on the equation specified in Paragraph 1.5.E., below.
   a. Failure of system to perform at design conditions.
   b. Loss of communications between devices on the communications network.
   c. Failure of one or more input/output components.
   d. Failures of any type affecting ten or more input/output points simultaneously.
   e. Failure of any type affecting one or more regulatory control loops or sequential control strategies thereby causing a loss of the automatic control of the process variable or process sequence operation.
   f. Failure of power supply. Where redundant power supplies are provided, failure of one power supply shall not constitute a system failure provided the backup power supply operates properly and maintains supply power. Failure of the backup supply to operate properly and maintain supply power shall constitute a system failure.
5. The system availability shall be calculated based on the following equation:

$$A = \frac{MTBF}{MTBF + MTTR} \times 100\%$$

Where:
A = system availability in percent
MTBF = average time interval between consecutive system failures
MTTR = mean time required to repair system failures

6. Time between failures shall be the period between the time that a reported system failure has been corrected and the time of subsequent notification of CONTRACTOR that another system failure has occurred in terms of operating hours.
7. Time to repair shall be the period between the time that CONTRACTOR is notified of a system failure and the time that the system has been restored to proper operation in terms of hours with an allowance for the following dead times which shall not be counted as part of the time to repair period.
   a. Actual travel time for service personnel to get to the plant site up to a maximum of six hours from the time CONTRACTOR is notified of a system failure.
   b. Time for receipt of spare parts to the plant site once requested up to a maximum of 24 hours. No work shall be done on the system while waiting for delivery of spare parts.

c. Dead time shall not be counted as part of the system available period. The dead time shall be logged and the duration of the OAD extended for an amount of time equal to the total dead time.

8. Completion of a 30 consecutive day period without any restarts of the OAD and with a system availability in excess of 99.7 percent will constitute acceptance of the System by OWNER.
9. Submit a request of acceptance after 25 consecutive day period without any restarts to the ENGINEER for approval.
10. All parts and maintenance materials required to repair the system prior to completion of the OAD shall be supplied by CONTRACTOR, at no additional cost to OWNER. If parts are obtained from the contractual spare parts inventory, they shall be replaced to provide a full complement of parts as specified.
11. A System Malfunction/Repair Reporting Form shall be completed by the OWNER and ENGINEER to document system failures, to record CONTRACTOR notification, arrival and repair times and CONTRACTOR repair actions. Format of the form shall be developed and agreed upon prior to the start of the OAD.

+ + END OF SECTION + +

SECTION 01781

OPERATING AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide Operating and Maintenance Data in the form of instructional manuals for use by the OWNER'S personnel for:
   1. All equipment and systems.
   2. All valves, gates and related accessories.
   3. All instruments and control devices.
   4. All electrical gear.

B. Training or start-up on any system, process, or piece of equipment shall **not** be allowed until Operating and Maintenance Manuals are reviewed by the ENGINEER and the Operating and Maintenance Manuals have been turned over and approved by OWNER.

C. Operating and Maintenance Data:
   The term "Operating and Maintenance Data" includes all product related information and documents which are required for preparation of the operating and maintenance manual. It also includes all data which shall accompany said manual as directed by current regulations of any participating government agency.

1.2 SUBMITTALS

A. Format Requirements:
   1. Use 8-1/2-inch by 11-inch quality paper of a minimum 20 pound. Larger drawings or illustrations are acceptable if neatly folded to the size of 8-1/2-inch by 11-inch and each drawing or illustration placed inside of an individual clear plastic or vinyl sheet protector.
   2. All text must be legible typewritten, or machine printed originals or high-quality copies of same. Manuals that contain copies that are not clear, not completely legible, off-center, skewed, or where text or drawings are cut by the binding holes shall be subject to disapproval. Pages that contain approval or date stamps, comments or other markings that cover any portion of text or drawing are unacceptable. Electronically transmitted facsimile (fax) copies are also unacceptable.
   3. Each page shall have a binding margin of approximately 1-1/2-inches and be punched for placement in a “D-ring” loose-leaf binder. Provide minimum 1-inch size, not larger than 3-inches, white in color, D-ring binders. Binders shall not be filled to more than 3/4 maximum of their capacity.
   4. Identify each binder by using the City of Phoenix Templates provided located in Section 01331 – Reference Forms, form numbers 01781-C, D, E and F. Identification shall be included on the Cover Page, Binder Spine, Title Page, Table of Contents and CD Label Non-uniform binders will not be acceptable.

i. Title "OPERATING AND MAINTENANCE INSTRUCTIONS".
ii. Enter Facility and Project Name in Template.
iii. Enter Specification Section Number and Title in Template.
iv. Enter Name(s) of the Provider of the Manual in Template.
v. Enter WSD WS Project Number in Template.

5. Coordinate with the ENGINEER and OWNER to develop a comprehensive, practical, and consistent indexing system for the Operating and Maintenance Manuals. The ENGINEER and the OWNER shall review the indexing system before any manuals are submitted in draft form.
6. Use dividers and indexed tabs between major categories of information such as operating instructions, preventive maintenance instructions, or other. When necessary, place each major category in a separate binder.
7. Provide a Table of Contents for each binder using the provided City of Phoenix Template located in Section 01331 – Reference Forms, form number 01781-E. The Table of Contents will have an appendix place holder for the final Test Data Forms. The soft copy content shall be identical to the hard copy's Table of Contents.
8. Identify products by their functional names in the table of contents and at least once in each chapter or Section. Thereafter, abbreviations and acronyms may be used if their meaning is explained in a table in the back of each binder. Use of model or catalog numbers or letters for identification is not acceptable.
9. Indicate all components of the equipment on catalog pages by highlighting or some other clearly definable medium for ease of identification.

B. Submittal Requirements

1. Submit operating and maintenance data to the ENGINEER within seven (7) days after approval of Shop Drawings, unless noted otherwise.
2. Final approval of all O&M Manuals will only be provided after the OWNER's DOCUMENTS MANAGER, (Rosalinda Z. Webb, (602) 534-9099) has reviewed and approved the individual final O&M Manuals. A copy of the signed Final Approval checklist shall be included in the O&M Manuals provided to the OWNER.
3. Preliminary Copies to:
   i. Number of preliminary copies: One Soft Copy (CD/PDF) of each O&M Manual (except for field test data) shall be submitted to the ENGINEER for review. The O&M Manual shall conform to the requirements as specified herein.
   ii. Each preliminary O&M Manual must be submitted to and reviewed by ENGINEER and approved by the OWNER fourteen (14) days prior to equipment start-up. ENGINEER to determine timeline for the submittal review process.
4. Final Copies:
   i. Number of Final Copies: One Hard Copy and One Soft Copy (CD/PDF) of each manual.
   ii. Twenty-One 21 days prior to placing the equipment into service

submit all final hard copies and soft copies of the approved O&M Manual to the ENGINEER.

iii. Soft Copy shall be in, "PDF" format on CD – including "character recognition (OCR)" and shall include all information provided in hard copy. The PDF file shall be a complete electronic copy of the hardcopy with bookmarks set for each tab in the hardcopy. The PDF file shall include the Cover Page, Binder Spine, Title Page and Table of Contents (use provided City of Phoenix Templates,) to be labeled with Facility Name, WS Number, Project Title, Manual Title, Specification Section and Volume Number, if applicable. Volumes shall be organized in a rational manner with the separation at a bookmark tab and must also be properly labeled with the following: Facility Name, WS Number, Project Title, Manual Title, Specification Section and Volume Number. Must be computer generated. Handwritten labels are not acceptable.

C. Operating and Maintenance Data Requirements, *in addition to* requirements within the listed Sections/Specifications, but are not limited to, the following:

1. Provide a completed O&M Manual Review Form, form number 01781-A – Operating & Maintenance Data Review Check List completed by CONTRACTOR.
2. A copy of the Specification Section for which the Operating and Maintenance (Product/Equipment) Manual applies.
3. Provide the completed Equipment Information Forms, in accordance with the requirements of Section 01600, General Equipment Provisions. If multiple manufacturers of equipment are provided in a single manual, provide a separate data sheet for each.
4. Provide the completed Equipment Manufacturer/Vendor/Installer Form. Form to include name, address, phone number, fax number, e-mail address, and website of manufacturer, manufacturer's local service representative (at a minimum), and subcontractor or installer. If multiple manufacturers of equipment are provided in a single manual, provide a separate form for each.
5. Written reference to CMMS Tag number, as specified under Section 01752.
6. Equipment and System Startup and Performance Testing, paragraph 1.3.A.1.d., and as provided in Section 01630, Computerized Maintenance Management System Tags.
7. Copy of Warranty Bond and Service Contract, as applicable and Unit of Responsibility Certification Form 01600-B and Manufacturer's Installation Certification form 01620-A as with the requirements of Section 01600.
8. As-built circuit diagrams, wiring diagrams, schematics and functional drawings, as applicable, and either a nameplate drawing or a copy of nameplate.
9. Control Panel Drawings as required by Specification 17260 are to be provided in hard copy and electronically in AutoCAD version 2017 or newer.

10. Complete, detailed written operating instructions for each product or piece of equipment including equipment function; operating characteristics; limiting conditions; operating instructions for startup, normal and emergency conditions; regulation and control; and shutdown.
11. Complete, detailed Preventive Maintenance Instructions include, but are not limited to, the following Preventive maintenance data to be submitted as required by Section 01785, Preventive Maintenance Data Submittal Form 01785-A, Personnel Maintenance Lesson/Training Plan Spec 01821, and Manufacturer's Instruction Certification Forms 01821-A & 01821-B.
12. Recommended spare parts lists, by generic title and identification number, and local sources of supply for parts.
13. Written explanations of all safety considerations relating to operating and maintenance procedures, including Safety Data Sheets (S.D.S.'s) for all fluids, oils, chemicals, and volume of each liquid used by each piece of equipment being supplied.
14. Provide installation data in accordance with Section 01731, Installation Data.
15. Final test data, where applicable, shall be submitted as an appendix when completed.

D. Changes After Installation:
1. Final test data, changes and/or upgrades made to the systems after initial installation and during the start-up and commissioning phases, including equipment information and as-built wiring schematics, shall be submitted as an appendix to the Operating and Maintenance Manuals.
2. Two (2) copies of all revised Shop Drawings and Documentation that represent changes made during start-up and commissioning shall be submitted to the ENGINEER to replace initial drawings and documentation contained in the Operating and Maintenance Manuals.

1.3 OPERATING AND MAINTENANCE

A. Operating and Maintenance data shall be provided for the following equipment.

Equipment	*Specification Section*
Vertical Submersible Pumps	11212
Biofilter	13124
Plug Valves	15112
Flow Meter	17052

1.4 OPERATING AND MAINTENANCE TRANSMITTAL FORM

A. Upon receipt of the Vendor Operating & Maintenance Manual from the Manufacturer /Supplier, complete the ENGINEER section of Form 01781-B and the Submittal Transmittal Form 01332-A and submit to the CITY PROJECT MANAGER. CITY PROJECT MANAGER to complete Form 01781-B and deliver to the OWNER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01782

RECORD DOCUMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Maintain and provide the ENGINEER with Record Documents as specified below, except where otherwise specified or modified in Division 2, Site Work, through Division 17, Instrumentation.

B. Definitions
   1. Contract Documents: The contract documents include the drawings, specifications, and addenda developed and furnished to the CONTRACTOR at the beginning of construction.
   2. As-Built Drawings: As-built drawings are an annotated set of drawings prepared by the CONTRACTOR. They show, in red, as-constructed changes to the original Contract Documents that have been made during the construction process. The As-Built Drawings may include supplemental drawings to provide the necessary detail, comply with project standards or where annotation would otherwise be impractical.
   3. Record Drawings: Record Drawings are prepared by the ENGINEER and reflect as-constructed changes that the CONTRACTOR annotated in the As-Built Drawings.
   4. Record Documents: The Record Documents include Record Drawings, specifications, addenda, approved shop drawings, samples, photographs, change orders, other modifications to the Contract Documents, test records, survey data, field orders, Request for Information, submittals, Warranty certificates, and all other documents pertinent to the CONTRACTOR'S Work.

C. Maintenance of Documents:
   1. Three sets of black line sets of plans, including any Addenda, of the Drawings will be furnished to CONTRACTOR by the OWNER.
   2. Maintain in CONTRACTOR'S field office in clean, dry, legible condition complete sets of the following: Drawings, Specifications, Addenda, approved Shop Drawings, Samples, Photographs, Change Orders, other modifications of Contract Documents, test records, survey data, Field Orders, and all other documents pertinent to CONTRACTOR'S Work.
   3. Provide files and racks for proper storage and easy access. File in accordance with filing format of Construction Specification Institute (CSI), unless otherwise approved by ENGINEER.
   4. Make documents available at all times for inspection by ENGINEER and OWNER.
   5. Record Documents shall not be used for any other purpose and shall not be

removed from CONTRACTOR'S office without ENGINEER'S approval.

6. Any contractually required testing provided by others shall be thoroughly documented by the CONTRACTOR and maintained with the project Record Documents. All testing results shall be maintained in their own separate log for the project; being kept current weekly and made readily available for viewing at any time.

D. Marking System: Changes, revisions, additions and deletions, to the record set of Drawings shall be marked in Red.

E. Recording:
1. Submit as-built drawings and make a record of the locations of all work completed as part of the project. The as-builts must indicate the locations of the beginning(s) and end(s) of the construction, and all valves, fire hydrants, pipe fittings, service connections and appurtenances. They must also show locations and elevations where significant elevation changes occur or changes in direction in all pipe alignments. Their locations must be shown by stationing and dimensioning from appropriate monument lines or in their absence appropriate lot lines, property lines or easement line references.
2. Global Positioning System (GPS) Recording: For construction projects located in the Right-Of-Way, certain asset's locations are required to be recorded with survey-grade GPS device such as Trimble GSA-6000 GeoXH (or equivalent) currently used by CITY staff to locate assets. The contractor shall coordinate with the ENGINEER to identify assets requiring GPS coordinates (northing and easting) and elevation to the top of the buried asset. The following GPS coordinate set up shall be followed by the CONTRACTOR:
   a. Coordinate System: US State Plane 1983
   b. Zone: Arizona Central 0202 (Grid)
   c. Datum: NAD 1983 (2011)
   e. Elevation: NGVD 29
   f. Altitude Units: feet
   h. Coordinate Unit: International feet
   i. Coordinate order: North/East
   j. Projection: Transverse Mercator

   The GPS coordinates shall be recorded on a spreadsheet provided by the ENGINEER. The ENGINEER will review the GPS coordinates provided by the CONTRACTOR and confirm their accuracy by navigating to the assets using the provided coordinates to ensure the accuracy tolerance is met. The confirmation process shall be performed before the assets are buried to ensure accuracy compliance. The coordinates will be submitted to the CITY at the project completion to be loaded into the CITY's asset registry system. In general, GPS coordinates are required for but not limited to:
   a. Valves for Water pipes, Reclaimed Water pipes, and sewage forcemains,
   b. Fire Hydrants
   c. Tap for Water Service Line, Reclaimed Water Service, and Lateral tap for

sewer service
   d. Manholes
   e. Cleanouts
3. Label the Cover Sheet, Index and each supplemental sheets of each document "PROJECT RECORD" in 2-inch-high printed letters.
4. Keep the As-Built Drawings current. CONTRACTOR'S refusal, failure, or neglect to maintain current As-Built Drawings shall constitute sufficient basis for the ENGINEER to recommend the withholding of some or all of any payment due.
5. Do not permanently conceal any Work until required information has been recorded.
6. Drawings: Legibly mark to record actual construction including:
   a. Depths of various elements of foundation in relation to datum.
   b. Horizontal and vertical location of underground utilities and appurtenances referenced to permanent surface improvements.
   c. Location of internal utilities and appurtenances concealed in construction referenced to visible and accessible features of structure.
   d. Field changes of dimensions and details.
   e. Changes made by Change Order or Field Order.
   f. Details not on original Drawings.
7. Specifications and Addenda: Legibly mark up each Section to record:
   a. Manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed.
   b. Changes made by Change Order or Field Order.
   c. Other matters not originally specified.

F. Record Drawings:
1. As-Built Drawings shall be prepared for all the Work included in the Contract. On a weekly basis, furnish to the ENGINEER a full-size annotated copy of the As-Built Drawings that include changes from the previous week's As-Built Drawing submittal. Annotations shall include redlined "clouds" of only those changes from the previous week's submittal. The redlined As-Built Drawings shall show the actual in-place installation of the items installed under this Contract. The redlined As-Built Drawings shall show the Work in plan and sections as required for clarity with reference dimensions and elevations that will be used to develop complete Record Drawings.
2. Develop and furnish to the ENGINEER, redlined Instrumentation and Control and Electrical Drawings showing one-line diagrams with all conduit and wire sizes shown of the distribution systems and the actual in-place grounding system, lighting arrangement, motor control centers, corrected wiring diagrams, equipment and conduit and cable plans.
   a. The Contract Drawings may be used as a starting point in developing these Instrumentation and Control and Electrical As-Built Drawings. Subcontractor and manufacturer drawings may be included in this drawing package. The drawing package must be fully integrated and include the necessary cross references between drawings. The drawing

package shall include interconnection and termination details to equipment furnished under this Contract.

b. All As-Built Drawings must be submitted on a weekly basis for approval of the ENGINEER. This shall include the following composite drawings for the system being furnished:
   1) Schematic (Elementary) Diagrams: This shall include, but not be limited to, complete schematics including items furnished by others for the following:
      a) Motor Control Circuits for Starters furnished under this Contract.
      b) HVAC Control Panels furnished under this Contract.
   2) Wiring (Connection) Diagrams: These shall be included for all pre-wired equipment furnished under this Contract.
   3) Interconnection Diagrams: These shall include all interconnections to be furnished under this Contract.
   4) Conduit and Cable Schedules: These shall include all conduit and cable furnished under this Contract.
   5) Dimension of Outline Drawings: These shall include all equipment furnished under this Contract.
   6) Power and Lighting Layout Drawings: These shall include all conduits and wiring furnished under this Contract.

3. In addition to the redlined As-Built Drawings, prepare and submit CAD ".dwg" files, version 2017 or later, for all supplemental drawings used to complete the As-Built Drawings.
4. Survey results shall be posted to the as-builts on a weekly basis.

G. Submittals:
1. Acceptance of CONTRACTOR'S monthly application for payment shall be dependent on the ENGINEER'S acceptance and agreement that CONTRACTOR'S As-Built Drawings and weekly submittals are complete, thorough and acceptable in showing all Work up through and including such work as CONTRACTOR is claiming for completion and payment on CONTRACTOR'S application for payment. Any items which do not appear on the As-Built Drawings in complete and acceptable form shall not be paid for in CONTRACTOR'S monthly payment.
2. Examination by the ENGINEER of CONTRACTOR'S As-Built Drawings will be made on a weekly basis to determine completion for consideration of monthly pay application. Also, make available all As-Built Drawings at all times to the ENGINEER for examination.
3. Prior to Completion of the Work, deliver final As-Built Drawings to ENGINEER. Substantial completion will not be made until satisfactory final As-Built Drawings are received by ENGINEER.
4. Accompany final and weekly submittals with transmittal letter containing:
   a. Date.
   b. Project title and number.
   c. CONTRACTOR'S name and address.

d. Title and number of each As-Built Drawings.
e. Certification that each document as submitted is complete and accurate.
f. Signature of CONTRACTOR, or his authorized representative.

PART 2 - PRODUCTS (NOT USED)

PART 3 -EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01783

SPARE PARTS AND MAINTENANCE MATERIALS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Submit a complete list of all spare parts required for the project for review and comments to the ENGINEER and OWNER by no later than 50 percent of the project construction completion. The list shall include details such as equipment identification, part description, manufacture, and manufacturer part number, location in system, local vendor, storage requirements, storage location, and approximate cost. This completed list will be used to inventory all parts at time of turn over to the OWNER.

B. Spare parts and materials required to be supplied in the Contract Documents shall be furnished in manufacturer's unopened cartons, boxes, crates or other protective covering suitable for preventing corrosion or deterioration for the maximum length of storage which may be normally anticipated. They shall be clearly marked and identified as to the name of manufacturer or supplier, applicable equipment, part number, description and location in the equipment. All parts shall be protected and packaged for a shelf life of at least ten years.

C. During construction, store parts in buildings or trailers with floor, roof and closed sides and in accordance with manufacturers' recommendations. Protect from weather, condensation and humidity.

D. Parts and materials shall be delivered to the OWNER upon Substantial Completion of the Work or during the commissioning period of the system. Until that occurs, place spare parts in permanent storage rooms or areas approved by the OWNER. The turnover procedures shall be developed by the ENGINEER.

E. Provide a letter of transmittal along with the Spare Parts Receiver Form 01783-A in Specification 01331 – Reference Forms.

F. Full responsibility for loss or damage to parts and materials until they are transmitted to the OWNER, belongs to CONTRACTOR.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01784

POST FINAL INSPECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Approximately one week after final acceptance by the OWNER, ENGINEER will make arrangements with OWNER and CONTRACTOR for a Post-Final Inspection and will send a written notice to OWNER and CONTRACTOR advising of the date and time of the inspection.

B. After the inspection, ENGINEER will inform CONTRACTOR of any corrections required.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01785

PREVENTIVE MAINTENANCE DATA

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide Preventive Maintenance Data for new assets for use by the OWNER'S personnel:
   1. To ensure assets reach their maximum potential life.
   2. To meet asset warranty condition
   3. To perform preventive maintenance as recommended by the asset manufacturer.

B. The asset commissioning process shall not commence until the asset's preventive maintenance information has been documented in the city's Computer Maintenance Management System (CMMS) by the City's Water Asset Management (WAM) Team and city's operation and maintenance staff have been trained on the preventive maintenance procedures as described in 01821 - Instruction of Operating and Maintenance Personnel.

C. To ensure that the project commissioning will not be delayed and to allow the CITY adequate time to load all project data into the CMMS, the CONTRACTOR shall submit all required preventive maintenance data to the ENGINEER and the CITY with the respective shop drawing package for each asset.

D. Clarification:
   1. The term "preventive maintenance instructions" includes all information and instructions required to keep a product or piece of equipment properly maintained according to the manufacturer's recommendation to fulfill the equipment warranty conditions and ensure the equipment or asset reaches its maximum potential life.

   2. The maintenance tasks frequency are driven by calendar, run-time, or meter reading.

1.2 SUBMITTALS

A. All preventive maintenance information described above in paragraph 1.1.C shall be provided to the ENGINEER separate from the Operating and Maintenance Manual submittal. The CONTRACTOR shall submit the preventive maintenance information package as part of the shop drawing submittal package to the ENGINEER for review and approval. **SHOP DRAWING SUBMITTAL PACKAGE WILL NOT BE APPROVED WITHOUT ACCEPTANCE OF PREVENTIVE MAINTENANCE INFORMATION AS DESCRIBED IN THIS SPECIFICATION SECTION.**

B. All assets preventive maintenance information shall be reviewed and approved by the ENGINEER and the CITY and to be uploaded in the city's CMMS by the department's

WAM Team. All information shall be submitted to the CITY electronically following the CITY's 01785A – Preventive Maintenance Data Submittal Form in Section 01331 – REFERENCE FORMS, which is included at the end of this specification section as an example. The City will provide this form in MS ACCESS form to the ENGINEER. The information shall be per the asset's manufacturer's recommendation and includes the following:

1. Preventive maintenance task name
2. Estimated hours to perform the task itself. This does not include employee preparation, equipment access, or safety log-out/tag-out procedure time.
3. Frequency of the task based on calendar days or run-hours, or metering log.
4. Number of staff required to perform the task safely according to the manufacturer's recommended procedure.
5. Written procedure for every preventive maintenance task in MS WORD file format as recommended by the manufacturer that:
    a. List the required specialty tools or equipment.
    b. Include illustration or figure to aid staff's understanding of the asset maintenance.
    c. Describe the procedure for performing inspection of the equipment in operation as appropriate.
    d. Describe component removal and/or installation and disassembly and/or assembly procedures.
    e. Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.
    f. Define recommended torque limited, mounting, calibration and/or alignment procedures and settings, as appropriate.
    g. Describe components to evaluate or inspect when performing annual inspection.
    h. Provide lubricant and replacement part recommendations and limitations.
6. Identify recommended predictive maintenance tasks such as oil analysis, vibration analysis, infrared thermal scanning, etc. and their frequency, estimated task duration, and number of staff required to perform the task safely.
7. List all assets by asset IDs and description that will require preventive maintenance tasks.
8. The ENGINEER shall format the preventive maintenance information and instructions into the MS ACCESS file format, to be provided by the CITY, and arrange as indicated in the example below.

C. Preventive Maintenance Training Plan
    1. Each manufacturer shall submit a preventive maintenance lesson plan for each asset type according to Section 01821 – Instruction of Operating and Maintenance Personnel.
    2. The preventive maintenance training plan for each asset type shall be submitted a minimum of 40 days prior to scheduled instruction or coordinate with the

OWNER if this will conflict with construction schedule.

D. Example of Preventive Maintenance Information Form

Project Name: *"Cave Creek Water Reclamation Plant Rehabilitation"*	**City Project #** *WS85123456*
Engineer: *"Preventive Engineering Company"*	**Contractor:** *"Preventive Maintenance Constructor"*
Asset Type Description: *"Submersible Pumps"*	**Asset Manufacturer:** *"John Smith Pump Company"*

	Preventive Maintenance Task Description	**Class**	**Category**	**Task Duration (Hrs)**	**Est. Staff**	**Fre**	**Freq. Unit (Run-Time Hrs or Days)**	**Preventive Maintenance Procedure MS WORD File Name**
1.	*Change oil*	*Preventive*	*Lubrication*	*2*	*1*	*185*	*Days*	*"1234"*
2.	*Annual Inspection*	*Predictive*	*Condition Assessment*	*4*	*2*	*365*	*Days*	*"6789"*
3.	*Major overhaul*	*Preventive*	*Re-build*	*8*	*2*	*1500*	*Hrs*	*"xyz"*
4.	---			---	--	--	--	--

Assets IDs	**Asset Description**	**Max. Life (yrs)**	**Warranty**			**Warranty Certificate Reference No.**
			Start Date	**End Date**	**Duration (Mos)**	
12345678	*Raw Water Pumping, Pump No.2*	*10*	*09/15/2014*	*09/15/2015*	*12*	*"jklmn"*
98765432	*Finished Water Pumping, Pump No. 4*	*15*	*01/01/2014*	*01/01/2017*	*36*	*"a12345"*
------	------	----	--		---	---

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01810

COMMISSIONING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section Includes: Responsibility of the OWNER, ENGINEER and CONTRACTOR during the Commissioning Phase(s) of the Project.

B. Start-up and Commissioning of the Work, or a specified part of the Work, under this Project shall be as described in Section 01111, Schedule of Completion and Section 01143, Coordination with OWNER'S Operations. Work under this Section shall not start until the Work under Section 01111, Schedule of Completion, Section 01143, Coordination with OWNER'S Operation, Section 01751, Starting and Placing Equipment in Operation, Section 01752, Equipment and System Start-Up and Performance Testing; Section 01781, Operation and Maintenance Data, Section 01782, Record Documents and Section 01821, Instruction of Operations and Maintenance Personnel. Also, Special Tests as defined under the individual technical specifications, Divisions 0 to 18 has been completed; and Notice of Substantial Completion for the Work as defined in the Supplementary Conditions has been completed and issued by the ENGINEER. Spare parts shall also be on-site and accepted prior to Commissioning.

1.2 DEFINITIONS

A. Commissioning: The sequential process in which a newly constructed facility is put into successful operation.

B. Successful Operation: The resultant operation of all the processes and related controls in a manner that is consistent with the Contract Documents.

C. Manual Operational Mode: This operational mode represents the lowest level of control philosophy utilized in the plant instrumentation and control system. For all practical purposes, it means that an operational control decision requiring equipment or process monitoring, or control will require an individual to physically go to the local control for the associated task in order to operate the facility. In the manual operational mode, the focus will be on verifying that the equipment and processes function correctly, independent of the instrumentation system and control system. The estimated duration of the manual commissioning period is 25 percent of the total Work/Work area commissioning duration.

D. Semi-Automatic Operational Mode: The highest level of control philosophy utilized in the plant instrumentation and control system.

1.3 SUBMITTALS

A. Preventive and Unscheduled Maintenance Plan: Submit detailed plan prior to start of Commissioning for providing all preventive and unscheduled maintenance of all equipment and facilities in the plant throughout the entire commissioning phase of the project.

B. OWNER'S Personnel Training Schedule and Plan: Submit detailed plan and schedule for training OWNER'S personnel in accordance with Section 01821, Instruction of Operations and Maintenance Personnel.

1.4 REQUIREMENTS

A. Commissioning process will commence after issuance of the Work/Work area Notice of Substantial Completion to CONTRACTOR.

B. The commissioning process for the Project will consist of the following:

Commissioning Phases		
Work/Work Area	**Commissioning Requirements**	**Commissioning Duration (Calendar Days)**
Primary Sensors and Field Instruments	All instruments in manual (local) and semi automatic modes of operation	30 Consecutive Uninterrupted Days

C. Items required to be completed prior to the start of Commissioning include:
1. All Vendor Operations & Maintenance Manuals.
2. All required Training.
3. All required spare parts.
4. After approval of the Specification 01630 - Computerized Maintenance Management System Tags, CONTRACTOR shall provide and install all tags.
5. Any other items required under the contract.

D. During the course of the Commissioning Process, the ENGINEER and OWNER will evaluate design related issues and recommend design modifications which shall be implemented by CONTRACTOR through the Change Order process.

E. No system or subsystem shall be started up for continuous operation unless all components of that system or subsystem, including instrumentation, have been tested and proven to be operable as intended by the Contract Documents.

1.5 RESPONSIBILITIES

A. Responsibilities listed do not relieve CONTRACTOR from all other responsibilities and duties associated with project closeout as defined in Division 0 and Division 1, General Requirements of the Specifications.

B. CONTRACTOR'S Responsibilities during the Commission Process:
   1. Provide on call service (24 hours per day and seven days per week), which includes all staff, labor, materials, equipment and appurtenances required for carrying out CONTRACTOR'S commissioning duties described below.
   2. All Change Order work resulting from the evaluation of design-related issues by the ENGINEER and OWNER.
   3. All preventive and unscheduled maintenance of all equipment and facilities. This shall include, but not be limited to the following:
      a. Providing all lubricants.
      b. Lubrication of all equipment in accordance with Manufacturer's recommendations.
      c. Perform all Manufacturer recommended preventive maintenance, including instrument calibrations.
      d. Exercise all equipment not in use during Commissioning phase.
      e. Repair all failed equipment.
      f. Periodic check of all equipment alignment, vibration, and noise levels to ascertain conformance with Specifications.
      g. Provide all parts required for equipment repair.
      h. Provide all tools and miscellaneous equipment required for equipment repair.
      i. Administration/logging/documentation of all preventive maintenance and repair work.
      j. Cleanup associated with equipment failure and repair.
      k. Daily cleanup of buildings and site.
      l. Landscaping maintenance.
      m. Roadway cleanup and maintenance.
      n. Replacement of all HVAC filters.
   4. Warranty related issues/items.
   5. Other contractual requirements including, but not limited to, incomplete Work list.

C. OWNER'S Responsibilities during the Commissioning Process:
   1. Perform all laboratory analysis required for plant operations.
   2. Assisting ENGINEER in the evaluation of design related issues and recommendations of modifications to be implemented by CONTRACTOR through the change order process.

D. ENGINEER'S Responsibilities during Commissioning Process:
   1. Provide staff for Commissioning Phases.
   2. Assist OWNER with Operation of facilities.
   3. Provide OWNER with systems training of the Commissioning Process.
   4. Provide liaison and coordination between CONTRACTOR and OWNER'S activities.
   5. Administer Change Order work performed by CONTRACTOR.

E. Based upon the data compiled during the commissioning period modifications may be required. The ENGINEER and OWNER may issue a request for proposal to modify the Work, to change design or process related issues. A respond to these requests is expected. Appropriate cost and time adjustment will be made to address the proposed change.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01821

INSTRUCTION OF OPERATING AND MAINTENANCE PERSONNEL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide the services of factory-trained maintenance specialists to instruct OWNER'S operating and maintenance personnel in the recommended operation and the preventive maintenance procedures for equipment specified in the equipment Sections.

B. The qualifications of specialists shall be subject to approval by ENGINEER.

C. The scheduling of these services shall be coordinated with the OWNER and ENGINEER, with a minimum of 30 days prior notice.

D. Manufacturer shall provide a combination of classroom and field training. All training shall be conducted at the OWNER's Facility, unless otherwise stated in the equipment Sections. Class size shall be limited to no more than 15 trainees. Manufacturer shall provide training, or as approved by OWNER.

E. Manufacturer shall allow any and all training sessions to be digitally recorded by OWNER.

F. Section 01600, General Equipment Provisions, Section 01620, Installation of Equipment, Section 01751, Starting and Placing Equipment in Operation, and Section 01752, Equipment and System Startup and Performance Testing, includes, additional requirements for manufacturer's and supplier's field and test data.

G. Instruction of OWNER'S personnel shall commence only after the equipment has been started, approved preventive maintenance information has been turned over to the OWNER, and acceptance tests have been completed according to the provisions in Section 01751, Starting and Placing Equipment in Operation, and Section 01752, Equipment and System Startup and Performance Testing.

H. Submit a copy of this Section to all manufacturers of equipment for this contract.

1.2 SUBMITTALS

A. Manufacturer shall submit for approval the following:
   1. Proposed Operation Lesson Plan for each scheduled instruction 14 days prior to commencement of training. Lesson plans shall be approved a minimum of 7

days prior to scheduled instruction.

2. Proposed Manufacturer's Recommended Preventive Maintenance Training Plan for each asset type a minimum of 40 days prior to scheduled instruction or coordinate with the OWNER if this will conflict with construction schedule.
3. Credentials of their designated operating and maintenance instructor shall include a brief resume and specific details of the instructor's experience pertaining to; operation of, maintenance of, and training for the equipment specified.
4. Training Request Form: Submit the Training Request Form Number 01821-B to the ENGINEER 14 days prior to the requested training date. Contractor may obtain form from the OWNER.
5. There shall be separate "Operating" and "Maintenance" staff training if requested by the OWNER.

1.3 INSTRUCTION LESSON PLAN

A. Manufacturer's proposed Lesson Plan shall include the elements presented in the outline of Instruction Lesson Plan in Paragraph 1.3.D., below, of this Section. Specific components and procedures shall be identified in the proposed Lesson Plan.

B. Manufacturer's proposed Lesson Plan shall detail specific instruction topics. Training aids to be utilized in the instruction shall be referenced and attached where applicable to the proposed Lesson Plan. "Hands-On" demonstrations planned for the instruction shall be described in the Lesson Plan.

C. The manufacturer shall indicate the estimated duration of each segment of the training Lesson Plan.

D. Instruction Lesson Plan shall include the following as a minimum:
   1. Equipment Operation:
      a. Describe equipment's operating (process) function.
      b. Describe equipment's fundamental operating principals and dynamics.
      c. Identify equipment's mechanical, electrical and electronic components, and features.
      d. Identify all support equipment associated with the operation of subject equipment (e.g., air intake filters, valve actuators, motors).
      e. Recommend standard operating procedures to cover start-up, routine monitoring, and shutdown of the equipment.
   2. Detailed Component Description:
      a. Identify and describe in detail each component's function.
      b. Where applicable, group related components into subsystems. Describe subsystem functions and their interaction with other subsystems.
      c. Identify and describe in detail equipment safeties and control interlocks.

3. Equipment Preventive Maintenance (PM):
   a. Identify all recommended PM tasks, their frequency, estimated task duration, and number of staff required to perform the task safely.
   b. Identify all recommended predictive maintenance tasks such as oil analysis, vibration analysis, infrared thermal scanning, etc. and their frequency, estimated task duration, and number of staff required to perform the task safely.
   c. PM task procedures shall include:
      1) Perform an inspection of the equipment in operation.
      2) Spot potential trouble symptoms and anticipate breakdowns.
      3) Forecast maintenance requirements (predictive maintenance).
      4) Provide lubricant and replacement part recommendations and limitations.
      5) Describe appropriate cleaning practices and recommended intervals.
      6) Identify and describe the use of special tools required for maintenance of the equipment.
      7) Describe component removal/installation and disassembly/assembly procedures.
      8) Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.
   d. Define recommended torque, mounting, calibration and/or alignment procedures and settings, as appropriate.
   e. Describe recommended procedures to check/test equipment following a corrective repair.
   f. Perform at least two "hands-on" demonstrations of all PM procedures.
   g. All PM tasks and procedures shall be submitted to the ENGINEER for review and approval and documented in the City's computer maintenance management system (CMMS) by the Asset Management Team as described in 01785 – PREVENTIVE MAINTENANCE DATA.
4. Equipment Troubleshooting:
   a. Define recommended systematic troubleshooting procedures.
   b. Provide component specific troubleshooting checklists.
   c. Describe applicable equipment testing and diagnostic procedures to facilitate troubleshooting.

1.4 TRAINING AIDS

A. The manufacturer's instructor shall incorporate training aids as appropriate to assist in the instruction. As a minimum, the training aids shall include text and figure handouts. Other appropriate training aids are:
   1. Audio-Visual Aids (e.g., films, slides, videotapes, overhead transparencies, posters, blueprints, diagrams, catalogue sheets).
   2. Equipment cutaways and samples (e.g., spare parts and damaged equipment).
   3. Tools (e.g., repair tools, any customized tool, measuring and calibrating

instruments).

B. The manufacturer's instructor shall utilize descriptive class handouts during the instruction. Photocopied class handouts shall be good quality reproductions. Class handouts should accompany the instruction with frequent reference made to them. Customized handouts developed especially for the instruction are encouraged. Handouts planned for the instruction shall be attached with the manufacturer's proposed Lesson Plan.

1.5 "HANDS-ON" DEMONSTRATIONS

A. The manufacturer's instructor shall present "hands-on" demonstrations of operating and maintenance of the equipment for each scheduled group. The proposed "hands-on" demonstrations should be described in the manufacturer's proposed Lesson Plan.

1.6 TRAINING SCHEDULE

A. Each manufacturer shall provide as a minimum the following hours of training. Travel time and expenses are responsibility of manufacturer and are not included in training schedule time.

Equipment	*Section*	*Training Hours*
Biofilter	13124	16

B. The plant operators work on a shift schedule. Develop the training schedule to account for training classes for each shift.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 02145

DIVERSION OF WATER OR SEWAGE FLOW AND DEWATERING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This section describes the existing conditions for temporary bypassing and dewatering of water systems or sewers for internal television inspection (CCTV), cleaning operations and/or rehabilitation of project pipelines. Temporary bypass pumping is very important for the project, including the maintenance of service to customer connections or making alternative arrangements acceptable to customers.

B. Requirements:
   1. Proved all labor, materials and supervision to temporary bypass flow around the work in accordance with the specified needs of the rehabilitation method being utilized and dewater the pipelines in preparation for cleaning and rehabilitation.
   2. Provide the design of the bypass arrangement and describe the means and methods of accomplishing the bypassing and submitted to the ENGINEER to determine conformance to project objectives.
   3. Prior to placing the bypass system into operation, successfully test the system to 1.5 times the maximum operating pressure of the system.
   4. Notify the ENGINEER 48 hours prior to shutting down or operating the bypass. Provide continuous manned monitoring of the bypass flow.
   5. Should a spill occur, immediately contact the ENGINEER and provide immediate and proper cleanup.

C. Experience:
   1. Utilize staff and/or a subcontractor that has been directly responsible for the completion of a project that required the bypass pumping of water or sewage flows in excess of 2 mgd.

1.2 SUBMITTALS

1. At the Preconstruction Conference, submit drawings and complete design data showing methods and equipment proposed to be utilized in the water piping or sewer bypassing for review by the ENGINEER. Include the following information in the submittal.

a. Drawings indicating the scheme and location of temporary water or sewer line plugs, bypass discharge lines and the method and location for discharging the bypass lines.
b. Capacities of pumps, prime movers and standby equipment.
c. Design calculations proving adequacy of the system and selected equipment sealed by a Professional Civil Engineer, registered in the State of Arizona.
d. Standby Power Source
e. Staffing Plan
f. Secondary Containment Provisions
g. Spill Response Plan
h. Odor Control Plan

1.3 JOB CONDITIONS

A. Available Flow Data:
1. Available flow data for the water systems or sewers to be rehabilitated at the projects is located in Part 3, Section 3.1 of this specification. Flow data for the service laterals is not available. Determine the flow in service laterals and submit the data to the ENGINEER.

B. Protection:
1. Bypassing to the ground surface, receiving waters, storm drains or bypassing which results in soil or groundwater contamination or any potential health hazards is not permitted.

C. Scheduling:
1. The bypassing system is not allowed to be shut down between shifts, on holidays, weekends or during work stoppage without written permission from the ENGINEER. Provide an attendant, around the clock, whose only duty is to maintain the bypass pumping system until the bypassing of that specific pipeline is no longer required.

D. Service Lines:
1. Water or sanitary sewers to be bypassed may have service lines connected to adjacent users. The known service lines have been shown on the construction drawings. Verify the locations of these lines and any other service lines not shown on the drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide temporary pumps, conduits and other equipment to bypass flow around the work area. Furnish all necessary labor and supervision to set up and operate the pumping and bypass system.
   1) Provide critical grade sound attenuated pumps capable of achieving an operating noise level of 70 decibels or less measured at a distance of 50 feet from the operating pump for the bypass pumping. Conduct sound measurement tests in accordance with the American National Standards S. 13-1971.
   2) Provide pumps and bypass lines of adequate capacity and size to handle the required capacity.
   3) Each internal combustion engine, used for any purpose on the job or related to the job, shall be equipped with a muffler of a type recommended by the manufacturer. No internal combustion engine shall be operated on the project without said muffler.

B. Maintain on site, sufficient equipment and materials to ensure continuous and successful operation of the bypass system. Unless otherwise approved by ENGINEER, provide standby pumps on site for a minimum 50% redundancy of the bypass system flow except at least 100% redundant capacity must be provided if only one pump is being used to bypass flows. Provide, install in-place, make fully operational and be fueled at all times the standby pumps, equipment and piping. Maintain on site a sufficient number of valves, tees, elbows, connections, tools, water line or sewer plugs, piping and other parts or system hardware to ensure immediate repair or modifications of any part of the system as necessary.

C. Unless otherwise approved by ENGINEER, provide and install fully operational redundant bypass line(s) so they can be placed in service in the event one of the bypass lines develops a leak. Provide 33% redundancy in the bypass piping for design flows, except at least one redundant bypass line must be provided when less that three bypass lines are provided by design. Provide and install independent valves on all lines for the bypass pump system so they can be quickly activated or removed form service if necessary.

D. Install all pumps, generators and other equipment with sufficient secondary containment to protect against gasoline, oil and hydraulic fluid spills. Provide a berm at the edge of the containment to prevent direct runoff of spills.

PART 3 - EXECUTION

3.1 ESTIMATED FLOWS IN THE PROJECT PIPELINE

A. The following paragraph provides estimated peak daily dry weather flow information for the project pipeline. The information was obtained from the City of Phoenix. For questions pertaining to this information contact the City

Phoenix, Water Services Department, 200 West Washington Street, Phoenix, Arizona, during normal business hours.

B. The approximate estimated dry weather low flow, average daily dry weather flow and peak dry weather flow for Project Segment at the eastern influent sewer main are listed below in Table 1. Use of this flow data in no way relieves responsibilities for design, construction and operation of an adequate and properly functioning bypass system. Rain events may result in significantly larger flow rates. Make own determination of bypass capacity needs. The bypass design must provide sufficient capacity to handle this increase.

TABLE 1

Dry Weather Flow Estimates

Project	Low Flow	Average Flow	Peak Flow
18" Eastern Sewer Main	1.5 MGD	2 MGD	2.4 MGD

C. Monitoring Flows:
1. Monitor flows and bypass operations during the course of the project to ensure proper operation and ensure against upstream surcharges and/or spills.

D. Service Lines:
1. Water or sewer service to customers must be maintained during the course of the work, unless other acceptable arrangements are made with the customer.
2. The ENGINEER shall provide a public information representative to accompany the CONTRACTOR when visiting customers to discuss bypass pumping of services or making alternate arrangements with the customer to discuss bypass pumping of services or making alternate arrangements with the customer for service outages.
   a. No matter what arrangement is made, cooperate with the ENGINEER to provide the City of Phoenix documentation that all affected customers have been contacted and arrangements made for continuous service or alternate accommodations. This document must be submitted prior to start of work on the section of line affected.

E. Notifications;
1. Cooperate fully in providing the ENGINEER with advance notice and details pertaining to work schedule and individual service arrangements.

2. Notify the ENGINEER and City of Phoenix of any planned service interruptions at least two weeks prior to the event.

3. The ENGINEER or local public involvement firm retained by the ENGINEER shall perform notification of the work to the public. Notification shall be made door to door with printed handouts or door hangers. The information provided includes, at a minimum, the reason for the interruption, the time period of the interruption and a local 24 hour telephone hotline number for project information.
   a. The first notification is to be five days before interruption of service. Much grater advance notice may be required if an alternate to pumping the customer's service is proposed.
   b. The second notification is to be 24 hours prior to interruption of service.

3.2 PROTECTION

A. Water or wastewater spills, overflows and backups into customer's properties are not allowed. Bypassing to the ground surface, receiving waters, storm drains or bypassing which results in groundwater contamination or potential health hazards are not allowed.

B. Inspect the entire bypass pumping and piping system for leaks or spills on an hourly basis. Create an inspection log and enter the time of the inspections and the conditions of the piping and the name of the inspector into the log for review by the ENGINEER.

C. Provide ENGINEER a copy of an emergency spill response plan. Plan shall address notification and clean up procedures. Immediately take action to halt and clean up all spills and immediately notify ENGINEER of any/all spills.

D. Perform all work in compliance with OSHA standards and in no case will noise levels be permitted which would interfere with the work of the City or others. Noise levels shall be in accordance with City of Phoenix noise ordinance. Utilize sound attenuated bypass pumps with a maximum decibel rating of 70 db @ 50 feet.

E. Odor Control:
   1. Employ methods and procedures that mitigate the generation and discharge of objectionable odors to the surface environment at all times.
   2. Add ferric chloride to the wastewater flow upstream of bypass pumping operations to reduce odor. Make determination of flow characteristic for required dosing.
      a. Add the ferric chloride from a location upstream that will allow 10 to 15 minutes reaction time before the flow enters the work area. The

chemical dosing shall reduce odors generated from the wastewater stream to a level acceptable to the City. If this is not accomplished by adding the ferric chloride only, an additional control may be required. Add hydrogen peroxide downstream to the flow that has been dosed with ferric chloride. The Hydrogen peroxide shall be added to allow a 5 – minute reaction time before the flow enters the work area. Any dosage combination of the two chemicals may be used to ensure continuous control of odors acceptable to the City.

3.3 DAMAGES

A. Repairs for any damage that may result from negligence, inadequate or improper installation, maintenance, insufficient and operation of bypass system, including mechanical or electrical failures are the responsibility of the CONTRACTOR.

+ + END OF SECTION + +

SECTION 02220

DEMOLITIONS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required for demolitions, removal and disposal Work.
   2. Included, but not limited to, are demolition and removals of existing materials, equipment, or work necessary to install the Work as shown on the Drawings, specified and required to connect same with existing work in an approved manner. Demolition includes structural concrete, foundations, walls, doors, windows, structural steel, metals, roofs, masonry, attachments, appurtenances, piping, electrical and mechanical equipment, paving, curbs, walks, fencing, and similar existing facilities.
   3. Demolitions and removals which may be specified under other Sections shall conform to requirements of this Section.
   4. Pay for all landfill disposal fees.

1.2 SUBMITTALS

A. Schedule: Submit for approval proposed methods, equipment, and operating sequences. Include coordination for shut-off, capping, temporary services, continua-tion of utility services, and other applicable items to ensure no interruption of OWNER'S operations.

1.3 JOB CONDITIONS

A. Protection:
   1. Perform all demolition and removal Work to prevent damage or injury to structures, occupants thereof and adjacent features which might result from falling debris or other causes, and so as not to interfere with the use, and free and safe passage to and from adjacent structures.
   2. Closing or obstructing of roadways, sidewalks, and passageways adjacent to the Work by the placement or storage of materials will not be permitted, and all operations shall be conducted with a minimum interference to traffic on these ways.
   3. Erect and maintain barriers, lights, sidewalk sheds, and other necessary protective devices.

4. Repair damage to facilities to remain, or to any property belonging to the OWNER or occupants of the facilities. Comply with requirements of Section 02230, Clearing.

B. Scheduling:
1. Carry out operations so as to avoid interference with OWNER'S operations and work in the existing facilities. Comply with requirements of Section 01143, Coordination with OWNERS Operations.

C. Notification:
1. At least 48 hours prior to commencement of a demolition or removal, notify ENGINEER, in writing, of proposed schedule therefore. OWNER will inspect the existing equipment and mark for identification those items which are to remain the property of the OWNER. Do not start removals without the permission of the ENGINEER.

D. Explosives:
1. Do not bring explosives on site nor use explosives without written consent of authorities having jurisdiction. Such written consent will not relieve CONTRACTOR of total responsibility for injury or damage caused by CONTRACTOR'S blasting operations.
2. Perform all blasting, if permitted, in compliance with applicable governing regulations.

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. All materials and equipment removed from existing work, shall become the property of CONTRACTOR, except for those which OWNER has identified and marked for their use. All materials and equipment marked by the OWNER to remain the property of the OWNER shall be carefully removed by CONTRACTOR, so as not to be damaged, and shall be cleaned and stored on or adjacent to the site in a protected place specified by the ENGINEER or loaded onto trucks provided by the OWNER.

B. Dispose of all demolition materials, equipment, debris, and all other items not marked by the OWNER to remain off the site and in conformance with all existing applicable laws and regulations.

C. Surfaces of walls, floors, ceilings, or other areas which are exposed by any of the removals specified herein, and which will remain as architecturally finished surfaces shall be repaired and re-finished by CONTRACTOR with the same or matching

materials as the existing adjacent surface or as may be otherwise approved by the ENGINEER.

D. Pollution Controls: Use water sprinkling, temporary enclosures, and other suitable methods to limit the amount of dust and dirt rising and scattering in the air to the lowest practical level. Comply with governing regulations pertaining to environmental protection.
   1. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.
   2. Clean adjacent structures, facilities, and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to conditions existing prior to the start of the Work.

E. Building Demolition (NOT USED)

F. Pavement Demolition:
   1. All asphalt and concrete pavement demolition shall terminate at cut edges. All edges shall be linear and have a vertical cut face.

3.2 STRUCTURAL REMOVALS

A. Remove structures to the lines and grades shown on the Drawings, unless otherwise directed by the ENGINEER. Where no limits are shown on the Drawings, the limits shall be 4-inches outside the item to be installed. The removal of masonry beyond these limits shall be at CONTRACTOR'S expense and these excess removals shall be reconstructed to the satisfaction of the ENGINEER, with no additional compensation to CONTRACTOR.

B. Existing wet well bottom shall be core drilled before backfilling to ensure adequate drainage after abandonment.

C. Existing Manhole No. 1 shall be core drilled before backfilling to ensure adequate drainage after abandonment.

D. All concrete, brick, tile, concrete block, roofing materials, reinforcement, structural or miscellaneous metals, plaster, wire mesh and other items contained in or upon the structure shall be removed and taken from the site, unless otherwise approved by the ENGINEER. Demolished items shall not be used in backfill.

E. After removal of parts or all of masonry walls, slabs and like work which tie into the Work or existing work, the point of junction shall be neatly repaired so as to leave only finished edges and surface exposed.

F. The jambs, sills and heads of any windows, passageways, doors, or other openings cut into the Work or existing work, shall be dressed with new masonry, concrete or metal to provide a smooth, finished appearance.

G. Where new anchoring materials, including bolts, nuts, hangers, welds and reinforcing steel, are required to attach the Work to the existing work they shall be included under this Section, except where specified elsewhere.

3.3 MECHANICAL REMOVALS

A. Mechanical removals shall consist of dismantling and removing of existing piping, pumps, motors, equipment and other appurtenances as specified, shown, or required for the completion of the Work. Mechanical removals shall include cutting, capping, and plugging as required, except that the cutting of existing piping for the purpose of making connections thereto will be included under Division 15, Mechanical.

B. Existing process, water, chemical, gas, fuel oil and other piping not required for the Work shall be removed where shown on the Drawings or where it will interfere with the Work. Piping not indicated to be removed or which does not interfere with the Work shall be removed to the nearest solid support, capped and left in place. Chemical and fuel lines and tanks shall be purged and made safe prior to removal or capping. Where piping that is to be removed passes through existing walls, it shall be cut off and properly capped on each side of the wall.

C. When underground piping is to be altered or removed, the remaining piping shall be properly capped. Abandoned underground piping shall be removed.

D. Waste and vent piping shall be removed to points shown. Pipe shall be plugged with cleanouts and plugs. Where vent stacks pass through an existing roof that is to remain, they shall be removed and the hole in the roof properly patched and made watertight.

E. Any changes to potable water piping and other plumbing and heating system work shall be made in conformance with all applicable codes and under the same requirements as other underground piping. All portions of the potable water system that have been altered or opened shall be pressure tested and disinfected in accordance with Section 15050, Piping Systems, and Section 15051, Buried Piping Installation, and local codes. Other plumbing piping and heating piping shall be pressure tested only.

3.4 ELECTRICAL REMOVALS AND DEMOLITION

A. Electrical removals shall consist of the removal of existing transformers, distribution switchboards, control panels, motors, conduits and wires, poles and overhead wiring, panelboards, lighting fixtures, and miscellaneous electrical equipment all as shown on the Drawings, specified, or required to perform the Work.

B. All existing electrical equipment and fixtures to be removed shall be removed with such care as may be required to prevent unnecessary damage, to keep existing systems in operation and to keep the integrity of the grounding systems.

C. Motor Control Centers and Switchgear shall be removed or modified as shown on the Drawings. Motor Control Centers and Switchgear to be removed shall be disconnected and dismantled, and all components shall be disposed of off the site. Circuit breakers and other control equipment on modified Motor Control Centers and Switchgear that will no longer be used shall be removed, unless otherwise shown on the Drawings or specified. All new openings cut into the modified Motor Control Centers and Switchgear shall be cut square and dressed smooth to the dimensions required for the installation of the new equipment.

D. Motors shall be disconnected and removed where shown on the Drawings or specified. Motors not designated by the OWNER to be salvaged shall be removed from the site. Motors or other electrical gear designated for reuse shall be stored in enclosed, heated storage.

E. Abandoned Exposed Conduit and Wire: Generally, whenever a piece or groups of equipment are removed, all associated electrical power or control wiring which are no longer required shall be removed. The wire shall be removed back to the power source or control panel. The conduit, unless otherwise indicated, shall be removed back to the nearest junction box or point of conduit embedment. Abandoned conduits or direct-burial cable concealed in floor or ceiling slabs, or in walls, shall be cut flush with the slab or wall at the point of entrance. The conduits shall be suitably plugged and the area repaired in a flush, smooth, approved manner. Exposed conduits and their supports shall be disassembled and removed from the site. Repair all areas of work to prevent rust spots on exposed surfaces.

F. Where shown on the Drawings or otherwise required, wiring in the underground duct or direct-burial cable system shall be removed. All such wiring shall be salvaged and stored as specified. Verify the function of all wiring before disconnecting and removing it. Ducts which are not to be reused shall be plugged where they enter buildings and made watertight.

G. Existing panelboards where shown on the Drawings shall be removed and disposed of off the site. Where shown on the Drawings or specified, they shall be replaced with new panelboards at the same or adjacent locations. All cutting and patching necessary for the removal and replacement of panelboards shall be performed.

H. Existing lighting fixtures shall be removed or relocated as shown on the Drawings. Fixtures not relocated shall be removed from the site. Relocated fixtures shall be carefully removed from their present location and reinstalled where shown on the Drawings.

I. Existing wall switches, receptacles, starters, and other miscellaneous electrical equipment, shall be removed and disposed of off the site, as required. Care shall be taken in removing all equipment so as to minimize damage to architectural and structural members. Any damage incurred shall be repaired by CONTRACTOR to the satisfaction of the ENGINEER, at no additional cost to the OWNER.

3.5 ALTERATIONS AND CLOSURES

A. Alterations shall conform with the Contract Documents, and the directions and approvals of the ENGINEER.

B. Where alterations require cutting or drilling into existing floors, walls, and roofs, the holes shall be repaired in a manner approved by the ENGINEER. Repair such openings with the same or matching materials as the existing floor, wall, or roof or as otherwise approved by the ENGINEER. All repairs shall be smoothly finished, unless otherwise approved by the ENGINEER.

C. Openings in existing concrete slabs, ceilings, masonry walls, floors and partitions shall be closed and sealed as shown on the Drawings or otherwise directed by the ENGINEER. The Work shall be keyed into the existing work in a manner approved by the ENGINEER. Reinforcing steel shall be welded to the existing reinforcing. Welding shall conform to AWS D12.1, Reinforcing Steel Welding Code. In general, use the same or matching materials as the existing adjacent surface. The finished closure shall be a smooth, tight, sealed, permanent closure acceptable to the ENGINEER.

3.6 CLEAN-UP

A. Remove from the site all debris resulting from the demolition operations as it accumulates. Upon completion of the Work, all materials, equipment, waste, and debris of every sort shall be removed, and premises shall be left, clean, neat and orderly. Comply with requirements of Section 02315, Structural Excavation and Backfill, and Section 02230, Clearing.

+ + END OF SECTION + +

SECTION 02230

CLEARING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals required to perform all clearing and grubbing as shown on the Drawings and specified.

B. The Work covered by this Section consists of removing and disposing of all trees, stumps, bush, roots, shrubs, vegetation, logs, rubbish, and other objectionable material from the site, as required to perform the Work.

1.2 QUALITY ASSURANCE

A. Codes and Standards: State and local laws and code requirements shall govern the hauling and disposal of trees, shrubs, stumps, roots, rubbish, debris and other matter.

1.3 JOB CONDITIONS

A. Protection:
   1. Streets, roads, adjacent property and other works and structures shall be protected throughout the entire Project. Return to original condition, satisfactory to the ENGINEER, damaged facilities caused by CONTRACTOR'S operations.
   2. Trees, shrubs, grassed and landscaped areas, which are to remain, shall be protected by fences, barricades, wrapping or other methods as shown on the Drawings, specified or approved by the ENGINEER. Equipment, stockpiles, etc. shall not be permitted within tree branch spread. Trees shall not be removed without approval of the ENGINEER, unless shown or specified.

B. Salvable Improvements:
   1. Unless specified elsewhere, carefully remove items to be salvaged and store on premises in approved location, all in accordance with recommendations of specialists recognized in the Work involved.

1.4 GUARANTEE

A. Guarantee that Work performed under this Section will not permanently damage trees, shrubs, turf or plants designated to remain, or other adjacent work or facilities. If damage resulting from CONTRACTOR'S operations appears during the period up

to 18 months after completion of the Project, replace damaged items, at no additional cost to OWNER.

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CLEARING AND GRUBBING

A. Limits of clearing shall be all areas within the Contract limit lines, except as otherwise shown on the Drawings. Damage outside these limits caused by CONTRACTOR'S operations shall be corrected at CONTRACTOR'S expense.

B. Remove from the site and satisfactorily dispose of all trees, shrubs, stumps, roots, brush, masonry, rubbish, scrap, debris, pavement, curbs, fences and miscellaneous other structures not covered under other Sections as shown on the Drawings, specified or otherwise required to permit construction of the Work. Comply with requirements of Section 02220, Demolitions.

C. No cleared or grubbed material may be used in backfills or structural embankments. Comply with requirements of Section 02315, Structural Excavation and Backfill.

D. Burning on the site will not be allowed.

E. In order to avoid additional removal or damage, existing trees and shrubs shall be trimmed as required. Trimmed or damaged trees shall be treated and repaired by persons with experience in this specialty who are approved by ENGINEER. Trees and shrubs intended to remain, which are damaged beyond repair or removed, shall be replaced by CONTRACTOR at no additional cost to OWNER.

F. Control air pollution caused by dust and dirt and complies with governing regulations.

3.2 TOPSOIL REMOVAL

A. Topsoil is defined as friable clay loam surface soil found in a depth of not less than 4-inches. Topsoil shall be substantially free of subsoil, clay lumps, stones, and other objects over 2-inches in diameter, and without weeds, roots, and other objectionable material.

B. Strip topsoil which is satisfactory to whatever depths are encountered, and in such manner as to prevent intermingling with the underlying subsoil or other objectionable material. Remove heavy growths of grass from areas before stripping.

1. Where trees are shown on the Drawings or directed by the ENGINEER to be left standing, stop topsoil stripping a sufficient distance from such trees to prevent damage to the main root system.

C. Stockpile topsoil in storage piles in areas shown on the Drawings, or where otherwise approved by ENGINEER. Construct storage piles to freely drain surface water. Cover storage piles, if required, to prevent windblown dust. Topsoil in excess of quantity required shall remain property of OWNER.

D. Dispose of excess topsoil as waste material off site.

+ + END OF SECTION + +

SECTION 02315

STRUCTURAL EXCAVATION AND BACKFILL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals required to perform all excavating, backfilling, filling and grading, and disposing of earth materials as shown on the Drawings, specified, and required for construction of retaining walls, manholes, vaults, structure foundations, underground ductbanks, electrical manholes and handholes, and other structures and facilities required to complete the Work in every respect.
   2. All necessary preparation of subgrade for slabs, foundations and pavements is included.
   3. All temporary means required to prevent discharge of sediment to water courses from dewatering systems or erosion are included.
   4. On-site excavated material will be classified for use as backfill material. Excavation materials include all materials regardless of type, character, composition, moisture, or condition thereof.
   5. Perform all earthwork as specified in this Section.

B. General:
   1. All project work, including excavation and backfilling, shall be performed within the project limits.
   2. All earth work shall be performed within the City of Phoenix property limits.

1.2 QUALITY ASSURANCE

A. Testing Services:
   1. General: Testing of materials, testing for moisture content during placement and compaction of fill materials, and of compaction requirements for compliance with technical requirements of the Specifications shall be performed by a testing laboratory as designated in Section 01452, Testing Laboratory Services Furnished by CONTRACTOR.
   2. (NOT USED)
   3. (NOT USED)
   4. Responsibilities and Duties of CONTRACTOR:
      a. The use of testing services shall in no way relieve CONTRACTOR of the responsibility to furnish materials and construction in full compliance with the Contract Documents.
      b. To facilitate testing services:

1) Secure and deliver to the ENGINEER or to the testing agency, without cost, preliminary representative samples of the materials he proposes to use and which are required to be tested.
2) Furnish such casual labor as is necessary to obtain and handle samples at the Work site or at other sources of material.
3) Advise the OWNER'S testing agency at least two days in advance of any backfill operations to allow for completion of quality tests and for the assignment of personnel.

c. CONTRACTOR'S Testing Service shall inspect and approve subgrades and fill layers before further construction Work is performed thereon.

d. Responsibility belongs to CONTRACTOR to accomplish the specified compaction for backfill, fill, and other earthwork, and to control his operations by confirmation tests to verify and confirm that CONTRACTOR has complied, and is complying at all times, with the requirements of these Specifications concerning compaction, control, and testing.

e. The frequency of CONTRACTOR'S confirmation tests shall be not less than as follows; each test location for trenches shall include tests for each layer, type, or class of backfill from bedding to finish grade.
1) Trenches for structures, and underground ductbanks:
a) In open fields: Two locations every 1,000 linear feet.
b) Along dirt or gravel roads or off traveled right-of-way: Two locations every 500 linear feet.
c) Crossing paved roads: Two locations along each crossing.
d) Under pavement cuts or within two feet of pavement edges: One location every 400 linear feet.
e) Compaction test shall be taken at least every 2 feet of total lift and 75 feet linearly.
2) For structural backfill: On 30-foot intervals on all sides of the structure for every compacted lift but no less than one per lift on each side of the structure for structures less than 60 feet long on a side.
3) In embankment or fill: One per 1000 square feet on every compacted lift.
4) Base material: One per 1000 square feet on every compacted lift.
5) Footing Subgrade: For each strata of soil on which footings will be placed, conduct at least one test to verify required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested strata, when acceptable to ENGINEER.
6) Paved Areas and Building Slab Subgrade: Make at least one field density test of subgrade for every 500 square feet of paved area or building slab, but in no case less than three tests. In each compacted fill layer, make one field density test for every 1000 square feet of overlaying building slab or paved area, but in no case less than three tests.

7) Foundation Wall Backfill: Take at least two field density tests, at locations and elevations as directed by the ENGINEER.

f. Copies of the test reports shall be submitted promptly to the ENGINEER. CONTRACTOR'S tests to be performed by a soils testing laboratory acceptable to the ENGINEER.

g. Demonstrate the adequacy of compaction equipment and procedures before exceeding any of the following amounts of earthwork quantities:
   1) 200 linear feet of trench backfill.
   2) 10 cubic yards of structural backfill.
   3) 100 cubic yards of embankment work.
   4) 50 cubic yards of base material.

h. Until the specified degree of compaction on the previously specified amounts of earthwork is achieved, no additional earthwork of the same kind shall be performed.

i. Periodic compliance tests will be made by the ENGINEER to verify that compaction is conforming to the requirements previously specified, at no cost to CONTRACTOR. Remove the overburden above the level at which the ENGINEER wishes to test and shall backfill and recompact the excavation after the test is complete.

j. If compaction fails to conform to the specified requirements, remove and replace the backfill at proper density or shall bring the density up to specified level by other means acceptable to the ENGINEER. Subsequent tests required to confirm and verify that the reconstructed backfill has been brought up to specified density shall be paid by CONTRACTOR. CONTRACTOR'S confirmation tests to be performed in a manner acceptable to the ENGINEER. Frequency of confirmation tests for remedial Work shall be double that amount specified for initial confirmation tests.

B. Permits and Regulations:
   1. Obtain all necessary permits for Work in roads, rights-of-way, railroads, etc. Also, obtain permits as required by local, state and federal agencies for discharging water from excavations.
   2. Perform excavation Work in compliance with applicable requirements of governing authorities having jurisdiction.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM A 36, Specification for Structural Steel.
   2. ASTM A 328, Specification for Steel Sheet Piling.
   3. ASTM D 422, Method for Particle-Size Analysis of Soils.
   4. ASTM D 427, Test Methods for Shrinkage Factors of Soils by the Mercury Method.
   5. ASTM D 698, Test Method for Laboratory Compaction Characteristics of Soil.
   6. ASTM D 1556, Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

7. ASTM D 2166, Test Method for Unconfined Compressive Strength Of Cohesive Soils.
8. ASTM D 2922, Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
9. ASTM D 4318, Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
10. AISC Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings.
11. OSHA Standard, Title 29, Code of Federal Regulations, Part 1926, Section .650 (Subpart P - Excavations).
12. Phoenix Building Code.
13. Uniform Standard Specifications for Public Work Construction by the Maricopa Association of Governments (MAG) as supplemented by the City of Phoenix, Section 206, Structure Excavation and Backfill, Section 604, Placement of Controlled Low Strength Material, Section 702, Base Materials, Section 725, Portland Cement Concrete, Section 728, Controlled Low Strength Material. Where there is a conflict between MAG Standard Specifications as supplemented by the City of Phoenix and this Specification, provisions of this Specification shall govern.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Excavation and Backfill Submittals:
      a. Excavation Plan: Prior to start of excavation operations, a written plan shall be submitted to demonstrate compliance with OSHA Standard 29 CFR Part 1926.650. As a minimum, excavation plan shall include:
         1) Name of competent person.
         2) Excavation method(s) or protective system(s) to be used.
         3) Copies of "manufacturer's data" or other tabulated data if protective system(s) are designed on the basis of such data.
      b. Excavation and backfill requirements detailing sheeting and bracing, or other protective system(s), dewatering systems, cofferdams, and underpinning.
      c. Shop Drawings shall be prepared by a Registered Professional Engineer, licensed in the State of Arizona, recognized as an expert in the specialty involved. Drawings shall be submitted to ENGINEER for record purposes only. Calculations shall not be submitted. Drawing submittals will not be checked and will not imply approval by ENGINEER of the Work involved. Sole responsibility for designing, installing, operating and maintaining whatever system is necessary to satisfactorily accomplish all necessary sheeting, bracing, protection, underpinning and dewatering belongs to CONTRACTOR.
      d. Samples of all materials, including select backfill, general backfill, crushed stone and sand shall be submitted to the ENGINEER and the

testing service. Samples of the proposed material shall be submitted at least 14 days in advance of its anticipated use.

2. Test Reports:
   a. Testing laboratory shall submit copies of the following reports directly to ENGINEER, with copy to CONTRACTOR:
      1) Tests on borrow material.
      2) Tests on footing subgrade.
      3) Field density tests.
      4) Optimum moisture - maximum density curve for each soil used for backfill.
      5) Tests of actual unconfined compressive strength or bearing tests of each strata.
      6) Reports of observations for conformance of borrow material to the Project Geotechnical Report.

1.4 JOB CONDITIONS

A. Subsurface Information: Refer to Section 00700, General Conditions, and Section 00800, Supplementary Conditions, for available data on subsurface conditions. The data is not intended as a representation or warranty of continuity of conditions between soil borings nor of groundwater levels at dates and times other than date and time when measured. OWNER will not be responsible for interpretations or conclusions by CONTRACTOR. Data is solely made available for the convenience of CONTRACTOR.
   1. Additional test borings and other exploratory operations may be made by CONTRACTOR, at no additional cost to OWNER.
   2. Refer to and comply with the requirements of Section 02220, Demolitions.

B. Existing Structures: The Drawings show certain surface and underground structures adjacent to the Work. This information has been obtained from existing records. It is not guaranteed to be correct or complete and is shown on the Drawings for the convenience of CONTRACTOR. Explore ahead of the required excavation to determine the exact location of all existing structures. Structures shall be supported and protected from damage by CONTRACTOR. If they are broken or damaged, restore them immediately, at no additional cost to the OWNER.

C. Existing Utilities: Locate existing underground utilities in the areas of the Work. If utilities are to remain in place, provide adequate means of protection during all operations.
   1. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult piping or utility owner and ENGINEER immediately for directions as to procedure. Cooperate with OWNER and utility owner in keeping services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.

2. In general, service lines to individual houses and businesses are not shown on the Drawings, however, assume that a service exists for each utility to each house or business.
3. Do not interrupt existing utilities serving facilities occupied and used by OWNER or others, except when permitted in writing by ENGINEER and then only after acceptable temporary utility services have been provided.
4. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.

D. Use of Explosives:
1. The use of explosives will not be permitted.
2. Do not bring explosives onto site or use in the Work without prior written permission from authorities having jurisdiction. Provide copy of authorization to ENGINEER. Sole responsibility for handling, storage, and use of explosive materials when their use is permitted belongs to CONTRACTOR.

E. Protection of Persons and Property: Barricade open excavations occurring as part of the Work and post with warning lights. Operate warning lights during hours from dusk to dawn each day and as otherwise required.
1. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

F. Dust Control: Conduct all operations meeting the requirements specified in Section 01414, Earthmoving and Dust Control.

G. Roadways and Walks: Unless otherwise approved by ENGINEER, excavated material and materials of construction shall be so deposited, and the Work shall be so conducted, as to leave open and free for pedestrian traffic all crosswalks, and for vehicular traffic a roadway not less than ten feet in width. All hydrants, valves, fire alarm boxes, letter boxes, and other facilities which may require access during construction shall be kept accessible for use. During the progress of the Work, maintain such crosswalks, sidewalks, and roadways in satisfactory condition and the Work shall at all times be so conducted as to cause a minimum of inconvenience to public travel, and to permit safe and convenient access to private and public property along the line of the Work.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Backfill and Fill Materials:
1. Materials acceptable for use as backfill against walls, foundations, underground ductbanks, and other structures shall be stockpiled native sandy clay or granular

soils obtained from on-site excavations and which are uniformly mixed, contain no organic matter, nor contain rocks or fragments greater than 4-inches in size, nor have greater than 40 percent passing the 200 sieve. The maximum expansion of on-site materials shall be 1.5 percent as performed on a sample remolded to approximately 95 percent of the maximum dry density as determined in accordance with ASTM D 698 at two percent below optimum moisture content under a 100 psf surcharge pressure.

2. Backfill and fill materials from off-site sources shall consist of silty or clayey sand soils which are uniformly mixed, contain no organic matter and which have a Plasticity Index less than ten. The maximum particle size of imported soils shall be 4-inches or less, if required to satisfy trenching, landscaping, or other requirements. The maximum expansion of off-site materials shall be 1.5 percent as performed on a sample remolded to approximately 95 percent of the maximum dry density as determined in accordance with ASTM D 698 at two percent below optimum moisture content under a 100 psf surcharge pressure.
3. All materials for use as backfill and fill material shall be tested by the laboratory and approved by the ENGINEER.
4. If on-site material is unsuitable as determined by the ENGINEER, select backfill or approved off-site fill shall be used.
5. Fill adjacent to structures is classified as backfill to a distance measured horizontally from the structure that is equal to the depth from the finished grade. Outside these limits the fill is classified as embankments, unless otherwise specified.

B. Select Backfill: Select Backfill for use beneath concrete slabs and asphaltic pavements shall be crushed aggregate conforming to the requirements below:

Sieve Sizes (Square Openings)	Percentage by Weight Passing Sieve
1-1/4-inch	100
No. 4	38 to 65
No. 8	25 to 60
No. 30	10 to 40
No. 200	3 to 12

C. Fill Material for Embankments:
1. Fill materials for use as embankments, and as miscellaneous landscaping materials exterior to plant facilities, shall consist of soils obtained from on-site excavations or off-site sources that are uniformly mixed, contain no organic material, rocks or fragments greater than 3-inches in size.
2. All materials for use as described above shall be tested by the laboratory and approved by the ENGINEER.

D. Drainage Fill: Washed, uniformly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1-1/2 inch sieve and not more than five percent passing a No. 4 sieve. Crushed stone or gravel shall be crushed rock or

gravel conforming to the requirements of Section 02318, Crushed Stone, Gravel, and Decomposed Granite.

E. General Backfill and Fill Materials: Provide approved soil materials for backfill and fill, free of clay, rock or gravel larger than 6-inches in any dimension, debris, waste, frozen materials, vegetable and other organic matter and other deleterious materials. Previously excavated materials meeting these requirements may be used for backfill.

PART 3 -EXECUTION

3.1 INSPECTION

A. Provide ENGINEER with sufficient notice and with means to examine the areas and conditions under which excavating, filling, and grading are to be performed. The CONTRACTOR to call for a final inspection by the ENGINEER of all components to be buried and comply with the inspection recommendations. ENGINEER will notify CONTRACTOR if conditions are found that may be detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3.2 SITE PREPARATION

A. Clear all areas to be occupied by permanent construction or embankments of all trees, brush, roots, stumps, logs, wood and other materials and debris. Clean and strip subgrades for fills and embankments of vegetation, sod, topsoil and organic matter. All waste materials shall be removed from site and properly disposed of by CONTRACTOR. Burning is not permitted. Refer to and comply with the requirements of Section 02230, Clearing.

3.3 TEST PITS

A. General:
   1. Excavate and backfill, in advance of the construction, test pits to determine conditions or location of the existing utilities and structures. Perform all Work required in connection with excavating, stockpiling, maintaining, sheeting, shoring, backfilling and replacing pavement for the test pits.
      a. Responsibility for the definite location of each existing facility involved within the area of his excavation for Work under this Contract belongs to CONTRACTOR. Care shall be exercised during such location work to avoid damaging and/or disrupting the affected facility. Responsibility for repairing, at his expense, damage to any structure, piping, or utility caused by his Work, belongs to CONTRACTOR.

B. No separate payment will be made for test pits shown on the Drawings.

C. Payment for test pits ordered by ENGINEER will be paid for under the unit price bid.

D. No separate payment will be made for test pits made by CONTRACTOR for his own use.

3.4 EXCAVATION

A. Perform all excavation required to complete the Work as shown on the Drawings, specified and required. Excavations shall include earth, sand, clay, gravel, hardpan, boulders not requiring drilling and blasting for removal, decomposed rock, pavements, rubbish, and all other materials within the excavation limits, except rock.

B. Excavations for structures and underground ductbanks shall be open excavations. Provide excavation protection system(s) required by ordinances, codes, law and regulations to prevent injury to workmen and to prevent damage to new and existing structures or pipelines. Unless shown on the Drawings or specified otherwise, protection system(s) shall be utilized under the following conditions.
   1. Excavation Less Than Five Feet Deep: Excavations in stable rock or in soil conditions where there is no potential for a cave-in may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded, or shored and braced.
   2. Excavations More Than Five Feet Deep: Excavations in stable rock where there is no potential for a cave-in may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded or shored and braced.
   3. Excavation protection system(s) shall be installed and maintained in accordance with drawings submitted under Article 1.3, above.

C. Where the structure or ductbank is to be placed below the ground water table, well points, cofferdams or other acceptable methods shall be used to permit construction of said structure under dry conditions. Dry conditions shall prevail until concrete has reached sufficient strength to withstand earth and hydrostatic loads. In addition, protect excavation from flooding until all walls and floor framing up to and including grade level floors are in place and backfilling has begun. Water level shall be maintained below top of backfill at all times.

D. Pumping of water from excavations shall be done in such a manner to prevent the carrying away of unsolidified concrete materials, and to prevent damage to the existing subgrade.

E. The elevation of the bottom of footings shown on the Drawings shall be considered as approximate only and ENGINEER may order such changes in dimensions and elevations as may be required to secure a satisfactory footing. All structure excavations shall be hand-trimmed to permit the placing of full widths, and lengths of footings on horizontal beds. Rounded and undercut edges will not be permitted.

F. When excavations are made below the required grades, without the written order of ENGINEER, they shall be backfilled with select backfill material, as directed by ENGINEER, at the expense of CONTRACTOR.

G. Excavations shall be extended sufficiently on each side of structures, footings, etc., to permit setting of forms, installation of shoring or bracing or the safe sloping of banks.

H. Subgrades for roadways and structures shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud, muck, and other soft or unsuitable materials; and shall remain firm and intact under all construction operations. Subgrades which are otherwise solid, but which become soft or mucky on top due to construction operations, shall be reinforced with select backfill material. The finished elevation of stabilized subgrades shall not be above subgrade elevations shown on the Drawings. Proof roll all subgrades prior to placing of select fill and general fill material.

I. Material Storage: Stockpile satisfactory excavated materials in approved areas, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.
   1. Locate and retain soil materials away from edge of excavations.
   2. Dispose of excess soil material and waste materials as specified hereinafter.
   3. Stockpiled excavated soils for use as subsequent fill shall be classified by laboratory as on-site granular or sandy clay soils. Use and placement of fill shall be performed as specified for each class.
   4. Excess soil from excavations shall be disposed of off-site. Disposal shall be in accordance with state and local regulatory requirements.

J. Where ENGINEER considers the existing material beneath the bedding material unsuitable, CONTRACTOR remove same and replace it with select backfill.

3.5 UNAUTHORIZED EXCAVATION

A. All excavation outside the lines and grades shown on the Drawings, and which is not approved by ENGINEER, together with the removal and disposal of the associated material shall be at CONTRACTOR'S expense. Unauthorized excavations shall be filled and compacted with select backfill by CONTRACTOR at his expense.

3.6 DRAINAGE, EROSION CONTROL AND DEWATERING

A. Erosion Control:
   1. In general, the construction procedures outlined herein shall be implemented to assure minimum damage to the environment during construction. Take any and all additional measures required to conform to the requirements of applicable codes and regulations, and the requirements specified in Section 01412, Stormwater Pollution Prevention Plan and Permit.

2. Whenever possible, access and temporary roads shall be located and constructed to avoid environmental damage. Provisions shall be made to regulate drainage, avoid erosion and minimize damage to vegetation.
3. Where areas must be cleared for storage of materials or temporary structures, provisions shall be made for regulating drainage and controlling erosion, subject to the ENGINEER'S approval.
4. Temporary measures shall be applied to control erosion and to minimize the silting of the existing waterways, and natural ponding areas. Such measures shall include, but are not limited to, the use of berms, baled straw silt barriers, gravel or crushed stone, mulch, slope drains and other methods. These temporary measures shall be applied to erodible materials exposed by any activities associated with the construction of this Work.
    a. Special care shall be taken to eliminate depressions that could serve as mosquito pools.
    b. Temporary measures shall be coordinated with the construction of permanent drainage facilities and other Work to the extent practicable to assure economical, effective, and continuous erosion and silt control.
    c. Provide special care in areas with steep slopes. Disturbance of vegetation shall be kept to a minimum to maintain stability.
5. Remove only those shrubs and grasses that must be removed for construction. Protect the remainder to preserve their erosion-control value.
6. Install erosion and sediment control practices where shown on the Drawings and according to applicable standards, codes and specifications. The practices shall be maintained in effective working condition during construction and until the drainage area has been permanently stabilized.
7. Mulching to be used for temporary stabilization.
    a. Suitable Materials for Mulching:
        1) Unrotted straw or salt hay: 1-1/2 to 2 tons/acre.
        2) Asphalt emulsion or cutback asphalt: 600 to 1200 gal. /acre.
        3) Wood-fiber or paper-fiber (hydroseeding): 1500 lbs./ acre.
        4) Mulch netting (paper, jute, excelsior, cotton or plastic).
    b. Straw or salt hay mulches should be immediately anchored using peg and twine netting or a mulch anchoring tool or liquid mulch binders.
8. After stabilization, remove all straw bale dikes, debris, etc., from the site.
9. In the event of any temporary Work stoppage, take steps any temporary or environmental damage to the area undergoing construction.
10. In the event CONTRACTOR repeatedly fails to satisfactorily control erosion and siltation, the OWNER reserves the right to employ outside assistance or to use its own forces to provide the corrective measures indicated. The cost of such work, plus engineering costs, will be deducted from monies due CONTRACTOR.
11. Prevent blowing and movement of dust from exposed soil surfaces and access roads to reduce on and off-site damage and health hazards. Control may be achieved by irrigation in which the site shall be sprinkled with water until the surface is moist. The process shall be repeated as needed.

B. Drainage and Dewatering:
   1. Provide and maintain adequate drainage and dewatering equipment to remove and dispose of all surface water and ground water entering excavations, or other parts of the Work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, therein is inspected by the ENGINEER and backfill operations have been completed and approved.
      a. The different working areas on the site shall be kept free of surface water at all times. Install drainage ditches and dikes and shall perform all pumping and other Work necessary to divert or remove rainfall and all other accumulations of surface water from the excavations and fill areas. The diversion and removal of surface water shall be performed in a manner that will prevent the accumulation of water behind temporary structures or at any other locations within the construction area where it may be detrimental.
      b. Water used for working or processing, resulting from dewatering operations, or containing oils or sediments that will reduce the quality of the water downstream of the point of discharge, shall not be directly discharged. Such waters shall be diverted through a settling basin or filter before being discharged.
      c. Responsibility belongs to CONTRACTOR for the condition of any pipe, conduit or channel used for drainage purposes and all such pipes, conduits or channels shall be left clean and free of sediment.
      d. Remove water from excavations as fast as it collects.
   2. Provide, install and operate sufficient trenches, sumps, pumps, hose, piping, well points, deep wells, etc., necessary to depress and maintain the ground water level below the base of the excavations during all stages of construction operations. The ground water table shall be lowered in advance of excavation, for a sufficient period of time so as to permit dewatering of fine grain soils, and maintained two feet below the lowest subgrade excavation made until the structure has sufficient strength and weight to withstand horizontal and vertical soil and water pressures from natural ground water. The system shall be operated on a 24-hour basis and standby pumping facilities and personnel shall be provided to maintain the continued effectiveness of the system. If, in the opinion of the ENGINEER, the water levels are not being lowered or maintained as required by these Specifications, install additional or alternate dewatering devices as necessary, at no additional cost to the OWNER.
      a. Elements of the system shall be located so as to allow a continuous dewatering operation without interfering with the construction of the permanent Work. Where portions of the dewatering system are located in the area of permanent construction, submit details of the methods he proposes to construct the permanent Work in this location for the approval of the ENGINEER. Controls of ground water shall continue until the permanent construction provides sufficient dead load to withstand the hydrostatic uplift of the normal ground water, until concrete has attained sufficient strength to withstand earth and hydrostatic loads, and until all

waterproofing Work has been completed. Dispose of all water removed from the excavation in such a manner so as not to endanger any portion of the Work under construction or completed. Convey water from the excavations in a closed conduit. Before discontinuing dewatering operations or permanently permitting the rise of the ground water level, computations shall be made to show that any structure affected by the water level rise is protected by backfill or other means to sustain uplift. Use a safety factor of 1.25 when making these computations.

b. Dewatering operations shall not be discontinued without the prior authorization of the ENGINEER.

c. Design of dewatering system, including both drawings and calculations, shall be performed by a Registered Professional Engineer in the State of Arizona and shall be employed by CONTRACTOR. Dewatering system shall be designed so as to avoid settlement or damage to existing structures and utilities.

C. Disposal of Water Removed by Dewatering System:

1. CONTRACTOR'S Dewatering System will discharge to from the existing wet well to the new lift station wet well, after new wet well has been tested and accepted, in accordance with State and Federal regulations.
2. Dispose of all water removed from the excavation in such a manner as not to endanger public health, property, or any portion of the Work under construction or completed.
3. Dispose of water in such a manner as to cause no inconvenience to OWNER, ENGINEER, or others involved in Work about the site.
4. Convey water from the construction site in a closed conduit. Do not use trench excavations as temporary drainage ditches.

3.7 SHEETING, SHORING AND BRACING FOR STRUCTURE EXCAVATIONS

A. General:

1. Used material shall be in good condition, not damaged or excessively pitted. All steel or wood sheeting designated to remain in place shall be new. New or used sheeting may be used for temporary work.
2. All timber used for breast boards (lagging) shall be new or used, meeting the requirements for Douglas Fir Dense Construction grade with a bending strength not less than 1500 psi or Southern Pine No. 2 Dense.
3. All steel work for sheeting, shoring, bracing, cofferdams etc., shall be designed in accordance with the provisions of the "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings", of the AISC except that field welding will be permitted.
4. Steel sheet piling shall be manufactured from steel conforming to ASTM A 328. Steel for soldier piles, wales and braces shall be new or used and shall conform to ASTM A 36.

5. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.
6. Unless otherwise shown on the Drawings, specified, or ordered, all materials used for temporary construction shall be removed when Work is completed. Such removal shall be made in a manner not injurious to the structure or its appearance or to adjacent Work.
7. Provide permanent steel sheet piling or pressure creosoted timber sheet piling wherever subsequent removal of sheet piling might permit lateral movement of soil under adjacent structures. Cut off tops as required, but at least three feet below grade, and leave permanently in place.
8. The clearances and types of the temporary structures, insofar as they affect the character of the finished Work, and the design of sheeting to be left in place, will be subject to the approval of ENGINEER; but responsibility for the adequacy of all sheeting, shoring, bracing, coffer-damming, etc., belongs to CONTRACTOR.
9. Safe and satisfactory sheeting, shoring and bracing shall be the entire responsibility of CONTRACTOR.
10. All municipal, County, State and Federal ordinances, codes, regulations and laws shall be observed.

B. Sheeting Left in Place:
1. Steel sheet piling shown on the Drawings to be left in place shall consist of rolled sections of the continuous interlocking type, unless otherwise approved. The type and design of the sheeting and bracing shall conform to the above specifications for all steel work for sheeting and bracing. Steel sheeting designated to be left in place shall be new.
2. Steel sheet piling to be left in place shall be driven straight to the lines and grades as shown on the Drawings or directed. The piles shall penetrate into firm materials with secure interlocking throughout the entire length of the pile. Damaged piling having faulty alignment shall be pulled and replaced by new piling.
3. The type of guide structure used and method of driving for steel sheet piling to be left in place shall be subject to the approval of ENGINEER. Jetting will not be permitted.
4. Cut off piling left in place to the grades shown on the Drawings or directed by ENGINEER and remove the cut offs from the site.
5. Clean wales, braces and all other items to be embedded in the permanent structure and ensure that the concrete surrounding the embedded element is sound and free from air pockets or harmful inclusions. Provisions shall include the cutting of holes in the webs and flanges of wale and bracing members, and the welding of steel diaphragm waterstops perpendicular to the centerline of brace ends which are to be embedded.
6. Subsequent to removal of the inside face forms, and when removal of bracing is permitted, cut back steel at least 2-inches inside the wall face and patch opening

with cement mortar. Concrete shall be thoroughly worked beneath wales and braces, around stiffeners and in any other place where voids may be formed.

7. Portions of sheeting or soldier piles and breast boards which are in contact with the foundation concrete shall be left in place, together with wales and bracing members which are cast into foundation or superstructure concrete.

C. Removal of Sheeting and Bracing:
   1. Remove sheeting and bracing from excavations, unless otherwise directed in writing by ENGINEER. Removal shall be done so as to not cause injury to the Work. Removal shall be equal on both sides of excavation to ensure no unequal loads on pipe or structure.
   2. Defer removal of sheeting and bracing, where removal may cause soil to come into contact with concrete, until the following conditions are satisfied:
      a. Concrete has cured a minimum of seven days.
      b. Wall and floor framing up to and including grade level floors are in place.

3.8 TRENCH SHIELDS

A. Excavation of earth material below the bottom of a shield shall not exceed the limits established by ordinances, codes, laws and regulations.

B. When using a shield for the installation of structures, the bottom of the shield shall not extend below the top of the bedding for the structures.

C. When a shield is removed extreme care shall be taken to prevent damage to the structures or the disturbance of the bedding for structures. Structures that are disturbed shall be removed and reinstalled as specified.

3.9 PLACEMENT OF FILL AND BACKFILL

A. General:
   1. All select backfill and backfill required for structures, embankments, and ductbanks and required to provide the finished grades shown on the Drawings and as described herein shall be furnished, placed and compacted by CONTRACTOR. Refer to and comply with the requirements of Section 02318, Crushed Stone, Gravel, and Decomposed Granite.
   2. Backfill excavations as promptly as Work permits, but not until completion of the following:
      a. Acceptance by the ENGINEER of construction below finish grade, including dampproofing, waterproofing and perimeter insulation.
      b. Inspection, testing, approval, and recording of locations of underground ductbanks.
      c. Removal of concrete formwork.
      d. Removal of shoring and bracing, and backfilling of voids with satisfactory materials.
      e. Removal of trash and debris.

3. Fill containing organic materials or other unacceptable material shall be removed and replaced with approved fill material as specified.

B. Placement of Select Backfill, Backfill and Fill:
1. Select backfill shall be placed to the grades shown on the Drawings. The lift thickness and compaction moisture content range given herein are approximate. These values shall be finally determined from the laboratory test results on the fill materials. Testing requirements shall be as specified in Paragraph 3.9.E., below.
2. All select backfill shall be placed in horizontal loose lifts, not exceeding 8-inches in thickness, and shall be mixed and spread in a manner assuring uniform lift thickness after placing. Each lift shall be compacted by not less than two complete coverages of the specified compactor. Select backfill shall be placed to the underside of all concrete slabs. The fill material shall extend a minimum of two feet outside the face of each structure and be 12-inches below finished grade on all structures. The maximum slope of select backfill to the subgrade shall be one vertical to one horizontal.
3. Backfill and fill around and outside of structures and over select backfill shall be deposited in layers not to exceed 8-inches in uncompacted thickness and mechanically compacted, using platform type tampers. Compaction of structures backfilled by rolling will be permitted provided the desired compaction is obtained and damage to the structure is prevented. Compaction of select backfill and/or backfill by inundation with water will not be permitted. All materials shall be deposited as specified herein and as shown on the Drawings.
4. The material shall be placed at a moisture content and density as specified under Paragraph 3.9.E., below. Provide equipment capable of adding measured amounts of water to the backfill and/or select backfill material to bring it to a condition within the range of the required moisture content. Provide equipment capable of discing, aerating, and mixing the soil to ensure reasonable uniformity of moisture content throughout the fill material and to reduce the moisture content of the borrow material by air drying, if necessary. If the subgrade or lift of earth material must be moisture conditioned before compaction, the fill material shall be sufficiently mixed or worked on the subgrade to ensure a uniform moisture content throughout the lift of material to be compacted. Materials at moisture content in excess of the specified limit shall be dried by aeration or stockpiled for drying.
5. No backfill or fill material shall be placed when free water is standing on the surface of the area where the fill is to be placed. No compaction of fill will be permitted with free water on any portion of the fill to be compacted. No fill shall be placed or compacted in a frozen condition or on top of frozen material. Any fill containing organic materials or other unacceptable material previously described shall be removed and replaced with approved fill material prior to compaction.
6. Compaction shall be performed with equipment suitable for the type of fill material being placed. Select equipment that is capable of providing the

minimum density required by these Specifications. Hand operated compacting equipment shall be used within a distance of ten feet from the wall of any completed below grade structure. Equipment shall be provided that is capable of compacting in restricted areas next to structures and around piping. The effectiveness of the equipment selected shall be tested at the commencement of compacted fill Work by construction of a small section of fill within the area where fill is to be placed. If tests on this section of fill show that the specified compaction is not obtained, increase the amount of coverages, decrease the lift thicknesses and/or obtain a different type of compactor.

7. Levels of backfill against concrete walls shall not differ by more than two feet on either side of walls, unless walls are adequately braced, or all floor framing is in place up to and including grade level slabs. Particular care shall be taken to compact structure backfill, which will be beneath pipes, roads, or other surface construction or structures. In addition, wherever a trench passes through structure backfill, the structure backfill shall be placed and compacted to an elevation 12-inches above the top of the pipe before the trench is excavated. Compacted areas, in each case, shall be adequate to support the item to be constructed or placed thereon.
8. The compaction requirements specified are predicated on the use of normal materials and compaction equipment. In order to establish criteria for the placement of a controlled fill so that it will have compressibility and strength characteristics compatible with the proposed structural loadings, a series of laboratory compaction and/or compressive strength tests shall be performed on the samples of materials submitted by CONTRACTOR. From the results of the laboratory tests, the final values of the required percent compaction, the acceptable compaction moisture content range, and the maximum permissible lift thickness will be established for the fill material and construction equipment proposed.
9. Control the water content of fill material during placement within the range necessary to obtain the compaction specified. In general, the moisture content of the fill shall be within three percent of the optimum moisture content for compaction as determined by laboratory tests. Perform all necessary work to adjust the water content of the material to within the range necessary to permit the compaction specified. Do not place fill material when free water is standing on the surface of the area where the fill is to be placed. No compaction of fill will be permitted with free water on any portion of the fill to be compacted.
10. Compact fill shall be compacted by at least two coverages of all portions of the surface of each lift by compaction equipment. One coverage is defined as the condition obtained when all portions of the surface of the fill material have been subjected to the direct contact of the compactor.
11. If the specified densities are not obtained because of improper control of placement or compaction procedures, or because of inadequate or improperly functioning compaction equipment, perform whatever Work is required to provide the required densities. This Work shall include complete removal of unacceptable fill areas, and replacement and recompaction until acceptable fill is provided.

12. If any settlement occurs, repairs will be at CONTRACTOR'S expense. Make all repairs and replacements necessary within 30 days after notice from ENGINEER or OWNER.
13. Special attention is required to assure compaction under all piping to spring line, if the compaction process is not satisfactory to the ENGINEER. The CONTRACTOR shall use half-sack slurry for backfill to spring line.

C. Backfill in Electrical Ductbank Trenches:
1. Compacted backfill shall be required for the full depth of the trench, below and above the electrical ductbank. Where the trench for one ductbank passes beneath the trench for another pipe or ductbank select backfill shall be placed to the level of the bottom of the upper trench.
2. Placement and compaction of backfill in electrical ductbank trenches shall conform to the requirements of Paragraph 3.9.B., above.

D. Crushed Stone Placement:
1. Crushed stone shall be placed where shown on the Drawings to the limits shown.
2. Crushed stone shall be place in hand tamped lifts, not to exceed 6-inches.

E. Compaction Density Requirements:
1. The degree of compaction required for all types of fills shall be as listed below. Material shall be moistened or aerated as necessary to provide the moisture content that will facilitate obtaining the specified compaction.

Material Thick.(in)	Required Minimum Density-Percent Compaction (ASTM D 698)	*Maximum Uncompacted Lift (inches)
Subgrade and Subbase Fill:		
Below concrete slabs on grade	95	8
Below base of footings or mats, structural slabs and tank floors	95	8
Below asphalt concrete paving	95	12
**Structural Backfill:		
More than 5 feet below final grade	100	8
Less than 5 feet below grade	95	8
Aggregate Base Course:		
Below concrete slabs or mats	95	8
Below asphalt paving	100	8
Trench Backfill, below and above ductbanks	95	12

* Where applicable.

** Structural backfill shall not be used for support of facilities which are susceptible to damage from differential settlement of the fill section relative to walls.

All fill must be wetted and thoroughly mixed to achieve optimum moisture content, ±three percent, with the following exceptions: On site clayey soils optimum to plus three percent.

Natural undisturbed soils or compacted soil subsequently disturbed or removed by construction operations shall be replaced with materials compacted as specified above.

2. CONTRACTOR'S testing service shall perform tests necessary to provide data for selection of fill material and control of placement water content.
3. Field density tests, to ensure that the specified density is being obtained, shall be performed by CONTRACTOR'S testing service during each day of compaction Work.
4. If the tests indicate unsatisfactory compaction, provide the additional compaction necessary to obtain the specified degree of compaction. All additional compaction Work shall be performed by CONTRACTOR, at no additional cost to the OWNER, until the specified compaction is obtained. This Work shall include complete removal of unacceptable (as determined by the ENGINEER) fill areas and replacement and recompaction until acceptable fill is provided.

F. Replacement of Unacceptable Excavated Materials: In cases where over-excavation for the replacement of unacceptable soil materials is required, the excavation shall be backfilled to the required subgrade with select backfill material and thoroughly compacted as specified in Paragraph 3.9.E., above. Sides of the excavation shall be sloped in accordance to the maximum inclinations specified for each structure location.

3.11 GRADING

A. General: Uniformly grade areas within limits of grading under this Section, including adjacent transition areas. Smooth subgrade surfaces within specified tolerances, compact with uniform levels or slopes between points where elevations are shown on the Drawings, or between such points and existing grades.

B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes, and as follows:
   1. Pavements: Shape surface of areas under pavement to line, grade and cross-section, with finish surface not more than 1/2-inch above or below the required subgrade elevation.

C. Grading Surface of Fill Under Building Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/2-inch when tested with a ten foot straightedge.

D. Compaction:
   1. After grading, compact subgrade surfaces to the depth and percentage of maximum density for each area classification.

3.12 PAVEMENT SUBBASE COURSE

A. General: Place subbase material, in layers of specified thickness, over ground surface to support pavement base course.
   1. Refer to Section 02742, Bituminous Paving, for paving Specifications.

B. Grade Control: During construction, maintain lines and grades including crown and cross-slope of subbase course.

C. Shoulders: Place shoulders along edges of base course to prevent lateral movement. Construct shoulders of acceptable soil materials, placed in such quantity to compact to thickness of each base course layer. Compact and roll at least a 12-inch width of shoulder simultaneously with compacting and rolling of each layer of base course.

D. Placing: Place base course material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting base material during placement operations.
   1. When a compacted base course is shown on the Drawings to be 6-inches thick or less, place material in a single layer. When shown on the Drawings to be more than 6-inches thick, place material in equal layers, except no single layer more than 6-inches or less than 3-inches in thickness when compacted.

3.13 DISPOSAL OF EXCAVATED MATERIALS

A. Material removed from the excavations which does not conform to the requirements for fill or is in excess of that required for backfill shall be hauled away from the project site by CONTRACTOR and disposed of in compliance with ordinances, codes, laws and regulations at no additional cost to the OWNER. Refer to and comply with the requirements of Section 02230, Clearing.

3.14 RESTORING AND RESURFACING EXISTING ROADWAYS AND FACILITIES

A. Place 1-1/2 inches of temporary bituminous pavement immediately after backfilling trenches in paved roadways which are to be retained for permanent use. Maintain the surface of the paved area over the trench in good and safe condition during progress of the entire Work, and promptly fill all depressions over and adjacent to the trench caused by settlement of backfilling. The permanent replacement pavement shall be equal to that of the existing roadways, unless otherwise specified.

B. Pavement, gutters, curbs, sidewalks or roadways disturbed or damaged by the CONTRACTOR'S operations, except areas designated "New Pavement" or "Proposed Pavement", shall be restored by CONTRACTOR at his own expense to as good condition as they were previous to the commencement of the Work and in accordance with applicable local and state highway specifications.

3.15 PRECONSOLIDATION

A. Where shown on the Drawings, preconsolidate soils prior to construction. These areas shall be brought up to finished grade a minimum of three months prior to the start of construction of the structures situated thereon. If any settlement occurs during this period, the settled area shall be promptly brought up to grade by the placement of additional fill.

B. After the topsoil has been stripped, settlement plates shall be placed where shown on the Drawings and specified.

C. Fill material to be placed over the preconsolidation areas and the method of placement shall be as specified under Article 3.10, above. Should removal of 6-inches of topsoil result in a subgrade elevation below the base slab of proposed structures, the remaining topsoil and other unacceptable material shall be removed until suitable subgrade materials are exposed. The subgrade shall then be brought up to the proposed base slab elevation with special compacted fill.

D. Settlement plates for the observation of subsoil consolidation under fill loads shall be installed at the locations and furnished in accordance with the details shown on the Drawings. Level the areas occupied by settlement plates so that the base of each plate will be at an elevation approximately equivalent to the average ground surface within a radius of five feet from the plate location. All small depressions in the ground surface at the plate location shall be filled with sand before seating the plate. The installed plate shall include the first five-foot pipe section tightly seated in the base coupling with the pipe marked at one foot intervals measured from the base of the plate. All marks on this and subsequent sections shall be painted with high visibility paint. The uppermost mark shall be permanently recorded by cutting a horizontal slot into the pipe with a hacksaw exactly five feet above the base of the plate. The installation of the settlement plate and its marking shall be approved by ENGINEER before placement of the 6-inch sand cover to anchor the plate as shown on the Drawings. Subsequent to approval, establish the elevation of the base of the plate by determining the elevation of the uppermost mark on the pipe section.

E. During the filling operations, add five foot sections of pipe to the settlement plate as required to maintain the top of the pipe above the fill surface at all times. When pipe sections are added, they shall be tightly joined and the additional section marked by painting at one foot intervals and including a hacksaw slot exactly five feet above the hacksaw slot made in the previous pipe section. The addition of all settlement plate

extensions shall be approved by the ENGINEER before fill placement resumes in the area.

F. Provide barricades around the settlement plate extensions to protect them from damage during construction. In the event that a plate is damaged by the construction operations, replace or repair it in a manner satisfactory to ENGINEER.

G. Measure and record the elevation of the settlement plate and the elevation of the fill surface at the plate location once each week after the plates are installed and submit these data to ENGINEER.

H. Do not start construction of structures situated on areas to be preconsolidated until sufficient settlement has occurred. The degree of settlement considered sufficient shall be determined by ENGINEER from readings of settlement plates.

I. In no case shall construction commence within three months of fill placement.

J. Prior to topsoiling and seeding, the filled area shall be cut back and graded to the proper subgrade, if necessary.

3.16 PIEZOMETERS

A. Prior to the start of excavation, install piezometer at locations shown on the Drawings.

B. Each piezometer shall consist of a 1/2-inch diameter pipe equipped with a well point screen in the bottom three feet, and placed in a five-foot length of sand packing at the bottom of a bore hole with a five foot long grout seal above the sand packing as follows: A boring to receive the piezometer shall be extended to the bedrock surface and cased for its entire length. After the boring is completed, clean wash water shall be circulated until the return water is clear of fines. The bottom foot of the bore hole shall be backfilled with clean concrete sand. The well point screen and a length of 1/2-inch diameter pipe, sufficient to reach from the top of the sand backfill to ground surface, shall be lowered to the previously placed sand with its well point screen end down and centered in the casing while the space surrounding the pipe is backfilled with additional clean concrete sand for a length of four feet above the tip of the well point. During all the backfilling operations, the casing shall be withdrawn in small increments so as to avoid disturbing the backfill but without exposing the sides of the hole above the backfill at any time. After tamping the sand backfill and while the 1/2-inch diameter pipe is centered in the casing a 4 to 3 to 1 mixture by volume of fine sand, cement and bentonite shall be poured around the pipe to fill a five foot length above the sand backfill. The casing shall be removed from this depth immediately after pouring the grout. The 1/2-inch diameter pipe shall be fitted with a threaded cap having a 1/8-inch diameter opening at the top. The elevation of the top of the pipe shall be determined by CONTRACTOR. Test fill each piezometer

after installation to determine by the response to filling that the device is operative. The test filling shall be repeated at regular intervals during the Work.

C. Each piezometer shall be accessible for reading at all stages of the Work. If necessary, the riser pipe may be shortened as excavation progresses; however, after each shortening the top of the pipe shall be rethreaded and the elevation of the top redetermined. Maintain the piezometers at least until the structure base is completed. However, do not remove a piezometer without approval of ENGINEER. Any piezometer which is damaged or destroyed or becomes inoperative shall be repaired or replaced at CONTRACTOR'S expense.

D. Record the water level in each piezometer and submit the data to ENGINEER at least once each day after the piezometers are installed.

3.17 TEMPORARY FENCING

A. Furnish and install a temporary fence surrounding his excavations and Work area, including the stockpile and storage areas. Fence shall have openings only at vehicular, equipment and worker access points.

B. Furnish and install a temporary screening fence as shown on the Drawings.

3.18 ENVIRONMENTAL PROTECTION AND RESTORATION

A. Refer to and comply with the requirements of Section 01412, Stormwater Pollution Prevention Plan and Permits.

+ + END OF SECTION + +

SECTION 02318

CRUSHED STONE, GRAVEL AND DECOMPOSED GRANITE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals required to furnish and install crushed stone, gravel and decomposed granite of the types specified at locations shown on the Drawings and as directed by the ENGINEER.

1.2 QUALITY ASSURANCE

A. Conform to all applicable requirements of Section 701 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Government (MAG) as supplemented by the City of Phoenix. Where there is a conflict between MAG Standard Specifications as supplemented by the City of Phoenix and these Specifications, the provisions of these Specifications shall govern.

B. Sampling and sieve analysis shall be performed in accordance with ASTM D 75 and ASTM C 136.

1.3 SUBMITTALS

A. Submit for approval the following:
   1. Furnish representative samples of the crushed stone and gravel to the ENGINEER and advise of the source location.
   2. Test reports, including sieve analyses, showing material compliance with specified requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
   1. Furnish and place crushed stone or screened gravel fill under pipe or structures where shown on the Drawings in addition to that required under other Sections. Comply with requirements of Section 15051, Buried Piping Installation.
   2. Crushed stone and gravel shall be clean, hard, sound, durable, uniform in quality, and free of any detrimental quantity of soft, friable, thin elongated, or laminated pieces, disintegrated material, organic matter, oil, alkali, or other deleterious substance.

3. The loss by abrasion in the Los Angeles abrasion machine, determine as prescribed in ASTM C 131, Grading A, shall not exceed ten percent, by weight, after 100 revolutions nor 40 percent after 500 revolutions.

B. Crushed Stone:
   1. Crushed stone shall consist of the product obtained by crushing rock, stone, or gravel so that at least 50 percent by weight of aggregate retained on the No. 4 sieve for 3/4-inch or larger maximum sizes, and 50 percent retained on the No. 8 sieve for maximum sizes less than 3/4-inch shall consist of particles which have at least one rough, angular surface produced by crushing.
   2. The gradation of crushed stone shall comply with ASTM D 448.

C. Gravel:
   1. Material designated herein as gravel shall be composed entirely of particles that are either fully or partially rounded and water worn.
   2. Crushed rock obtained by crushing rock which exceeds ASTM D 448 maximum gradation sizes may be combined provided it is uniformly distributed throughout and blended with the gravel. The quality and gradation requirements shall be as stated in this specification.

D. Decomposed Granite:
   1. Decomposed granite shall be ¾-inch minus, supplied form a single supply source, for a uniform appearance throughout the Project. It shall be free from lumps or balls of clay and shall not contain any calcareous coatings, caliches, organic matter of foreign substances.

PART 3 - EXECUTION

3.1 PLACING

A. Gravel shall be spread in layers of uniform thickness not exceeding 8-inches and shall be thoroughly compacted with suitable power-driven tampers or other power-driven equipment. The placing of crushed stone or gravel shall conform to applicable requirements of Section 02315, Structural Excavation and Backfill, except as noted above.

B. Prior to placing decomposed granite, all areas to receive it shall be sprayed with a pre-emergent herbicide according to the manufacturer's recommendations within Maricopa Association of Governments (civil) requirements. Do not spray herbicide on any areas designated to receive seeding. Decomposed granite shall be rolled uniformly for depth and compacted to all areas designated on the DRAWINGS to a minimum depth of 2 – inches.

+ + END OF SECTION + +

SECTION 02531

MANHOLES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install all precast and cast-in-place manholes.

B. General:
   1. Manholes shall conform in shape, size, dimensions, material, and other respects to the details shown on the Drawings or as directed by ENGINEER.
   2. Cast iron frames, grates and covers shall be the standard frame and grate or cover, unless otherwise shown on the Drawings, and shall be as specified in Section 05501, Miscellaneous Metal Fabrications, and Section 05561, Castings.
   3. Concrete for cast-in-place manholes and for inverts in precast and masonry manholes shall be Type "1" and shall conform to the requirements specified under Section 03300, Cast-In-Place Concrete.
   4. All manholes shall be precast construction, unless otherwise shown on the Drawings. All sanitary or process manholes carrying untreated wastewater shall be PVC lined or coated with Saueriesen or Sewer Shield 100.

1.2 QUALITY ASSURANCE

A. Standard Specifications and Details:
   1. Conform to all applicable requirements of Section 625 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG) as supplemented by the City of Phoenix. If there is a conflict between MAG Standard Specifications as supplemented by the City of Phoenix and these Specifications, the provision of these Specifications shall govern.

B. Reference Standards: Comply with the applicable provisions and recommendations of the following, unless otherwise shown or specified.
   1. ASTM C 139, Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes.
   2. ASTM C 140, Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
   3. ASTM C 207, Specification for Hydrated Lime for Masonry Purposes.
   4. ASTM C 478, Specification for Precast Reinforced Concrete Manhole Sections.

5. AWWA C 302, Reinforced Concrete Pressure Pipe, Noncylinder Type, for Water and Other Liquids.
6. MAG Section 625, as supplemented by the City of Phoenix.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Drawings showing design and construction details of all precast concrete and cast-in-place manholes, including details of joints between the manhole bases and riser sections and stubs or openings for connections.

PART 2 - PRODUCTS

2.1 PRECAST CONCRETE MANHOLES

A. Precast manholes shall conform to the details shown on the Drawings. Provide cast-in-place concrete bases where shown on the Drawings.

B. Except where otherwise specified, precast manhole components shall consist of reinforced concrete pipe sections especially designed for manhole construction and manufactured in accordance with ASTM C 478, except as modified herein.

C. Precast, reinforced concrete manhole bases, riser sections, flat slabs and other components shall be manufactured by wet cast methods only, using forms which will provide smooth surfaces free from irregularities, honeycombing or other imperfections.

D. Joints between manhole components shall be the tongue and groove type employing a single, continuous rubber O-ring gasket and shall conform to AWWA C 302. The circumferential and longitudinal steel reinforcement shall extend into the bell and spigot ends of the joint without breaking the continuity of the steel. Joints between the base sections, riser sections and top slabs of manholes 72-inches in diameter and less shall be rubber and concrete joints. Joints for manhole components greater than 72-inches in diameter shall be provided with steel bell and spigot rings.

E. All precast manhole components shall be of approved design and of sufficient strength to withstand the loads imposed upon them. They shall be designed for a minimum earth cover loading of 130 pounds per cubic foot, an H-20 wheel loading, and an allowance of 30 percent in roadways and 15 percent in rights-of-way for impact. Manhole bases shall have two cages of reinforcing steel in their walls, each of the area equal to that required in the riser sections. Wall thickness shall not be less than 5-inches. Concrete top slabs shall not be less than 8-inches thick.

F. Lifting holes, if used in manhole components, shall be tapered, and no more than two shall be cast in each section. Tapered, solid rubber plugs shall be furnished to seal

the lifting holes. The lifting holes shall be made to be sealed by plugs driven from the outside face of the section only.

G. The point of intersection (P.I.) of the sewer pipe centerlines shall be marked with 1/4-inch diameter steel pin firmly enclosed in the floor of each manhole base and protruding approximately 1-inch above the finished floor of the base.

H. Mark date of manufacture and name or trademark of manufacturer on inside of barrel.

I. The barrel of the manhole shall be constructed of various lengths of riser pipe manufactured in increments of one foot to provide the correct height with the fewest joints. Openings in the barrel of the manholes for sewers or drop connections will not be permitted closer than one foot from the nearest joint. Special manhole base or riser sections shall be furnished as necessary to meet this requirement.

J. A precast or cast-in-place slab or precast eccentric cone, as shown on the Drawings or approved by the ENGINEER, shall be provided at the top of the manhole barrel to receive the cast iron frame and cover.

K. No ladder or steps shall be installed / casted inside of a manhole.

2.2 MISCELLANEOUS METALS

A. Metal frames, covers, and similar required items shall be provided as shown on the Drawings and in accordance with Division 5, Metals.

2.3 DROP CONNECTIONS

A. Drop connections for manholes shall be constructed where shown on the Drawings or directed by the ENGINEER and shall conform to the design and details shown on the Drawings. Pipe and fittings shall be ductile iron or reinforced concrete, as shown on the Drawings or otherwise approved by the ENGINEER. Concrete for pipe encasement shall be Type "2" as specified under Section 03300, Cast-In-Place Concrete. Concrete shall be bonded to manhole in the manner shown on the Drawings or otherwise approved by ENGINEER.

PART 3 - EXECUTION

3.1 PLASTERING

A. The outside of grading rings shall be neatly plastered with 1/2-inch of cement mortar as the Work progresses.

3.2 MANHOLE BASES

A. Precast bases shall be set on a concrete or crushed stone foundation, as shown on the Drawings. Precast bases shall be set at the proper grade and carefully leveled and aligned.

3.3 PRECAST MANHOLE SECTIONS

A. Set sections vertical and in true alignment. The base of the bell or groove end at joints between components shall be buttered with 1:2 cement-sand mortar to provide a uniform bearing between components. All joints shall be sealed with cement mortar inside and out and troweled smooth to the contour of the wall surface. Raised or rough joint finishes will not be accepted.

B. Install sections, joints and gaskets in accordance with manufacturer's recommendations.

C. Lifting holes shall be sealed tight with a solid rubber plug driven into the hole from the outside of the barrel and the remaining void filled with 1 to 2 cement-sand mortar.

3.4 MANHOLE CHANNELS

A. All invert channels through manholes shall be constructed of Type “1” concrete. Channels shall be properly formed to the sizes, cross sections, grades, and shapes shown on the Drawings or as directed by the ENGINEER. Benches shall be built up to the heights shown on the Drawings or as directed by the ENGINEER and given a uniform wood float finish. Care shall be taken to slope all benches for proper drainage to the invert channel.

3.5 GRADING RINGS

A. Grading rings shall be used for all precast manholes, where required. Grade rings shall be a maximum of 12- inches in height, constructed on the roof slab or cone section on which the manhole frame and cover shall be placed. The height of the grade rings shall be such as is necessary to bring the manhole frame to the proper grade.

B. Each grading ring shall be laid in a full bed of mortar and shall be thoroughly bonded.

3.6 STUBS FOR FUTURE CONNECTIONS

A. As shown on the Drawings or required for connections, cast iron sleeves, ductile iron or reinforced concrete pipe stubs with approved watertight plugs shall be installed in manholes. Where pipe stubs, sleeves or couplings for future connections are shown

on the Drawings or directed by the ENGINEER, provide all materials and labor in order to complete the Work.

3.7 GRADING AT MANHOLES

A. All manholes in unpaved areas shall be built, as shown on the Drawings or directed by the ENGINEER, to an elevation higher than the original ground. The ground surface shall be graded to drain away from the manhole. Fill shall be placed around manholes to the level of the upper rim of the manhole frame, and the surface evenly graded on a 1 to 5 slope to the existing surrounding ground, unless otherwise shown on the Drawings or directed by the ENGINEER. The slope shall be covered with 4-inches of topsoil, seeded and maintained until a satisfactory growth of grass is obtained.

B. Manholes in paved areas and areas receiving gravel shall be constructed to meet the final surface grade as shown on the Drawings.

C. Sole responsibility for the proper height of all manholes necessary to reach the final grade at all locations belongs to CONTRACTOR. Caution: ENGINEER'S review of Shop Drawings for manhole components will be general in nature, provide an adequate supply of random length precast manhole riser sections to adjust any manhole to meet field conditions for final grading.

3.8 MANHOLE WATERTIGHTNESS

A. All manholes shall be free of visible leakage. Each manhole shall be tested for leaks and inspected, and all leaks shall be repaired in a manner subject to ENGINEER'S approval. Manhole testing shall conform with the requirements of Section 15051, Buried Piping Installation.

3.9 FLEXIBLE PIPE JOINT AT MANHOLE BASE

A. An approved flexible joint shall be provided between each pipe entering and exiting the manhole. This may be accomplished by the installation in the manhole base of the bell end of a pipe or by other means subject to approval of ENGINEER. Joints shall be similar to the approved pipe joints. The joint into the manhole base shall be completely watertight.

+ + END OF SECTION + +

SECTION 02742

BITUMINOUS PAVING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install hot mix hot-laid bituminous paving.
   2. The Work includes the following:
      a. Preparation of subgrade.
      b. Coarse graded base course.
      c. Fine graded surface course.
      d. Pavement marking.
      e. Testing as specified.

1.2 QUALITY ASSURANCE

A. Standard Specifications and Details:
   1. Conform to all applicable requirements of the Uniform Standard Specifications For Public Works Construction by the Maricopa Association of Governments (MAG) as supplemented by the City of Phoenix as follows:
      a. Section 321, Asphalt Concrete Pavement.
      b. Section 702, Base Materials.
      c. Section 703, Emulsified Asphalts.
      d. Section 710, Asphalt Concrete.
   2. If there is a conflict between the MAG Standard Specifications as supplemented by the City of Phoenix and these Specifications, the provisions of these Specifications shall govern.

   3. City of Phoenix, Streets and Traffic Department Standard Specifications.
      a. S.S.P-2 - Water-Bourne Traffic Binder Paint.

B. Reference Standards: Comply with the applicable provisions and recommendations of the following, unless otherwise shown or specified.
   1. ASTM C 117, Test Method for Materials Finer than No. 200 Sieve in Mineral Aggregates By Washing.
   2. ASTM C 136, Test Method for Sieve Analysis of Fine And Coarse Aggregates.
   3. ASTM D 698, Test Methods for Laboratory Compaction Characteristics of Soil using Standard Effort (12,400 ft-lbf/ft^3).
   4. MAG Standard Specifications, Section 321, as supplemented by the City of Phoenix.

5. MAG Standard Specifications, Section 702, as supplemented by the City of Phoenix.
6. MAG Standard Specifications, Section 710, as supplemented by the City of Phoenix.
7. Standard Specification S.S.P.-2, City of Phoenix Streets and Traffic Department.

C. Testing Services:
   1. General: Testing of materials and of compaction requirements for compliance with technical requirements of the Specifications shall be the duty of a testing laboratory provided by the OWNER, as described in Section 01451, Testing Laboratory Services Furnished by OWNER. Determination and testing of the proposed design mix for the hot-mix course shall be performed by a testing laboratory provided by CONTRACTOR, as described in Section 01452, Testing Laboratory Services Furnished by CONTRACTOR.
   2. Testing Services: The OWNER'S testing laboratory shall:
      a. Test CONTRACTOR'S proposed materials in the laboratory and field for compliance with the requirements of these Specifications.
      b. Perform field density tests to assure that the specified compaction of base course materials has been obtained.
      c. Report all test results to the ENGINEER and CONTRACTOR.
   3. Authority and Duties of OWNER'S Testing Laboratory: Technicians representing the testing laboratory shall inspect the materials in the field and perform compaction tests, and shall report their findings to the ENGINEER and CONTRACTOR. When the materials furnished or Work performed by the CONTRACTOR fails to fulfill Specifications requirements, the technician shall direct the attention of the ENGINEER and CONTRACTOR to such failure.
      a. The technician shall not act as foreman or perform other duties for CONTRACTOR. Work will be checked as it progresses, but failure to detect any defective Work or materials shall not in any way prevent later rejection when such defect is discovered, nor shall it obligate the ENGINEER for final acceptance. Technicians are not authorized to revoke, alter, relax, enlarge, or release any requirements of the Specifications, nor to approve or accept any portion of the Work.
   4. Responsibilities and Duties of CONTRACTOR: The use of testing services shall in no way relieve CONTRACTOR of his responsibility to furnish materials and construction in full compliance with the Contract Documents. To facilitate testing services:
      a. Secure and deliver to the ENGINEER and the testing laboratory representative samples of the materials he proposes to use and which are required to be tested.
      b. Furnish such casual labor as is necessary to obtain and handle samples at the project or at other sources of material.
      c. Advise the testing laboratory and ENGINEER sufficiently in advance of operations to allow for completion of quality tests and for the assignment of personnel.

D. Pre-Paving Meeting:
   1. Prior to the placement of Bituminous Paving, arrange a meeting at the job-site with the paver and its foreman, general CONTRACTOR and its foreman, ENGINEER and other representatives directly concerned with placement. Record the discussions of the conference and the decisions and agreements (or disagreements) and furnish a copy of the record to each party attending. Review foreseeable methods and procedures relating to the paving work, including but not necessarily limited to, the following:
      a. Review Project requirements, including Contract Documents, Project Schedule, approved Shop Drawings, pending and approved Change Orders and requests for information that may have been submitted by CONTRACTOR to ENGINEER.
      b. Review required samples, submittals, and documentation procedures.
      c. Review sub grade preparation
      d. Review availability of materials, tradesman, equipment and facilities needed to make progress, avoid delays and protect the Work from damaging conditions.
      e. Review required inspection, testing, certifying and quality control procedures.
      f. Review weather and forecasted weather conditions, and procedures for coping with unfavorable conditions.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. City of Phoenix Type A mix, giving complete data on materials, including source, location, percentages, temperatures and all other pertinent data.
   2. The submittal shall be reviewed by the ENGINEER and OWNER.

B. Material Certificates:
   1. In lieu of laboratory reports required in the State Standards, CONTRACTOR may submit certificates of compliance for the following:
      a. Coarse and fine aggregates from each material source and each required grading.
      b. Asphalt for each penetration grade.
      c. Job-mix design mixtures for each material or grade.
      d. Density of uncompacted bituminous concrete.
      e. Density of compacted bituminous concrete.
      f. Density and voids analysis for each series of bituminous concrete mixture test specimens.
      g. Bituminous concrete plant inspection.
   2. Certificates that materials, mixtures and plant comply with Specification requirements.
   3. Certificates signed by CONTRACTOR.

1.4 JOB CONDITIONS

A. Weather Limitations:
   1. For base paving 2-inches thick or greater, atmospheric temperature shall be 40°F and rising. For surface paving or pavement less than 2-inches thick, the surface temperature shall be 50°F or greater.
   2. No asphalt concrete shall be placed when the weather is foggy or rainy, or when the base on which the material is to be placed contains moisture in excess of the optimum. Asphalt concrete shall be placed only when the ENGINEER deter-mines that weather conditions are suitable.

B. Grade Control: Establish and maintain the required lines and grades, including crown and cross-slope for each course during construction operations.

PART 2 - PRODUCTS

2.1 PAVEMENT THICKNESS

A. Provide a minimum of 2-inch compacted premixed base course and minimum of 1.5-inch compacted surface course for a total compacted depth of 3.5)-inches or according to thickness detailed on the Drawings for pavement where shown on the Drawings.
B. All sides of the asphalt area shall be curbed flush with edge of asphalt, unless otherwise shown on the drawings, to retain the asphalt during placement and protect edges from damage by heavy equipment.

2.2 MATERIALS

A. Base Course:
   1. Base course material shall be a 1/2-inch hot mix asphalt concrete, consisting of a mixture of mineral aggregate and paving asphalt conforming to Section 710 of the MAG Standard Specifications. Gradation of the aggregate shall comply with the City of Phoenix Type A.
   2. The City of Phoenix Type A asphalt shall contain a minimum of 1.5 percent cement and 5.5 percent oil.

B. Surface Course:
   1. Surface course material shall be a 1/2-inch hot mix asphalt concrete, consisting of mineral aggregate and paving asphalt conforming to Section 710 of the MAG Specifications. Gradation of the aggregate shall comply with the City of Phoenix Type D.
   2. The City of Phoenix Type D asphalt shall contain a minimum of 1.5 percent cement and 5.5 percent oil.

C. Tack Coat: The tack coat shall be emulsified asphalt Type SS-1h according to MAG 329, unless directed otherwise by the ENGINEER.

2.3 TRAFFIC AND PARKING MARKING MATERIALS

A. Traffic and parking marking materials shall be a water-based paint conforming to the City of Phoenix Streets and Traffic Department Operations Division Specification S.S.P-2, Water-Bourne Traffic Binder Paint. Refer to paragraph 1.2.A.3.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the subgrade on which bituminous concrete will be installed. Notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

B. No materials shall be placed on subgrades, which are muddy or have water thereon.

3.2 CONSTRUCTION OF ROADWAYS

A. General:
   1. The pavement for bituminous-surfaced roads and parking areas shall consist of a 6-1/2-inch base course composed of aggregates and bituminous material, mixed hot in a central plant, and constructed on an aggregate base course prime coated with a rapid curing paving asphalt. A 1-1/2-inch surface course shall also be applied where shown on the Drawings.
   2. The roadways shall be constructed to the lines, grades, and typical sections shown on the Drawings.

B. Base and Surface Course:
   1. The base course mixture shall be transported to the site of paving and placed as soon as possible after mixing.
   2. The placement of the base course shall be completed over the full width of the section under construction on each day's run.
   3. Asphalt base and surface courses shall be spread and finished by means of self-propelled mechanical spreading and finishing equipment. The compacted thickness of layers placed shall not exceed 150 percent of the specified thickness except as approved, in writing, by the ENGINEER.
   4. Sufficient rolling equipment shall be furnished to satisfactorily compact and finish the amount of mixture being placed. However, there shall be a minimum of two rollers with two operators on the Project at all times. Upon direction of the ENGINEER, one of the rollers may be a pneumatic-tire roller. During rolling operations, the speed of the roller(s) shall not exceed three miles per hour. If ample number of rollers are not present, adjust the asphalt placement rate to accommodate the roller(s) speed. The type and required number of rollers shall be on the Project and in acceptable operating condition, prior to the placement of any asphalt material. All rollers shall be operated continuously

from the breakdown through finish rolling. CONTRACTOR may use vibratory rollers in lieu of the steel-wheeled roller, however when the thickness of the asphalt is 1-inch or less, all rolling will be done in the static mode.

5. When more than one width of asphalt concrete material will be placed, a 6-inch strip adjacent to the area on which future material is to be laid shall not be rolled until such material has been placed but shall not be left unrolled more than two hours after being placed, unless the 6-inch unrolled strip is first heated with a joint heater. After the first strip or width has been compacted, the second width shall be placed, finished and compacted as provided for the first width, except that rolling shall be extended to include the 6-inches of the first width not previously completed.
6. At any place not accessible to the roller, the mixture shall be thoroughly compacted with tampers and finished, where necessary, with a hot smoothing iron to provide a uniform and smooth layer over the entire area compacted in this manner.
7. Breakdown rolling shall begin as soon as the mixture will bear the roller without undue displacement. Rolling shall be longitudinal, overlapping on successive trips by at least 1/2 but not more than 3/4 the width of the rear wheels. Alternate trips of the roller shall be of slightly different lengths. The motion of the roller shall at all time be slow enough to avoid displacement of the mixture. Finish rolling shall be done by means of a steel-wheeled roller or a vibratory steel-wheel roller operating in the static mode.

C. Tack Coat:
1. A tack coat shall be applied to all existing and to each new course of bituminous surfaces prior to the placing of a succeeding layer of bituminous mixed material. The tack coat may be deleted when a succeeding layer of asphalt concrete is being applied over a freshly laid course that has been subjected to very little traffic when approved by the ENGINEER.
2. The same material that is specified above for the tack coat shall be applied to the vertical surfaces of existing pavements, curbs, and gutters, against which asphalt concrete is to be placed.
3. Tack coat shall be diluted in the proportion of 50 percent emulsion and applied at the rate of 0.05 to 0.10 gallons per square yard. Application shall be made in advance of subsequent construction as directed by the ENGINEER.
4. Tack coat shall be applied by pressure-type distributor trucks with insulated tanks. Hand spray by means of hose or bar through a gear pump or air tank shall be acceptable for resurface work, corners or tacking of vertical edges. Care shall be taken to provide uniform coverage. Equipment that performs unsatisfactory shall be removed from the job.

D. Construction Joints:
1. Construction joints shall be made in such a manner as to ensure a neat junction, thorough compaction and bond throughout.
2. A transverse joint extending over the full width of the strip being laid and at right angles to its centerline shall be constructed at the end of each day's work

and at any other times when the operations of placing the hot mixture are suspended for a period of time which will permit the mixture to chill. The forward end of a freshly laid strip shall be thoroughly compacted by rolling before the mixture has become chilled. When Work is resumed, the end shall be cut vertically for the full depth of the layer.

E. Joining of Pavements: When pavement is to join existing or previously laid pavement, the existing or previously laid pavement shall be neatly and carefully edged to allow for overlapping and feathering of the surface course material. A tack coat of bituminous prime coat material shall be placed at the interface of pavement and existing or previously laid pavement.

F. Curing: The pavement shall not be opened to traffic until directed by the ENGINEER. Construction traffic on the pavement shall be held to a minimum as allowed by the ENGINEER.

3.3 FRAME ADJUSTMENT

A. Set frames of drainage structures to final grade in an approved manner. Include existing frames and frames furnished under other Sections of these Specifications. Comply with requirements of Section 02771, Concrete Curbs, Gutters and Sidewalks.

3.4 PAVEMENT QUALITY REQUIREMENTS

A. General: In addition to other specified conditions, comply with the following minimum requirements:
   1. Provide final surfaces of uniform texture, conforming to required grades and cross sections.
   2. Take not less than one 4-inch diameter pavement specimen for each complete course for each 10,000 square feet of pavement, unless directed by ENGINEER.
   3. Repair holes from test specimens as specified for patching defective Work.

B. Density:
   1. If directed by ENGINEER, compare density of in-place material against laboratory specimen or certificates on same bituminous concrete mixture. Use nuclear devices.
   2. Minimum acceptable density of in-place course material shall be 90 percent of the recorded laboratory specimen or certificate density. Maximum acceptable density shall be 98 percent.

C. Thickness: In-place compacted thicknesses shall average not less than the thicknesses specified.

D. Surface Smoothness:

1. Test finished surface of each bituminous concrete course for smoothness, using a ten foot straightedge applied parallel to and at right angles to centerline of paved areas.
2. Check surfaced areas at intervals as directed by ENGINEER.
3. Surfaces will not be acceptable if exceeding the following:
   a. Base Course: 3/8-inch in ten feet.
   b. Surface Course: 1/4-inch in ten feet.
   c. Crowned Surfaces:
      1) Test crowned surfaces with a crown template, centered and at right angles to the crown.
      2) Surfaces will not be acceptable if varying more than 1/4-inch from the template.

3.5 PATCHING

A. As directed by ENGINEER, remove and replace all defective areas. Cut-out such areas and fill with fresh bituminous concrete. Compact to the required density.

3.6 CLEANING AND PROTECTION

A. Cleaning: After completion of paving operations, clean surfaces of excess or spilled bituminous materials and all foreign matter.

B. Protect newly finished pavement until it has become properly hardened by cooling.

C. Cover openings of drainage structures in the area of paving until permanent coverings are placed.

3.7 MARKING PAVEMENT

A. Cleaning:
   1. Sweep surface with power broom supplemented by hand brooms to remove loose material and dirt.
   2. Do not begin marking bituminous concrete pavement until approved by ENGINEER.

B. Application:
   1. Using mechanical equipment, provide uniform straight edges in two separate coats. Apply in accordance with paint manufacturer's recommended rates. Refer to paragraph 1.2.A.3.

CITY OF PHOENIX – 2002 APPROVED ASPHALT PLANTS AND MIX PRODUCT CODES

MIX / PLANTS	A-1 1/2" 4.3% W/C (High Volume)	A-1 1/2" 4.8% W/C (High Volume)	C-3/4" 5.0% W/C (High Volume)	C-3/4" 5.5% W/C (High Volume)	D-1/2" 5.1% W/C (High Volume)	D-1/2" 5.6% W/C (High Volume)
Vulcan (All Plants)	814325	814825	835025	835525	845125	845625
New West Val Vista #152	25AP152	25RP152	19AP152	19RP152	12AP152	12RP152
New West Sun City #302	25AP302	25RP302	19AP302	19RP302	12AP302	12RP302
New West Avondale #402	25AP402	25RP402	19AP402	19RP402	12AP402	12RP402
Mesa – East #1	732	741	535	544	431	438
Mesa – Sun #2	732	741	535	544	431	438
UM #10131 (01)	14301D	14801D	35001D	35501D	45101D	45601D
UM #10231 (02)	14302E	14801E	35001E	35501E	45101E	45601E
UM #11131 (11)	14301A	14801A	35004A	35504A	45103A	45601A
UM #11231 (12)	14302B	14801B	35003B	35504B	45101B	45602B
UM #14131 (41)	14301J	14801J	35002J	35504J	54101J	45601J

+ + END OF SECTION + +

SECTION 02981

DECORATIVE STONE LANDSCAPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals required to furnish and install decorative stone landscaping as shown on the Drawings and specified.
   2. The types of decorative stone landscaping Work required include the following:
      a. Decomposed granite.
      b. Pre-emergent herbicide.
   3. The extent of the decorative stone landscaping shall be as shown on the Drawings.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the decorative stone landscaping.

1.2 QUALITY ASSURANCE

A. Source Quality Control: Supply washed, screened, decomposed granite consisting of hard stone, free from coatings, obtained from a single source.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
   1. Selection of actual decorative stone available from the Supplier in individual, small polyethylene bags, for final selection by ENGINEER.
   2. Make available, for inspection and approval prior to placement of the material, a representative five-pound sample of the decorative stone selected by ENGINEER, from the approved supply source.

B. Shop Drawings: Submit for approval the name of intended decomposed granite source.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Decomposed Granite:
   1. Decomposed granite shall be of a size and color to match existing, supplied from a single supply source, for a uniform appearance throughout the Project. It

shall be free from lumps or balls of clay and shall not contain any calcareous coatings, caliche, organic matter, or foreign substances.

PART 3 - EXECUTION

3.1 GENERAL

A. Decomposed granite shall be placed upon completion of construction and upon ENGINEER'S approval of all fine grading, irrigation, and planting elements.

B. The areas to receive decomposed granite shall be relatively smooth. All rocks larger than 1-1/2-inches shall be removed and disposed of by CONTRACTOR.

C. Prior to placing decomposed granite, all areas to receive it shall be sprayed with a pre-emergent herbicide according to the manufacturer's recommendations. Do not spray herbicide on any areas designated to receive seeding.

3.2 CONTRACTOR'S INSPECTION

A. Examine the subgrade, verify the elevations, observe the conditions under which Work is to be performed, and notify the ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.3 PREPARATION

A. Outline areas to receive decorative stone landscaping and secure ENGINEER'S acceptance before start of Work. Make minor adjustments as may be requested by the ENGINEER.

3.4 PLACEMENT

A. Place decomposed granite to all areas designated on the Drawings to a minimum depth of 2-inches.

B. The top surface of the 2-inch decomposed granite layer shall be a minimum of 1-inches below any adjacent pavement or other elements.

C. After placing, all slope areas which have received decorative stone landscaping shall be watered down and rolled with a hand roller to assure adequate compaction of the material. A second application of pre-emergent herbicide shall be applied according to the manufacturer's recommendations.

3.5 MAINTENANCE

A. Repair all erosion channels that may form as directed by the ENGINEER until Final Completion.

B. Keep decorative stone landscaping free of any foreign material including, but not limited to, soil, debris and weeds, until Final Completion.

3.6 ENGINEER'S INSPECTION

A. When the decorative stone landscaping Work is completed, including maintenance, the ENGINEER will make an inspection to determine acceptability.

B. Where inspected decorative stone landscaping Work does not comply with the requirements, replace rejected Work and continue specified maintenance until reinspected by the ENGINEER and determined to be acceptable.

+ + END OF SECTION + +

SECTION 03100

CONCRETE FORMWORK

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install concrete formwork. The Work also includes:
      a. Providing openings in formwork to accommodate the Work under this and other Sections and building into the formwork all items such as sleeves, anchor bolts, inserts and all other items to be embedded in concrete for which placement is not specifically provided under other Sections.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the formwork.
   2. Coordinate formwork specifications herein with the requirements for finished surfaces specified in Section 03300, Cast-In-Place Concrete, and Section 03200, Concrete Reinforcement.

1.2 QUALITY ASSURANCE

A. Standard Specifications and Details:
   1. Conform to all applicable requirements of Section No. 505 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG) as supplemented by the City of Phoenix. Where there is conflict between MAG Standard Specifications as supplemented by the City of Phoenix and this Specification, provisions of this Specification shall govern.
   2. Examine the substratum and the conditions under which concrete formwork is to be performed, and notify the ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the ENGINEER.

B. Mock-Ups for Concrete Finishes: Provide formwork for mock-ups as required for finish work shown and specified for the Work. Place embedded materials in mock-up. Construct forms using facing materials such as form liners, where required, to provide specified finishes and to the requirements specified in Section 03300, Cast-In-Place Concrete. Obtain ENGINEER'S acceptance of each

mock-up prior to the start of formwork. Do not remove mock-up(s) until directed by ENGINEER.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified. Where conflicts may occur between the reference standards, the more restrictive provisions shall apply.
   1. ACI 117, Standard Tolerances for Concrete Construction and Materials.
   2. ACI 301, Standard Specifications for Structural Concrete.
   3. ACI 347, Guide for Concrete Formwork.
   4. ASTM C 805, Test Method for Rebound Number of Hardened Concrete.
   5. US Product Standard, PS-1-83 for Construction and Industrial Plywood.

D. Allowable Tolerances:
   1. Construct formwork to provide completed concrete surfaces complying with tolerances specified in ACI 347, Chapter 3.3, except as otherwise specified.
   2. Architectural Finish Formwork: Offset at panel joints: 1/8-inch.

E. Install all formwork and accessories for all facilities in accordance with manufacturers' instructions.

1.3 SUBMITTALS

A. Samples:
   1. Plywood form material used for smooth form finish, 4-inch square minimum.
   2. Form liner section large enough to show two full repeating patterns, but not less than 12-inches square.
   3. Controlled permeability formwork liner material, 8-inch square, minimum.
   4. Form Liner Sample Panel:
      a. Indicate texture and surface pattern, required backing, form tie treatment, and treatment at liner panel joints. Use form material to be used in the Work.
      b. Size: 3 feet by 4 feet (minimum).

B. Shop Drawings:
   1. Submit for approval the following:
      a. Fabrication and erection drawings of architecturally finished concrete surfaces as shown or specified. Show the general construction of forms including jointing, special formed joints or reveals, form liner installation, rustication, location and pattern of form tie placement, and other items which affect the finished concrete visually. ENGINEER'S review will be for general architectural applications and features only. Design of formwork for structural stability and sufficiency is CONTRACTOR'S responsibility.
      b. Taper tie installation, removal, and hole repair materials and procedures.
   2. Submit for information purposes the following:

a. Copies of manufacturer's data and installation instructions for proprietary materials, including form coatings, manufactured form systems, ties and accessories.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. On delivery to job site, place materials in area protected from weather, in accordance with manufacturers' recommendations.

B. Store materials above ground on framework or blocking. Cover wood for forms and other accessory materials with protective waterproof covering. Provide for adequate air circulation or ventilation. Store materials in accordance with the manufacturers' recommendations.

C. Handle materials to prevent damage in accordance with the manufacturers' recommendations.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Forms for Smooth Finish Concrete:
   1. Unless otherwise shown or specified, construct formwork for smooth concrete surfaces with plywood, metal, metal-framed plywood-faced, or other panel type materials acceptable to ENGINEER, to provide continuous, straight, smooth as-cast surfaces with no wood grain or other surface texture imparted by the formwork. Furnish in largest practical sizes to minimize number of joints and to conform to joint system shown or specified. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without bow or deflection.

B. Forms for Standard Finish Concrete:
   1. Form concrete surfaces designated to have a standard formed finish with plywood, lumber, metal, or other acceptable material. Provide lumber that is dressed on at least two edges and one side.

C. Forms for Architecturally Finished Concrete:
   1. Form finish concrete surfaces with units of face design, size, arrangement, and configuration as shown or as required to meet Project's job mock-up requirements. Provide solid backing and form supports to ensure stability of form liners.
   2. Form Material: Overlaid plywood, U.S. Products Standard PS-1-83 for Construction and Industrial Plywood. B-B high density overlaid concrete form, Class I.
   3. Form Liners: Rigid PVC or fiberglass in pattern shown.

4. Form Reuse: To be determined by ENGINEER at the time of installation.
5. Rustication Joints: Rigid PVC in profile shown.
6. Panel Joints: Conceal all joints behind rustication joints, unless approved by ENGINEER, in writing.

D. Cylindrical Columns and Supports:
1. Form round-section members with paper or fiber tubes, constructed of laminated plies using water-resistant type adhesive with wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist loads imposed by wet concrete without deformation.
   a. Provide manufacturer's seamless units to minimize spiral gaps or seams.
   b. Provide manufacturer's standard plastic-lined-interior units.
2. Fiberglass or steel forms may be used for cylindrical columns, if approved by ENGINEER.

E. Pan Forms:
1. Provide new forms for concrete pan-type construction complete with covers and end closures to form a true, clean, smooth concrete surface. Design units for easy removal without damaging placed concrete. Block adjoining pan units as required to avoid lateral deflection of formwork during concrete placement and vibration. Provide standard or tapered ends.
2. Exposed to view forms: Form joints are only acceptable in one-way joists at end caps and tapered end forms. Off set at form joints shall not exceed 1/8- inch.
3. Factory fabricate pan form units to required sizes and shapes, of one of the following materials:
   a. Steel: Minimum of 16 gage, free of dents, irregularities sag and rust. Use only new pan forms and reuse only once, if in satisfactory condition and approved by ENGINEER.
   b. Glass-Fiber Reinforced Plastic: Molded under pressure with matched dies, 0.11-inch minimum wall thickness.
   c. Asphalt-Impregnated Corrugated Material: Treated for moisture resistance with factory-applied polyethylene coating, and with top and side cover joints taped where concrete is exposed.

F. Form Ties:
1. Provide factory-fabricated, removable or snapoff metal form ties, designed to prevent form deflection, and to prevent spalling of concrete surfaces upon removal. Materials used for tying forms will be subject to approval of ENGINEER.
2. Unless otherwise shown, provide ties so that portion remaining within concrete after removal of exterior parts is at least 1.5-inch from the outer concrete surface. Unless otherwise shown, provide form ties that will leave a hole no larger than 1-inch diameter in the concrete surface.
3. Ties for exterior walls, below grade walls, and walls subject to hydrostatic pressure shall have waterstops.

4. All ties shall leave a uniform, circular hole when forms are removed.
5. Provide stainless steel form ties for planned exposed tie hole locations, where shown on the Drawings. When used, tiebreak back point shall be at least 1-inch from outer concrete surface.
6. Wire ties are not acceptable.

G. Form Coatings:
1. Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede the wetting of surfaces to be cured with water or curing compounds. For concrete surfaces, which will be in contact with potable water, the form coating shall be a mineral oil base coating.

H. Controlled Permeability Formwork (CPF) Liner:
1. Surface densification shall be provided for wall surfaces, where shown on the Drawings, through the use of a CPF liner material which wicks water and trapped air away from the form surface.
2. The CPF liner shall be a material such as Zemdrain MD2 as manufactured by E.I. DuPont, or equal. It shall have the following properties.
   a. Non-compressible under concrete pressure.
   b. Controlled pore size to permit drainage of excess water and air while retaining cement particles.
   c. Retains within its structure a minimum of 0.5 liters of water per square meter of material.
3. The CPF liner shall improve the performance of the characteristics of the concrete as follows:
   a. Surface hardness: In tests performed in accordance with ASTM C 805, the mean rebound number calculated for the CPF face shall exceed that of the control face (cast using standard formwork without CPF liner and the same concrete mix and placement procedures) by a minimum of five rebound units.
   b. The surface shall have a uniform texture and shall be free of minor surface defects from trapped air.

I. Void Forms
1. Void (carton) forms shall be made of corrugated fiberboard used to create a void space beneath grade beams and slabs on grade.
2. Void forms shall have moisture resistant treated paper faces, be laminated with waterproof adhesive, and shall be biodegradable. They shall have an interior fabrication of uniform braced cellular configuration and shall be capable of sustaining a minimum working load of 1000 psf for a minimum of ten days after concrete is placed.
3. Void forms shall be as manufactured by: Sheplers, SureVoid Products, or equal.

2.2 DESIGN OF FORMWORK

A. Design, erect, support, brace and maintain formwork so that it shall safely support vertical and lateral loads that might be applied, until such loads can be supported by the concrete structure. Carry vertical and lateral loads to ground by formwork system or in-place construction that has attained adequate strength for this purpose. Construct formwork so that concrete members and structures are of correct size, shape, alignment, elevation and position.

B. Design forms and falsework to include values of live load, dead load, weight of moving equipment operated on formwork, concrete mix, height of concrete drop, vibrator frequency, ambient temperature, foundation pressures, stresses, lateral stability, and other factors pertinent to safety of structure during construction.

C. Provide shores and struts with positive means of adjustment capable of taking up formwork settlement during concrete placing operations, using wedges or jacks or a combination thereof. Provide trussed supports when adequate foundations for shores and struts cannot be secured.

D. Support form facing materials by structural members spaced sufficiently close to prevent beyond tolerance deflection, in accordance with ACI 117. Fit forms placed in successive units for continuous surfaces to accurate alignment, free from irregularities and within allowable tolerances. For long span members without intermediate supports, provide camber in formwork as required for anticipated deflections resulting from weight and pressure of fresh concrete and construction loads.

E. Design formwork to be readily removable without impact, shock or damage to concrete surfaces and adjacent materials.

F. Provide formwork sufficiently tight to prevent leakage of cement paste during concrete placement. Solidly butt joints and provide backup material at joints as required to prevent leakage and fins.

G. Omit side forms of footings and place concrete directly against excavation only when formally requested by CONTRACTOR, in writing, and accepted by ENGINEER, in writing. When omission of forms is accepted, provide additional concrete required beyond the minimum design profiles and dimensions of the footings as detailed. No additional compensation will be made to CON-TRACTOR for additional concrete required.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and the conditions under which Work is to be performed and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 FORM CONSTRUCTION

A. Construct forms complying with the requirements of ACI 347; to the exact sizes, shapes, lines and dimensions shown; as required to obtain accurate alignment, location and grades; to tolerances specified; and to obtain level and plumb work in finish structures. Provide for openings, offsets, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required. Use selected materials to obtain required finishes. Finish shall be as determined by approved mock-up or sample panel, if specified.

B. Fabricate forms for easy removal without damaging concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where the slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and assure ease of removal.

C. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Brace temporary closures and set tightly to forms to prevent loss of cement paste. Locate temporary openings on forms in locations as inconspicuous as possible, consistent with requirements of the Work. Form intersecting planes of openings to provide true, clean-cut corners, with edge grain of plywood not exposed as form for concrete.

D. Falsework:
   1. Erect falsework and support, brace and maintain it to safely support vertical, lateral and asymmetrical loads applied until such loads can be supported by in-place concrete structures. Construct falsework so that adjustments can be made for take-up and settlement.
   2. Provide wedges, jacks or camber strips to facilitate vertical adjustments. Carefully inspect falsework and formwork during and after concrete placement operations to determine abnormal deflection or signs of failure; make necessary adjustments to produce finished Work of required dimensions.

E. Forms for Smooth Finish Concrete:

1. Do not use metal cover plates for patching holes or defects in forms.
2. Provide sharp, clean corners at intersecting planes, without visible edges or offsets. Back joints with extra studs or girts to maintain true, square intersections.
3. Use extra studs, walers and bracing to prevent bowing of forms between studs and to avoid bowed appearance in concrete. Do not use narrow strips of form material that will produce bow.
4. Assemble forms so they may be readily removed without damage to exposed concrete surfaces.
5. Form molding shapes, recesses, rustication joints and projections with smooth-finish materials, and install in forms with sealed joints to prevent displacement.

F. Corner Treatment:
1. Form exposed corners of beams, walls, foundations, bases and columns to produce smooth, solid, unbroken lines, except as otherwise shown. Exposed corners shall be chamfered.
2. Form chamfers with 3/4-inch by 3/4-inch strips, unless otherwise shown, accurately formed and surfaced to produce uniformly straight lines and tight edge joints. Use rigid PVC chamfers for all architecturally formed concrete. Extend terminal edges to required limit and miter chamfer strips at changes in direction.
3. Reentrant and unexposed corners may be formed either square or chamfered.

G. Joints:
1. Comply with the requirements of Section 03251, Concrete Joints, of these Specifications for treatment of joints. Locate as shown and specified.

H. Openings and Built-In Work:
1. Provide openings in concrete formwork shown or required by other Sections. Refer to Paragraph 1.1.B., above, for the requirements of coordination.
2. Accurately place and securely support items to be built into forms.

I. Sealing Formwork:
1. All formwork joints shall be tight fitting or otherwise sealed to prevent loss of cement paste.
2. All formwork, which rests against concrete surfaces, shall be provided with a compressible gasket material between the concrete and edge of form to fill any irregularities and create a tight seal.

J. Cleaning and Tightening:
1. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is to be placed. Retighten forms immediately after concrete placement, as required to eliminate cement paste leaks.

3.3 FORM COATINGS

A. Coat form contact surfaces with a non-staining form-coating compound before reinforcement is placed. Do not allow excess form coating material to accumulate in the forms or to come into contact with surfaces which will be bonded to fresh concrete. Apply in compliance with manufacturer's instructions.

B. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

C. For concrete surfaces that will be in contact with potable water, the form coating shall be a mineral oil base coating.

D. Do not use form coatings on form surfaces covered with CPF liner material.

3.4 INSTALLATION OF EMBEDDED ITEMS

A. Set and build into the formwork, anchorage devices and other embedded items, shown, specified or required by other Sections. Refer to Paragraph 1.1.B., above, for the requirements of coordination. Use necessary setting drawings, diagrams, instructions and directions.

B. Edge Forms and Screeds Strips for Slabs:
   1. Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in the finished slab surface. Provide and secure units to support screeds.

3.5 CONTROLLED PERMEABILITY FORMWORK LINER

A. Where shown on the Drawings, install controlled permeability formwork (CPF) liner material in accordance with manufacturer’s instructions so that it entirely and continuously covers the formwork surface.

B. Form release agent shall not be used on forms lined with CPF liner. Any residual traces of release agent on previously used forms shall be removed prior to placing the liner.

C. All joints and seams in the CPF liner shall be taped with materials recommended by the manufacturer. The CPF liner shall be attached to the form surface at intermediate spacing so as to prevent buckles and ripples in the liner material when warmed by the fresh concrete placement. Spacing of attachments shall not exceed 24-inches.

D. All form panel edges shall be taped around the corner with materials recommended by the manufacturer. The edges of penetrations through the form, including form tie holes, shall be taped or otherwise sealed.

E. The CPF liner shall be permitted to be reused once without removal from the forms. When reused, the liner material shall be washed, and all concrete or other foreign materials removed prior to reuse.

3.6 VOID FORMS

A. Install void forms where shown on the Drawings and to the thickness indicated in accordance with the manufacturer's recommendations.

B. Where void form is indicated, it shall be placed, to the grades and elevations shown, over an even, well compacted subgrade to form a continuous void space under the entire extent of the slab or grade beam.

C. For structural slab applications, 1/8-inch thick masonite or plywood sheet shall be placed over the void form. Void forms shall be placed in the largest pieces practical and shall be secured in place.

D. Properly surround and void around the upper portion of all drilled piers at the intersection of the slab, grade beam, or pier cap using a premanufactured, non-field cut sealed void form with a curved, radial, vertical edge adjacent to the drilled pier.

E. Void forms shall remain dry and undamaged prior to concrete placement. Damaged pieces shall be replaced prior to concrete placement. All joints and exposed ends shall be sealed to prevent leakage of concrete into the void space.

3.7 FIELD QUALITY CONTROL

A. Before concrete placement, check the formwork, including tolerances, lines, ties, tie cones, and form coatings. Make corrections and adjustments to ensure proper size and location of concrete members and stability of forming systems.

B. During concrete placement, check formwork and related supports to ensure that forms are not displaced, and that completed Work shall be within specified tolerances.

C. If CONTRACTOR finds that forms are unsatisfactory in any way, either before or during placing of concrete, placement of concrete shall be postponed or stopped until the defects have been corrected and reviewed by ENGINEER.

3.8 REMOVAL OF FORMS

A. Conform to the requirements of ACI 301, Section 2 and ACI 347, Chapter 3.7, except as specified below.

		Temperature (F)				
		Over 95°F	70°F-95°F	60°F-70°F	50°F-60°F	Below 50°F
a.	Walls	1 day	1 day	2 days	3 days	Do not remove
b.	Columns	2 days	1 day	3 days	4 days	forms until site-
c.	Beam Soffits	7 days	4 days	5 days	6 days	cured test cylinder
d.	Slabs 5 in. thick or less	7 days	5 days	6 days	7 days	develops 75% of 28-day strength.
e.	Slabs over 5 in. thick	7 days	6 days	7 days	7 days	

1. Removal of Forms and Supports: Continue curing in accordance with Section 03300, Cast-In-Place Concrete.

B. When high-early strength concrete is specified, a schedule for removal of forms will be developed in the field from the age/strength relationships established for the materials and proportions used by tests in accordance with ACI 301.

C. Form facing material shall remain in place a minimum of four days after concrete placement, unless otherwise approved by ENGINEER.

D. Results of suitable control tests of field-cured specimens may be used as evidence that the concrete has attained sufficient strength and that supporting forms and shoring may be removed prior to the periods indicated herein.

E. The time for removal of all forms will be subject to ENGINEER'S approval.

3.9 PERMANENT SHORES

A. Provide permanent shores as defined in ACI 347.

B. Reshores shall not be permitted.

3.10 RE-USE OF FORMS

A. Clean and repair surfaces of forms to be re-used in the Work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable. Apply new form coating compound material to concrete contact surfaces as specified for new formwork.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close all joints. Align and secure joints to avoid offsets. Do not use "patched" forms for exposed concrete surfaces. Form surfaces shall be subject to ENGINEER'S approval.

+ + END OF SECTION + +

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. Provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install concrete reinforcement.
2. The extent of concrete reinforcement is shown.
3. The Work includes fabrication and placement of reinforcement including bars, ties and supports, and welded wire fabric for concrete, encasements and fireproofing.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:

1. ASTM A82, Specification for Steel Wire, Plain, for Concrete Reinforcement.
2. ASTM A184, Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
3. ASTM A185, Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
4. ASTM A496, Specification for Steel Wire, Deformed, for Concrete Reinforcement.
5. ASTM A497, Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
6. ASTM A615, Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
7. ASTM A706, Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement.
8. ASTM A775, Specification for Epoxy-Coated Reinforcing Steel Bars.
9. ACI 315, Manual of Standard Practice for Detailing Reinforced Concrete Structures.
10. ACI 318, Building Code Requirements for Structural Concrete.
11. ACI SP66, Detailing Manual.
12. ANSI/AWS D1.4, Structural Welding Code - Reinforcing Steel.
13. CRSI 1MSP, Concrete Reinforcing Steel Institute (CRSI) Manual of Standard Practice.

B. Allowable Placing Tolerances: Comply with ACI 318, Chapter 7 - Details of Reinforcement except as specified below:
   1. Concrete surfaces which are in contact with liquids: 2-inches minimum coverage.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's specifications and installation instructions for all materials and reinforcement accessories. Comply with the requirements of Section 01332, Shop Drawing Procedures.
   2. Drawings for fabrication, bending, and placement of concrete reinforcement. Comply with ACI 315, Parts A and B. For walls, show elevations to a minimum scale of 1/4-inch to one foot. For slabs, show top and bottom reinforcing on separate plan views. Show bar schedules, stirrup spacing, diagrams of bent bars, arrangements and assemblies, as required for the fabrication and placement of concrete reinforcement unless otherwise noted. Splices shall be kept to a minimum. Splices in regions of maximum tension stresses shall be avoided whenever possible.
   3. Drawings detailing the location of all construction and expansion joints as required under Section 03251, Concrete Joints, shall be submitted and approved before Shop Drawings for reinforcing steel are submitted.
   4. Description of reinforcing weld locations and weld procedures.

B. Certificates:
   1. Submit one copy of steel producer's certificates of mill analysis, tensile and bend tests for reinforcing steel.
   2. Submit certification of welders and weld procedures for splices in accordance with ANSI/AWS D1.4 requirements.

1.4 DELIVERY, HANDLING AND STORAGE

A. Deliver concrete reinforcement materials to the site bundled, tagged and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings shown on placement diagrams. Comply with the requirements of Section 01651, Transportation and Handling of Materials and Equipment.

B. Store concrete reinforcement material at the site to prevent damage and accumulation of dirt or excessive rust. Store on heavy wood blocking so that no part of it will come in contact with the ground. Comply with the requirements of 01661, Storage of Materials and Equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Reinforcing Bars: ASTM A 615, and as follows:
   1. Provide Grade 60 for all bars, unless indicated otherwise.
   2. At beams and columns forming frames and wall boundary elements, where indicated on the Drawings, provide ASTM A 706 or ASTM A 615, Grade 60, with a maximum yield stress of 78,000 psi.

B. Mechanical Couplers: Reinforcement bars may be spliced with a mechanical connection. This connection shall be a full mechanical connection which shall develop in tension or compression, as required, at least 125 percent of specified yield strength (fy) of the bar in accordance with ACI 318.

C. Steel Wire: ASTM A 82.

D. Welded Smooth Wire Fabric: ASTM A 185.
   1. Furnish in flat sheets, not rolls.

E. Supports for Reinforcement: Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcement in place.
   1. Use wire bar type supports complying with CRSI “Manual of Standard Practice” recommendations, except as specified below. Do not use wood, brick, or other unacceptable materials.
   2. For slabs on grade, use precast concrete blocks, 4-inch square in plan, with embedded tie wire as specified by CRSI, “Manual of Standard Practice”. The precast concrete blocks shall have the same or higher compressive strength as specified for the concrete in which they are located.
   3. For all concrete surfaces, where legs of supports are in contact with forms, provide supports complying with CRSI "Manual of Standard Practice" as follows:
      a. At formed surfaces in contact with soil, weather, or liquid or located above liquid, supports shall be CRSI Class 1 for maximum protection. The plastic coating on the legs shall extend at least 1/2-inch upward from the form surface.
      b. At interior dry surfaces (not located above liquid), supports shall be either Class 1 or Class 2 for moderate protection.
      c. At formed surfaces with an architectural finish, use stainless steel protected legs (Type B).
   4. Over waterproof membranes, use precast concrete chairs.

F. Drilled Dowels
   1. Adhesive material for drilled dowels shall be a vinylester resin, epoxy resin, urethane methacrylate, or vinyl urethane resin. Polyester resin shall not be used. The resin shall be a high modulus, moisture insensitive type. The resin shall be

packaged in a cartridge type dispensing system with a mixing nozzle. The resin shall be formulated to maintain its bond and integrity under continuous submergence by water. The adhesive anchoring systems shall have an ultimate capacity in excess of 125 percent of the yield strength of the reinforcing steel at an embedment of 12 bar diameters.

2. Adhesive systems shall be:
   a. HIT HY150, manufactured by Hilti Corporation.
   b. HSE 2411, manufactured by Hilti Corporation.
   c. Epcon System Ceramic 6, manufactured by ITW Ramset/Redhead.
   d. Powerfast, manufactured by Powers/Rawl Fastening System.
   e. Or equal.

2.2 FABRICATION

A. General: Fabricate reinforcing bars to conform to required shapes and dimensions, with fabrication tolerances complying with CRSI, "Manual of Standard Practice". In case of fabricating errors, do not re-bend or straighten reinforcement in a manner that will injure or weaken the material.

B. Unacceptable Materials: Reinforcement with any of the following defects will not be permitted in the Work:
   1. Bar lengths, bends, and other dimensions exceeding specified fabrication tolerances.
   2. Bends or kinks not shown on approved Shop Drawings.
   3. Bars with reduced cross-section due to excessive rusting or other cause.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and the conditions under which concrete reinforcement is to be placed, and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. Comply with the applicable recommendations of specified codes and standards, and CRSI, "Manual of Standard Practice", for details and methods of reinforcement placement and supports.

B. Clean reinforcement to remove loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete.

C. Position, support, and secure reinforcement against displacement during formwork construction or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers, as required.
   1. Place reinforcement to obtain the minimum concrete coverages as shown and as specified in ACI 318. Arrange, space, and securely tie bars and bar supports together with 16 gage wire to hold reinforcement accurately in position during concrete placement operations. Set wire ties so that twisted ends are directed away from exposed concrete surfaces.
   2. Prior to placement of concrete, demonstrate to ENGINEER that the specified cover of reinforcement has been attained, by using a surveying level or string line.
   3. Reinforcing steel shall not be secured to forms with wire, nails or other ferrous metal. Metal supports subject to corrosion shall not touch formed or exposed concrete surfaces.

D. Install welded wire fabric in as long lengths as practical. Lap adjoining pieces at least one full mesh and lace splices with 16-gage wire. Do not make end laps midway between supporting beams, or directly over beams of continuous structures. Offset end laps in adjacent widths to prevent continuous laps.

E. Provide sufficient numbers of supports of strength required to carry reinforcement. Do not place reinforcing bars more than 2-inches beyond the last leg of any continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

F. Lap Splices:
   1. Provide standard reinforcement splices by lapping ends, placing bars in contact, and tying tightly with wire. Comply with requirements shown for minimum lap of spliced bars.

G. Mechanical Couplers:
   1. Mechanical butt splices shall be in accordance with the recommendation of the manufacturer of the mechanical splicing device. Butt splices shall develop 125 percent of the specified minimum yield tensile strength of the spliced bars or of the smaller bar in transition splices. Bars shall be flame dried before butt splicing. Adequate jigs and clamps or other devices shall be provided to support, align, and hold the longitudinal centerline of the bars to be butt spliced in a straight line.

H. Welded Splices
   1. When permitted by the ENGINEER, in writing, all welding of reinforcing bars shall conform to ANSI/AWS D1.4. Preheating and rate of cooling requirements shall be based on bar steel chemistry and ANSI/AWS D1.4 requirements. Welded splices shall be sized and constructed to transfer a minimum of 125 percent of the specified minimum yield tensile strength of the spliced bars or of the smaller bar in transition splices. Unless otherwise permitted by the

Engineer, welding of crossing bars (tack welding) for assembly of reinforcement is prohibited.

2. Welding of wire to wire, and of wire or welded wire fabric to reinforcing bars or structural steels, shall conform to applicable provisions of ANSI/AWS D1.4 and any supplementary requirements by the ENGINEER for the particular application.
3. After completion of welding on coated reinforcing bars, coating damage shall be repaired as specified herein. All welds and all steel splice members when used to splice bars shall be coated with the same material used for repair of coating damage.

I. Drilled Dowels
1. Drilled dowels shall be reinforcing dowels set in a resin adhesive in a hole drilled into hardened concrete.
2. Holes shall be drilled to the adhesive anchor system to the manufacturer's recommended diameter and depth to develop the required pullout resistance but shall not be greater in diameter than 1/4-inch more than the nominal bar diameter nor less than 12 times the nominal bar diameter in depth.
3. The hole shall be drilled by methods which do not interfere with the proper bonding of the resin. Only masonry type drill bits shall be used.
4. Existing reinforcing steel in the vicinity of proposed holes shall be located prior to drilling. The location of holes to be drilled shall be adjusted to avoid drilling through or nicking any existing reinforcing bars only after approval by the ENGINEER.
5. The hole shall be brushed (non-metallic bristle brush only) and blown clean with clean, dry compressed air to remove all dust and loose particles.
6. Resin shall be injected into the hole through the injection system-mixing nozzle (and any necessary extension tubes) placed to the bottom of the hole. The discharge end shall be withdrawn as resin is placed but kept immersed to prevent formation of air pockets. The hole shall be filled to a depth that ensures that excess material is expelled from the hole during dowel placement.
7. Dowels shall be twisted during insertion into the partially filled hole so as to guarantee full wetting of the bar surface with resin. The bar shall be inserted slowly enough to avoid developing air pockets.

3.3 INSPECTION OF REINFORCEMENT

A. Concrete shall not be placed until the reinforcing steel is inspected and permission for placing concrete is granted by ENGINEER. All concrete placed in violation of this provision will be rejected.

B. Formwork for walls and other vertical members will not be closed up until the reinforcing steel is inspected and permission for placing concrete is granted by ENGINEER. All concrete placed in violation of this provision will be rejected.

C. Testing of Drilled Dowels: Employ a testing agency to perform field quality control testing of the drilled dowel installation. After completion of the manufacturer's recommended curing period and prior to placement of connecting reinforcing, ten percent of drilled dowels installed shall be proof tested for pullout. The drilled dowels shall be tensioned to 60 percent of the specified yield strength. Where dowels are located less than six bar diameters from the edge of concrete, the ENGINEER will determine the tensile load required for the test. If any dowels fail, all installed dowels shall be tested. Dowels that fail shall be reinstalled and retested at CONTRACTOR'S expense.

D. Inspection of Welded Splices: Employ a testing agency to perform field quality control testing of the welded splices. All welded splices shall be visually inspected. A minimum of five percent of butt splice welds shall be radiographically tested. Any weld which is deficient in any way shall be repaired to be completely sound at the CONTRACTOR'S expense.

+ + END OF SECTION + +

SECTION 03251

CONCRETE JOINTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete joints.
   2. The types of concrete joints required include the following:
      a. Construction joints.
      b. Expansion joints.
      c. Control joints.
      d. Isolation joints.
      e. Waterstops.

B. General: All joints subject to hydrostatic pressure or in contact with soil, except non-water bearing slabs-on-grade, shall be provided with continuous waterstop.

1.2 QUALITY ASSURANCE

A. Standard Specifications Details:
   1. Conform all applicable requirements of Sections No. 505 and 729 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG) as supplemented by the City of Phoenix. Where there is a conflict between MAG Standard Specifications as supplemented by the City of Phoenix and this Specification, provisions of this Specification shall govern.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
   1. ACI 301, Standard Specifications for Structural Concrete.
   2. ASTM C 920, Standard Specification for Elastomeric Joint Sealants.
   3. ASTM D 412, Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension.
   4. ASTM D 624, Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
   5. ASTM D 1752, Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
   6. ASTM D 2240, Test Method for Rubber Property – Durometer Hardness.
   7. CRD-C572, U.S. Army Corps of Engineers Specifications for Polyvinyl- Chloride Waterstop.

C. All manufactured items shall be installed in accordance with manufacturer's instructions.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's specifications and installation instructions for all materials required.
   2. Layout of all construction and expansion joint locations prior to the submittal of steel reinforcement Shop Drawings. Comply with the requirements of Section 01332, Shop Drawing Procedures.

B. Samples: Submit for approval the following:
   1. Polyvinyl chloride waterstops for joints for each cross-section type used.
   2. Foam rubber and cork expansion joint fillers.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All materials used for joints in concrete shall be stored on platforms or in enclosures and covered to prevent contact with the ground and exposure to the weather and direct sunlight. Storage and handling requirements of the manufacturer shall also be followed.

PART 2 - PRODUCTS

2.1 WATERSTOPS

A. Polyvinyl Chloride:
   1. Material Requirements:
      a. Waterstops shall be extruded from an elastomeric polyvinyl chloride compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the requirements of these Specifications and the requirements of CRD-C572. No reclaimed or scrap material shall be used.
      b. Tensile strength of finished waterstop: 1400 psi, minimum.
      c. Ultimate elongation of finished waterstop: 280 percent, minimum.
      d. Minimum thickness shall be 3/8-inch.
      e. Waterstops shall be provided with a minimum of seven ribs equally spaced at each end on each side. The first rib shall be at the edge. Ribs shall be a minimum of 1/8-inch in height.
   2. Construction Joints: Waterstops shall be flatstrip ribbed type and 6-inches minimum in width, unless shown otherwise.
   3. Expansion Joints: Waterstops shall be centerbulb ribbed type and 9-inches minimum in width, unless shown otherwise. The centerbulb shall have a minimum outside diameter of 7/8-inch.
   4. Product and Manufacturer: Provide one of the following:
      a. W.R. Meadows, Incorporated.
      b. A.C. Horn, Incorporated.
      c. Greenstreak Plastic Products Company

d. Water Seals, Inc.
e. Paul Murphy Plastics Company.
f. Or equal.

2.2 HYDROPHILIC WATERSTOP MATERIALS

A. General Material Properties
1. Hydrophilic waterstop materials shall be bentonite-free and shall expand by a minimum of 80 percent of dry volume in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast. Provide only where indicated in the Contract Documents.
2. The material shall be composed of resins and polymers which absorb water and cause an increase in volume in a completely reversible and repeatable process. The waterstop material shall be dimensionally stable after repeated wet-dry cycles with no deterioration of swelling potential.
3. Select materials which are recommended by the manufacturer for the type of liquid to be contained.

B. Hydrophilic Rubber Waterstop
1. The minimum cross-sectional dimensions shall be 3/16-inch by 3/4-inch.
2. Product and Manufacturer: Provide one of the following:
a. Duroseal Gasket, by BBZ USA, Inc.
b. Adeka Ultraseal MC-2010M, by Asahi Denka Kogyo K.K.
c. Or equal.

C. Hydrophilic Sealant:
1. The hydrophilic sealant shall adhere firmly to concrete, metal, and PVC in dry or damp condition. When cured it shall be elastic indefinitely.
2. Product and Manufacturer: Provide one of the following:
a. Duroseal Paste, by BBZ USA, Inc.
b. Adeka Ultraseal P-201, by Asahi Denka Kogyo K.K.
c. SikaSwell S, by Sika Corporation.
d. Or equal.

D. Hydrophilic Injection Resin
1. Hydrophilic injection resin shall be acrylate-ester based. The viscosity shall be less than 50 cps. The resin shall be water soluble in its uncured state, solvent free, and non-water reactive. In the cured state it shall form a solid hydrophilic flexible material which is resistant to permanent water pressure and shall not attack bitumen, joint sealants, or concrete.
2. Product and Manufacturer: Provide one of the following:
a. Duroseal Inject 1K/2K, by BBZ USA, Inc.
b. Sika Injection 29, by Sika Corporation.
c. Or equal.

2.3 PREFORMED EXPANSION JOINT FILLER

A. Provide preformed expansion joint filler complying with ASTM D 1752, Type I (sponge rubber) or Type II (cork).

2.4 CONCRETE CONSTRUCTION JOINT ROUGHENER

A. Provide a water-soluble non-flammable, surface-retardant roughener.

B. Product and Manufacturer: Provide one of the following:
   1. Rugasol-S, as manufactured by Sika Corporation for horizontal joints only.
   2. Concrete Surface Retarder-Formula S, as manufactured by Euclid Chemical Company, for horizontal joints only.
   3. Concrete Surface Retarder-Formula F, as manufactured by Euclid Chemical Company, for vertical joints only.
   4. Or equal.

2.5 EPOXY BONDING AGENT

A. Provide a two-component epoxy-resin bonding agent.

B. Product and Manufacturer: Provide one of the following:
   1. Sikadur 32 Hi-Mod LPL, as manufactured by Sika Corporation.
   2. Eucopoxy LPL, as manufactured by the Euclid Chemical Company.
   3. Or equal.

2.6 EPOXY-CEMENT BONDING AGENT

A. Provide a three-component epoxy resin-cement blended formulated as a bonding agent.

B. Product and Manufacturer: Provide one of the following:
   1. Sika Armatec 110 EpoCem, as manufactured by Sika Corporation.
   2. Corr-Bond, as manufactured by the Euclid Chemical Company.
   3. Or equal.

2.7 RUBBER BONDING AGENT

A. Product and Manufacturer: Provide one of the following:
   1. Scotch-Grip 1300 Rubber Adhesive, as manufactured by 3M Company.
   2. Or equal.

2.8 NEOPRENE BEARING PADS

A. Product and Manufacturer: Provide one of the following:
   1. 65 Durometer, Sheet Neoprene No. 1200, as manufactured by Williams Products Company.
   2. Or equal.

2.9 JOINT SEALANT

A. Sealant used in expansion joints and other locations where it is shown and which will be subject to being submerged by water for any period of time shall be a two-part polyurethane type sealant meeting the requirements of ASTM C 920, Type M, Class 25. The sealant shall be specially formulated for continuous submerged conditions. The manufacturer's recommended primer must be used with the sealant.

B. The sealant shall meet the following requirements (measured at 73 degrees F and 50 percent RH):
   1. Ultimate hardness (ASTM D 2240, Type A, Shore): 20 to 45.
   2. Tensile strength (ASTM D 412): 200 psi, minimum.
   3. Ultimate elongation (ASTM D 412): 400 percent, minimum.
   4. Tear strength (ASTM D 624, die C): 75 pounds per inch of thickness, minimum.
   5. Color: light gray.

C. Product and Manufacturer: Provide one of the following:
   1. Permapol RC-270 Reservoir Sealant, as manufactured by Products Research and Chemical Corporation.
   2. Sikaflex-2c, as manufactured by Sika Corporation.
   3. Or equal.

2.10 SEALANT ACCESSORIES

A. Backer Rod: Backer rod shall be an extruded closed-cell polyethylene foam rod. The material shall be compatible with the sealant material used and shall have a tensile strength of not less than 40 psi and a compression deflection of approximately 25 percent at 8 psi. The rod shall be 1/8-inch larger in diameter than the joint width at joints less than 3/4-inch wide and 1/4-inch larger in diameter at joints 3/4-inch and wider.

B. Bond Breaker Tape: Bond breaker shall be polyethylene or TFE-fluorocarbon self adhesive tape, as recommended by the manufacturer.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and the conditions under which Work is to be performed and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 CONSTRUCTION JOINTS

A. Comply with the requirements of ACI 301 and as specified below.

B. Locate and install construction joints as shown on the Drawings. Additional construction joints shall be located as follows:

1. In walls locate joints at a spacing of 40 feet maximum and approximately 12 feet from corners.
2. In foundation slabs and slabs on grade locate joints at a spacing of approximately 40 feet. Place concrete in a strip pattern, unless otherwise indicated on the Drawings.
3. In mats and structural slabs and beams, at a spacing of approximately 40 feet. Locate joints in compliance with ACI 301, unless otherwise indicated on the Drawings.
4. Provide other additional construction joints as required to satisfactorily complete all Work.

C. Horizontal Joints:
1. Roughen concrete at the interface of construction joints by abrasive blasting, hydroblasting, or the use of surface retardants and water jets to expose the aggregate and remove accumulated concrete on projecting rebar immediately subsequent to form stripping, unless otherwise approved by ENGINEER. Immediately before placing fresh concrete, thoroughly clean the existing contact surface using a stiff brush or other tools and a stream of water under pressure. The surface shall be clean and wet, but free from pools of water at the moment the fresh concrete is placed.
2. Remove laitance, waste mortar or any other substance which may prevent complete adhesion. Where joint roughening was performed more than seven days prior to concrete placement or where dirt or other bond reducing contaminants are on the surface, additional light abrasive blasting or hydroblasting shall be done to remove laitance and all bond reducing materials just prior to concrete placement.
3. Place a 2-inch thick coat of mortar, one part sand and one part cement with water added to a flowable consistency or a 6-inch layer of Construction Joint Grout, as specified in Section 03600, Grout, over the contact surface of the old

concrete. Place fresh concrete before the mortar or grout has attained its initial set. If the concrete mix has the slump increased to at least 6-inches by addition of a high range water reducer, the placement of mortar or grout may be omitted.

D. Vertical Joints:
   1. Apply roughener to the form in a thin, even film by brush, spray or roller in accordance with the manufacturer's instructions. After roughener is dry, concrete may be placed.
   2. When concrete has been placed, remove joint surface forms as early as is necessary to allow for removal of the surface retarded concrete. Forms covering member surfaces shall remain in place as required by Section 03100, Concrete Formwork. Wash loosened material off with high-pressure water spray to obtain roughened surface subject to approval by ENGINEER. Alternately, the surface shall be roughened by abrasive blasting or hydroblasting to expose aggregate. The outer 1-inch of each side of the joint face shall be masked and protected from the blasting to avoid damage to the member surface.

3.3 EXPANSION JOINTS

A. Comply with the requirements of ACI 301 and as specified below.

B. Locate and install expansion joints as shown. Install joint filler in accordance with manufacturer's instructions. Sealants shall be installed as specified herein.

3.4 CONTROL JOINTS

A. Control joints shall be provided in non-water bearing slabs on grade only where specifically shown. A groove, with a depth of at least 25 percent of the member thickness, shall be formed or saw-cut in the concrete. This groove shall be filled with joint sealant material as specified in Section 07920, Caulking and Sealants.

B. Where the control joint is formed by sawcutting, the cut shall be made immediately after the concrete has set enough to support the saw and be cut without being damaged. The concrete shall be kept continually moist until the cutting operation.

C. Control joints may be formed with a tool or by insertion of a joint forming strip. After the concrete has gained its design strength, the upper portion of the joint forming strip shall be removed, and the void filled with sealant.

3.5 ISOLATION JOINTS

A. Wherever a sidewalk or other slab on grade abuts a concrete structure and is not shown doweled into that structure, an isolation joint shall be provided. Such joint shall be formed by a 1/2-inch joint filler with the upper 1/2-inch of the joint filled with sealant.

3.6 WATERSTOPS

A. General:
   1. Comply with the requirements of ACI 301 and as specified below. All joints shall be made in accordance with manufacturer's instructions.
   2. Obtain ENGINEER'S approval for waterstop locations not shown.
   3. Provide polyvinyl chloride waterstops in all joints in concrete which are intended to retain liquid or are located below grade up to an elevation at least 12-inches above grade or to an elevation at least 12-inches above overflow liquid level in tanks, whichever is higher, except where otherwise shown or noted.

B. Polyvinyl Chloride Waterstop:
   1. Tie waterstop to reinforcement, at a maximum spacing of 18-inches, so that it is securely and rigidly supported in the proper position during concrete placement. Continuously inspect waterstops during concrete placement to ensure their proper positioning.
   2. Splices in waterstops shall be performed by heat sealing the adjacent waterstop sections in accordance with the manufacturer's printed recommendations. It is required that:
      a. The material shall not be damaged by heat sealing.
      b. The splices shall have a tensile strength of not less than 60 percent of the unspliced materials tensile strength.
      c. The continuity of the waterstop ribs and of its tubular center axis shall be maintained.
   3. Only butt type joints of the ends of two identical waterstop sections shall be allowed to be made while the material is in the forms.
   4. All joints with waterstops involving more than two ends to be jointed together, and all joints which involve an angle cut, alignment change, or the joining of two dissimilar waterstop sections shall be prefabricated by CONTRACTOR or manufacturer prior to placement in the forms, allowing not less than 24-inch long strips of waterstop material beyond the joint. Upon being inspected and approved, such prefabricated waterstop joint assemblies shall be installed in the forms and the ends of the 24-inch strips shall be butt welded to the straight run portions of waterstop in place in the forms.
   5. Where a centerbulb waterstop intersects and is jointed with a non-centerbulb waterstop, care shall be taken to seal the end of the centerbulb, using additional PVC material, if required.
   6. The symmetrical halves of the waterstops shall be equally divided between the concrete placements at the joints and centered within the joint width, unless shown otherwise. Centerbulb waterstops shall be placed in expansion joints so that the centerbulb is centered on the joint filler material.
   7. When any waterstop is installed in the forms or is embedded in the first concrete placement and the waterstop remains exposed to the atmosphere for more than four days, suitable precautions shall be taken to shade and protect the exposed

waterstop from direct rays of the sun during the entire exposure and until the exposed portion of the waterstop is embedded in concrete.

8. Waterstop placed in joints intended for future concrete placement shall be protected from direct rays of the sun by temporary means until a permanent cover is installed so that the waterstop is not exposed to the direct rays of the sun for more than a total of four days.

C. Hydrophilic Rubber Waterstop and Sealant

1. Where a hydrophilic rubber waterstop or sealant is called for in the Contract Documents, or where approved by the ENGINEER, it shall be installed with the manufacturer's instructions and recommendations; except, as modified herein.
2. When requested by the ENGINEER, the manufacturer shall provide technical assistance in the field.
3. The waterstop or sealant shall be located as near as possible to the center of the joint and it shall be continuous around the entire joint. The minimum distance from the edge of the waterstop to the face of the member shall be 3-inches.
4. Where a hydrophilic rubber waterstop is used in combination with PVC waterstop, the hydrophilic rubber waterstop shall overlap the PVC waterstop for a minimum of 6-inches. The contact surface between the hydrophilic rubber waterstop the PVC waterstop shall be filled with hydrophilic sealant.
5. Where wet curing methods are used, hydrophilic rubber waterstop and sealant shall be applied after curing water is removed and just prior to the closing up of the forms for the concrete placement. Hydrophilic rubber waterstop and sealant shall be protected from the direct rays of the sun and from becoming wet prior to concrete placement. If the material does become wet and expands, it shall be allowed to dry until it has returned to its original cross sectional dimensions before concrete is placed.
6. The hydrophilic rubber waterstop shall be installed in a bed of hydrophilic sealant, before skinning and curing begins, so that any irregularities in the concrete surface are completely filled and the waterstop is bonded to the sealant. After the sealant has cured, concrete nails, with washers of a diameter equal to the waterstop width, shall be placed to secure the waterstop to the concrete at a maximum spacing of 18-inches.
7. Prior to installation of hydrophilic sealant, the concrete surface shall be wire brushed or sand blasted to remove any laitance or other materials that may interfere with the bonding. Surfaces of metal or PVC to receive sealant shall be cleaned of paint and any material that may interfere with bond. When sealant alone is shown on the Contract Documents, it shall be placed in a built up bead which has a triangular cross section with each side of the triangle at least 3/4- inch in length, unless indicated otherwise. Concrete shall not be placed until the sealant has cured as recommended by the manufacturer.

3.7 BONDING AGENT

A. Use epoxy bonding agent for bonding of fresh concrete to concrete that has been in place for at least 60 days or to existing concrete.

B. Use epoxy-cement bonding agent for the following:
   1. Bonding toppings and concrete fill to concrete that has been in place for at least 60 days or to existing concrete.
   2. For all locations where bonding agent is required and concrete cannot be placed within the open time period of epoxy bonding agent.
   3. Bonding of horizontal construction joints where these are required by the Drawings or approved by ENGINEER for foundation mats that are five feet thick or greater.

C. Use a cement-water slurry as a bonding agent for toppings and concrete fill to new concrete. The cement water slurry shall be worked into the surface with a stiff bristle broom and concrete shall be placed before the cement-water slurry dries.

D. Handle and store bonding agent in compliance with the manufacturer's printed instructions, including safety precautions.

E. Mix the bonding agent in complete accordance with the instructions of the manufacturer.

F. Before placing fresh concrete, thoroughly roughen and clean hardened concrete surfaces and coat with bonding agent not less than 1/16-inch thick. Place fresh concrete while the bonding agent is still tacky (within its open time), without removing the in-place bonding agent coat, and as directed by the manufacturer.

3.8 SEALANT INSTALLATION

A. Sealants shall be installed according to the manufacturer’s recommendations for sealant which is to be subjected to continuous submerged conditions and the following requirements. Prior to sealant installation, arrange to have a representative of the sealant manufacturer instruct the crew doing the Work as to the proper methods of surface preparation, mixing, and application of the sealant.

B. Surfaces to receive sealant shall be cleaned of all materials which could interfere with proper bonding. Concrete surfaces shall have all fins or other defects removed or repaired and shall receive a light abrasive blasting prior to priming and sealant application. All surfaces to receive sealant shall be completely dry.

C. Spaces to receive sealant shall be filled with joint filler as shown. Where not shown, the space shall be filled with joint filler or a backer rod so that the depth of sealant does not exceed the width of the space. Where the bottom of the space to receive sealant is formed by a material other than backer rod, a bond breaker tape shall be placed. The maximum sealant depth, at middle of the joint width, shall be 1/2-inch.

D. The primer and sealant used shall be supplied by the same manufacturer. No sealant shall be placed without the use of a primer.

E. Self-leveling sealants shall only be used in joints with a slope less than 0.5 percent and where maximum and minimum sealant depths can be maintained. Non-sag sealant shall be used at all other locations and may be used instead of self-leveling sealant. All non-sag sealant shall be tooled to a uniform concave surface before skinning and curing begins.

F. Sealant material shall be conditioned to be within the optimum temperature range recommended by the manufacturer for installation for a minimum of 16 hours prior to installation. Installation shall proceed only when the substrate is at a temperature recommended by the manufacturer. Sealant shall not be placed if there is a threat of imminent rainfall. Submit a letter certifying that the applied sealants were installed in accordance with the manufacturer's recommendations, including temperature, relative humidity, etc.

G. All joints to receive sealant shall be inspected by the ENGINEER prior to sealant placement.

H. All sealant shall achieve final cure at least seven days before the structure is filled with water.

I. Any sealant which, after the manufacturer's recommended curing time for the job conditions, fails to fully and properly cure shall be completely removed. The surfaces to receive sealant shall be completely cleaned of all traces of the improperly cured sealant and primer. The specified sealant shall then be reinstalled. All costs of such removal, surface treatment, and reinstallation shall be at the expense of CONTRACTOR.

3.9 BEARING PAD INSTALLATION

A. Neoprene Bearing Pad: Install with water insensitive adhesive in accordance with manufacturer's instructions.

+ + END OF SECTION + +

SECTION 03252

ANCHORAGE IN CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified, and required to furnish and install anchor bolts, concrete anchors (adhesive and expansion anchors), and concrete inserts.

B. Coordination: This Section includes all bolts, anchors and inserts required for the Work but not specified under other Sections.

C. The types of work using anchor bolts and anchors drilled into concrete or masonry includes, but is not limited to, the following:
   1. Structural members and accessories.
   2. Metal, wood, and plastic fabrications.
   3. Equipment.
   4. Sluice and slide gates.
   5. Tanks.
   6. Piping.
   7. Grating and floor plate.
   8. Electrical, Plumbing and HVAC Work.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown and specified.
   1. ASTM A 36, Specification for Structural Steel.
   2. ASTM A 123, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   3. ASTM A 153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   4. ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   5. ASTM A 484/A 484M, Specification for General Requirements for Stainless and Heat-Resisting Steel Bars, Billets and Forgings.
   6. ASTM A 525, Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
   7. ASTM A 536, Specification for Ductile Iron Castings.

8. ASTM A 570/A 570M, Specification for Structural Steel, Sheet and Strip, Carbon, Hot-Rolled.
9. ASTM B 633, Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
10. ASTM F 593, Specification for Stainless Steel Bolts; Hex Cap Screws, and Studs.
11. Federal Specification, FF-S-325 for Concrete Expansion Anchors.
12. Federal Specifications, WW-H-171E for Malleable Iron.

B. Expansion anchors and inserts shall be ICBO, UL, or FM approved.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Setting drawings and templates for location and installation of anchorage devices.
2. Copies of manufacturer's specifications, load tables, dimension diagrams and installation instructions for the anchorage devices.
3. Copies of ICBO, UL, or FM reports certifying load carrying capacities and installation requirements for the anchorage devices.

B. Samples: Submit for approval the following:
1. Representative samples of bolts, anchors and inserts as may be requested by ENGINEER. Review will be for type and finish only. Compliance with all other requirements is exclusive responsibility of CONTRACTOR.

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA

A. When the size, length or load carrying capacity of an anchor bolt, concrete anchor, or concrete insert is not shown on the Drawings, provide the following:
1. For anchor bolts (cast-in-place), provide the size, length and capacity required to carry the design load based on the values and requirements given in the Phoenix Building Code.
2. For concrete anchors (adhesive types) and concrete inserts, provide the size, length, type, and capacity required to carry the design load based on the values and requirements given in the ICBO Evaluation Report, or similar certifications by UL or FM, for the anchor to be used. Alternately the capacity may be based on independent testing lab capacities for tension and shear strength using a minimum safety factor of four. Consideration of reduced capacity due to spacing and edge distance shall be made.

B. Determine design loads as follows:
   1. For equipment anchors, use the design load recommended by the equipment manufacturer and approved by ENGINEER.
   2. For pipe hangers and supports, use one half of the total weight of: pipe, fittings, and water contained in pipe, plus the full weight of valves and accessories located between the hanger or support in question.
   3. Allowances for vibration are included in the safety factor specified above.
   4. Concrete anchors shall develop ultimate shear and pull-out loads of not less than the following values in 4000 psi concrete:

Bolt diameter Inches)	Min Shear (Pounds)	Min Pull-Out Load (Pounds)
1/2	5,000	7,600
5/8	8,000	12,000
3/4	11,500	17,000
7/8	15,700	20,400
1	20,500	28,400

2.2 APPLICATION

A. Where a concrete anchor is shown on the Drawings, either an adhesive anchor or anchor bolt shall be used. In masonry, where a concrete anchor is indicated, only anchor bolts and adhesive anchors shall be used.

B. Anchor Bolts (cast-in-place)
   1. Shall be used where indicated and may be used where concrete anchors are indicated.
   2. Where an anchor bolt is indicated, only a cast-in-place anchor bolt shall be used, unless another anchor type is accepted by the ENGINEER.
   3. Provide anchor bolts as shown on the Drawings or as required to secure structural steel to concrete or masonry.

C. Adhesive Anchors:
   1. Use wherever concrete anchors are shown on the Drawings.
   2. Use where subject to vibration or where buried or submerged.
   3. Use for pipe supports.
   4. Use in concrete and masonry.
   5. Shall not be used in ceilings.
   6. Shall not be used for pipe hangers.

D. Concrete Inserts:
   1. Use only where indicated.
   2. Use for pipe hangers and supports for the pipe size and loading recommended by the insert manufacturer.

2.2 MATERIALS

A. Anchor Bolts:
   1. Provide carbon steel bolts complying with ASTM A 307, headed or non-headed type, unless otherwise indicated.
   1. Provide stainless steel bolts complying with ASTM F 593, AISI Type 316 headed or non-headed type with nitronic 60 stainless steel nuts and locknuts, unless otherwise indicated.
   2. In buried or submerged locations, provide stainless steel bolts complete with washers complying with ASTM F 593, AISI Type 316 and with nitronic 60 stainless steel nuts and locknuts. Other AISI types may be used subject to ENGINEER'S approval.
   3. For equipment, provide anchor bolts, which meet the equipment manufacturer's recommendations for size, material, and strength.
   4. Provide anchor bolts as shown on the Drawings or as required to secure structural steel to concrete or masonry.
   5. Locate and accurately set the anchor bolts using templates or other devices as required.
   6. Protect threads and shank from damage during installation of equipment and structural steel.
   7. Comply with manufacturer's required embedment length and necessary anchor bolt projection.

B. Adhesive Anchors:
   1. Provide stainless steel adhesive anchors complying with ASTM F 593, AISI Type 316 with nitronic 60 stainless steel nuts and locknuts.
   2. In buried or submerged locations, provide stainless steel adhesive anchors complying with ASTM F 593, AISI Type 316 with nitronic 60 stainless steel nuts and locknuts.
   3. Anchors shall be of the size required for the concrete strength specified.
   4. Adhesive anchors shall consist of threaded rods or bolts anchored with an adhesive system into hardened concrete or grout-filled masonry. The adhesive system shall use a two-component adhesive mix and shall be injected with a static mixing nozzle following manufacturer's instructions. The embedment depth of the rod/bolt shall provide a minimum allowable bond strength that is equal to the allowable tensile capacity of the rod/bolt, unless noted otherwise on the Drawings.
   5. Product and Manufacturer: Provide one of the following:
      a. Epcon System Ceramic 6, as manufactured by ITW Ramset/Redhead.
      b. HIT HY-150 Injection Adhesive Anchor System, as manufactured by Hilti.
      c. Powerfast, as manufactured by Powers/Rawl.
      d. Or equal.

C. Concrete Inserts:

1. For piping, grating, floor plate and masonry lintels, provide malleable iron inserts. Comply with Federal Specification WW-H-171E (Type 18). Provide those recommended by the manufacturer for the required loading.
2. Finish shall be black.
3. Product and Manufacturer: Provide one of the following:
   a. Figure 282, as manufactured by ITT Grinnell.
   b. No. 380, as manufactured by Hohmann and Barnard, Incorporated.
   c. Or equal.

D. Powder actuated fasteners and other types of bolts and fasteners not specified herein shall not be used unless approved by ENGINEER.

E. Expansion anchors will not be allowed.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which anchor bolts, expansion anchors and concrete insert Work is to be installed, and notify ENGINEER, in writing, of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. Assure that embedded items are protected from damage and are not filled in with concrete.

B. Use concrete inserts for pipe hangers and supports for the pipe size and loading recommended by the insert manufacturer.

C. For the adhesive anchors and adhesive material, comply with the manufacturer's installation instructions on the hole diameter and depth required to fully develop the tensile strength of the anchor or reinforcing bar. Properly clean out the hole utilizing a non-metallic fiber bristle brush and compressed air to remove all loose material from the hole, prior to installing adhesive material.

D. Adhesive anchor manufacturer's representative shall observe and demonstrate the proper installation procedures for the adhesive anchors and adhesive material at no additional expense to OWNER. Each installer shall be certified in writing by the manufacturer to be qualified to install the adhesive anchors.

3.3 CLEANING

A. After embedding concrete is placed, remove protection and clean bolts and inserts.

3.4 FIELD QUALITY CONTROL

A. Employ a testing laboratory to perform field quality testing of installed anchors. Field engineer is to determine the level of testing which is required for the various types of adhesive anchors and anchor bolts. A minimum of ten percent of the adhesive anchors and reinforcing bars are to be tested to 50 percent of the ultimate tensile capacity of the adhesive anchor or reinforcing bar.

B. If failure of any of the adhesive anchors or reinforcing bars occurs, testing the remaining 90 percent will be required and the costs involved belong to the CONTRACTOR. Responsibility belongs to CONTRACTOR to correct improper workmanship, remove, and replace, or correct as directed by the ENGINEER, all adhesive anchors or bars found unacceptable or deficient, at no additional cost to the OWNER.

D. The independent testing and inspection agency shall complete a report on each area of the Work where concrete anchors are installed. The report shall summarize the observations made by the inspector and be submitted to ENGINEER.

E. Provide access for the testing agency to places where work is being produced so that required inspection and testing can be accomplished.

++ END OF SECTION ++

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown, specified and required to furnish and install cast-in-place concrete.
   2. The Work includes providing concrete consisting of portland cement, fine and coarse aggregate, water, and approved admixtures; combined, mixed, transported, placed, finished, and cured. The Work also includes:
      a. Providing openings in concrete to accommodate the Work under this and other Sections and building into the concrete all items such as sleeves, frames, anchor bolts, inserts and all other items to be embedded.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed in the concrete.

C. Classifications of Concrete:
   1. Type "1" concrete shall be steel reinforced and includes the following:
      a. All concrete, unless indicated otherwise.
   2. Type "2" concrete shall be placed without forms or with simple forms, with little or no reinforcing, and includes the following:
      a. Concrete fill within structures.
      b. Duct banks.
      c. Unreinforced encasements.
      d. Curbs and gutters.
      e. Sidewalks.
      f. Thrust blocks.
   3. Type "3" concrete shall be steel reinforced and used for slabs that require enhanced durability against wear. Provide where shown on the Drawings.
   4. Type "4" concrete shall be unreinforced and used where required as concrete fill under foundations, filling abandoned piping and wherever “lean” concrete is required on the Drawings.
   5. Lightweight Structural Concrete:
      a. Roof fill.

1.2 QUALITY ASSURANCE

A. Standard Specifications and Details:

1. Conform to all applicable requirements of Section Nos. 505, 725 and 726 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG) as supplemented by the City of Phoenix. Where there is a conflict between MAG Standard Specifications as supplemented by the City of Phoenix and this Specification, provisions of this Specification shall govern.

B. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ACI 214, Recommended Practice for Evaluation of Strength Test Results of Concrete.
   2. ACI 301, Specifications for Structural Concrete (includes ASTM Standards referred to herein).
   3. ACI 304, Guide for Measuring, Mixing, Transporting and Placing Concrete.
   4. ACI 305, Hot Weather Concreting.
   5. ACI 306, Cold Weather Concreting.
   6. ACI 309, Guide for Consolidation of Concrete.
   7. ACI 311, Guide for Concrete Inspection.
   8. ACI 318, Building Code Requirements for Structural Concrete.
   9. ANSI/NSF 61, Drinking Water System Components-Health Effects.
   10. AASHTO M 182, Burlap Cloth Made From Jute or Kenaf.
   11. AASHTO TP 23, Proposed Standard Method of Test for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying.
   12. ASTM C 31, Practice for Making and Curing Concrete Test Specimens in the Field.
   13. ASTM C 33, Specification for Concrete Aggregates.
   14. ASTM C 39, Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   15. ASTM C 42, Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
   16. ASTM C 94, Specification for Ready-Mixed Concrete.
   17. ASTM C109, Test Method for Compressive Strength of Hydraulic Cement Mortars.
   18. ASTM C 143, Test Method for Slump of Hydraulic- Cement Concrete.
   19. ASTM C 150, Specification for Portland Cement.
   20. ASTM C 157, Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   21. ASTM C 171, Specification for Sheet Materials for Curing Concrete.
   22. ASTM C 172, Practice for Sampling Freshly Mixed Concrete.
   23. ASTM C 231, Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
   24. ASTM C 260, Specification for Air-Entraining Admixtures for Concrete.
   25. ASTM C 309, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
   26. ASTM C 330, Specification for Lightweight Aggregates for Structural Concrete.
   27. ASTM C 494, Specification for Chemical Admixtures for Concrete.

28. ASTM C 618, Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
29. ASTM C 882, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
30. ASTM C 1240, Specification for Silica Fume for Use as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar, and Grout.
31. ASTM E 154, Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.
32. ASTM E 329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used for Construction.

C. Concrete Testing Service:
   1. Employ, at own expense, testing laboratories experienced in design and testing of concrete materials and mixes to perform material evaluation tests and to design concrete mixes. The same laboratory shall not be employed to both design concrete mixes and provide field testing.
      a. Testing agency shall meet the requirements of ASTM E 329.
      b. Selection of a testing laboratory is subject to ENGINEER'S approval.
      c. Submit a written description of the proposed concrete testing laboratory giving qualifications of personnel, laboratory facilities and equipment, and other information that may be requested by ENGINEER.
   2. Materials and installed Work may require testing and retesting, as directed by ENGINEER, at any time during the progress of the Work. Allow free access to material stockpiles and facilities at all times. Tests not specifically indicated to be done at OWNER'S expense, including the retesting of rejected materials and installed Work, shall be done at CONTRACTOR'S expense.

D. Qualifications of Water-Reducing Admixture Manufacturer:
   1. Water-reducing admixtures shall be manufactured under strict quality control in facilities operated under a quality assurance program. Furnish copy of manufacturer's quality assurance handbook to document the existence of the program. Manufacturer shall maintain a concrete testing laboratory that has been approved by the Cement and Concrete Reference Laboratory at the Bureau of Standards, Washington, D.C.
   2. Provide a qualified concrete technician employed by the admixture manufacturer to assist in proportioning the concrete for optimum use of the admixture. The concrete technician shall advise on proper addition of the admixture to the concrete and on adjustment of the concrete mix proportions to meet changing jobsite conditions.

E. Laboratory Trial Batch:
   1. Each concrete mix design specified shall be verified by a laboratory trial batch, unless indicated otherwise.
   2. Each trial batch shall include the following testing:
      a. Aggregate gradation for fine and coarse aggregates.

b. Fly ash testing to verify meeting specified properties, unless the fly ash supplier provides certification by an independent testing laboratory.
c. Slump.
d. Air content.
e. Compressive strength based on three cylinders each tested at seven days and at 28 days.
f. Shrinkage test as specified herein for Type "1" concrete mix designs.

3. Each trial batch shall provide the following information:
   a. Project identification name and number.
   b. Date of report.
   c. Complete identification of aggregate source of supply.
   d. Tests of aggregates for compliance with specified requirements.
   e. Scale weight of each aggregate.
   f. Absorbed water in each aggregate.
   g. Brand, type and composition of cement.
   h. Brand, type and amount of each admixture.
   i. Amounts of water used in trial mixes.
   j. Proportions of each material per cubic yard.
   k. Gross weight and yield per cubic yard of trial mixtures.
   l. Measured slump.
   m. Measured air content.
   n. Compressive strength developed at seven days and 28 days, from not less than three test cylinders cast for each seven day and 28-day test, and for each design mix.
   o. Shrinkage test results where required and as specified herein.
4. The requirement for a trial batch may be waived if the required test information has been provided in a previous laboratory trial batch run on the identical mix design within the previous two years. The same brand, type, and source of all materials must have been used.

F. Shrinkage Test:
1. Drying shrinkage tests will be made for the trial batch as specified herein.
2. Drying shrinkage specimens shall be 4-inch by 4-inch by 11-inch prisms with an effective gage length of 10-inches, fabricated, cured, dried and measured in accordance with the requirements of ASTM C 157 modified as follows: specimens shall be removed from molds at an age of 23 ±1 hours after trial batching, shall be placed immediately in water at 70°F ±3°F for at least 30 minutes, and shall be measured within 30 minutes thereafter to determine original length and then submerged in saturated lime water at 73°F ±3°F. Measurement to determine expansion expressed as a percentage of original length shall be made at age seven days. This length at age seven days shall be the base length for drying shrinkage calculations ("0" days drying age). Specimens then shall be stored immediately in a humidity control room maintained at 73°F ±3°F and 50 percent ±4 percent relative humidity for the remainder of the test. Measurements to determine shrinkage expressed as

percentage of base length shall be made and reported separately for 7, 14, 21, and 28 days of drying after seven days of moist curing.

3. The drying shrinkage deformation of each specimen shall be computed as the difference between the base length (at "0" days drying age) and the length after drying at each test age. The average drying shrinkage deformation of the specimens shall be computed to the nearest 0.0001-inch at each test age. If the drying shrinkage of any specimen departs from the average of that test age by more than 0.0004-inch, the results obtained from that specimen shall be disregarded. Results of the shrinkage test shall be reported to the nearest 0.001 percent of shrinkage. Compression test specimens shall be taken in each case from the same concrete used for preparing drying shrinkage specimens. These tests shall be considered a part of the normal compression tests for the project. Allowable shrinkage limitations shall be as specified in Part 2, herein.

F. Certification of Concrete Mix:
   1. The need for a trial batch may be waived if the following requirements are met. The compressive strength of each specified mix shall be verified by data from a series of a minimum of 30 consecutive tests that have been made within the previous 12 months. A test is defined as the average strength of all specimens of the same age fabricated from a sample taken from a single batch of concrete. All tests shall have been made on concrete which is identical in mix design to the submitted proposed mix design, including sources of aggregate and manufacturers of cementitious materials and admixtures. The tests must average above the specified strength with no individual test falling more than 500 psi below specified strength and no three consecutive tests averaging below specified strength. In addition, the standard deviation for the series of tests shall not exceed 640 psi as defined by ACI 214.

G. Sample Panels:
   1. Provide sample panels of wall finishes, 12-inches by 12-inches by 3-inches thick. Perform revisions and corrective work required to produce finished concrete and surfaces as required by ENGINEER.
      a. Construct additional sample panels as may be required if original results are not satisfactory.
   2. The continuity of color and texture for exposed concrete surfaces is of prime importance. Maintain such controls and procedures, in addition to those specified, as is necessary to provide continuous match of concrete Work with accepted samples.

H. Mock-up Panels:
   1. Fabricate mock-up panels representative of specified finished surfaces (--1--), at locations on the site as directed by ENGINEER. Form, reinforce, mix, cast, cure, and finish mock-up panels using selected materials and construction methods proposed for the Work. Provide mock-up panels as follows:
      a. Wall section of "L"-shaped panels, approximately 4 feet high by 3 feet each side by 8-inches thick and set on an 18-inch wide by 8-inch thick base,

unless otherwise shown. Form faces to represent each specified formed surface finish. Include not less than two form ties, two form panel intersections, one vertical construction joint and one horizontal construction joint. Construction joints are specified in Section 03251, Concrete Joints, of these Specifications.

b. Column section, approximately four feet high and not less than 12-inches diameter for round sections and not less than 12-inches in least dimension for rectangular sections for each specified formed finish, unless otherwise shown. Set column sections on a 6-inch thick concrete base which extends 8-inches beyond the column. Chamfer exposed edges of rectangular sample columns.

c. Slab-on-grade section, approximately four feet square and a minimum of 4-inches thick for each applied finish, with at least one construction joint and one expansion joint, if used.

d. Pan-formed section using at least two pan form units. Set units to illustrate method of blending exposed pan joints.

2. Reinforce mock-up panels as required to prevent cracking and to be structurally stable or as shown on the Drawings, but reinforcing steel shall not be less than 0.25 percent of the gross concrete cross section in each direction.

3. Protect mock-up panels from damage and do not remove them without written permission from ENGINEER. When directed, demolish mock-up panels and remove from the site.

I. Existing Sample Panels

1. The ENGINEER will identify sections of existing concrete members which will serve as reference examples of acceptable concrete finishes.

2. If appropriate existing concrete members do not exist to define all the finishes specified, sample sections shall be constructed as specified herein as needed.

J. Designated Finish Sample Areas

1. The ENGINEER will identify sections of concrete members to serve as reference examples of acceptable concrete finishes from the first members constructed for each finish.

2. At each section so designated, complete the finish as specified.

3. Where the specified concrete finish is not obtained, the member shall be repaired to provide an acceptable finish. The construction techniques used in the next such member placed shall be adjusted to produce the required finish.

4. Clearly mark each sample area with the name of the specified finish in such a manner that causes no damage to the finish.

5. Protect sample sections from damage and maintain access to view such sections.

1.3 SUBMITTALS

A. Samples: Submit samples of materials as specified and as otherwise may be requested by ENGINEER, including names, sources and descriptions.

B. Shop Drawings: Submit for approval the following:
   1. Manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures and bonding agents.
   2. List of concrete materials and concrete mix designs proposed for use. Include the results of all tests performed to qualify the materials and to establish the mix designs.
   3. The following information, if ready-mixed concrete is used.
      a. Physical capacity of mixing plant.
      b. Trucking facilities available.
      c. Estimated average amount that can be produced and delivered to the site during a normal eight-hour day, excluding the output to other customers.

C. Laboratory Test Reports: Submit copies of laboratory test reports for concrete cylinders, materials and mix design tests. ENGINEER'S review will be for general information only. Production of concrete to comply with specified requirements is the responsibility of CONTRACTOR.

D. Submit notarized certification of conformance to referenced standards when requested by ENGINEER.

E. Delivery Tickets: Furnish to ENGINEER copies of all delivery tickets for each load of concrete delivered to the site. Provide items of information as specified in ASTM C 94, Section 16.1.
   1. Provide batch tickets for each batch of job-site mixed concrete, as specified.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All materials used for concrete must be kept clean and free from all foreign matter during transportation and handling and kept separate until measured and placed in the mixer. Bins or platforms having hard clean surfaces shall be provided for storage. Suitable means shall be taken during hauling, piling and handling to ensure that segregation of the coarse and fine aggregate particles does not occur and the grading is not affected.

1.5 CONCRETE COORDINATION MEETING

A. A Concrete Coordination Meeting shall be held to review the detailed requirements of CONTRACTOR'S proposed concrete design mixes, to determine the procedures for producing proper concrete construction, and to clarify the roles of the parties involved shall be held no later than 14 days after the Notice to Proceed.

B. All parties involved in the concrete Work shall attend the conference, including but not limited to the following:
   1. CONTRACTOR'S representative.
   2. Testing laboratory representative.
   3. Concrete subcontractor.

4. Reinforcing steel subcontractor and detailer.
5. Concrete supplier.
6. Admixture manufacturer's representative.
7. ENGINEER.

C. The Concrete Coordination Meeting shall be held at a mutually agreed upon time and place. The ENGINEER shall be notified no less than five days prior to the date of the Concrete Coordination Meeting.

PART 2 - PRODUCTS

2.1 GENERAL

A. All admixtures, curing compounds, etc. used in concrete or the curing and repair of concrete, which can contact potable water, shall be certified as conforming to the requirements of ANSI/NSF 61 for contact with potable water when in the finished concrete.

2.2 CEMENTITIOUS MATERIALS

A. Cement:
   1. Portland cement, ASTM C 150, Type II. Type I may be used in lieu of Type II when acceptable to ENGINEER.
   2. Use Portland cement made by a well-known acceptable manufacturer and produced by not more than one plant. Alternate cement sources may be used provided that a mix design has been accepted and a trial batch verifying performance has been made.
   3. Do not use cement which has deteriorated because of improper storage or handling.

B. Fly Ash Mineral Admixture:
   1. Mineral admixtures, when used, shall meet the requirements of ASTM C 618 Class F, except as follows:
      a. The loss on ignition shall be a maximum of 4 percent.
      b. The maximum percent of sulfur trioxide (SO3) shall be 4.0.
   2. Fly ash shall be considered to be a cementitious material.
   3. Laboratory trial batches shall be tested to determine compliance with strength requirements, times of setting, slump, slump loss, and shrinkage characteristics.
   4. A substitution by weight, of the portland cement by fly ash, so that the total tricalcium aluminate content of the resulting cement plus fly ash is not greater than eight percent, will be considered. However, the fly ash shall not exceed 20 percent by weight of the cement plus fly ash.

C. Silica Fume Mineral Admixture:

1. Silica fume mineral admixture shall be the dry compacted or slurry form and shall meet the requirements of ASTM C 1240. Silica Fume shall be considered to be a cementitious material. Application rate shall be seven percent by weight of cement, unless indicated otherwise.
2. Product and Manufacturer: Provide one of the following:
   a. Rheomac SF100, as manufactured by Master Builders, Inc.
   b. Force 10,000 D, as manufactured by W.R. Grace & Company.
   c. Sikacrete 950 DP, as manufactured by Sika Corporation.
   d. Eucon MSA, as manufactured by the Euclid Chemical Company.
   e. Or equal.

2.3 AGGREGATES

A. General:
   1. Aggregates shall conform to the requirements of ASTM C 33 and as herein specified.
   2. Do not use aggregates containing soluble salts or other substances such as iron sulfides, pyrite, marcasite, ochre, or other materials that can cause stains on exposed concrete surfaces.

B. Fine Aggregate: Clean, sharp, natural sand free from loam, clay, lumps or other deleterious substances.
   1. Dune sand, bank run sand and manufactured sand are not acceptable.

C. Coarse Aggregate: Clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter, as follows:
   1. Crushed stone, processed from natural rock or stone.
   2. Washed gravel, either natural or crushed. Use of slag and pit or bank run gravel is not permitted.
   3. Lightweight Aggregate: ASTM C 330.

2.4 WATER

A. Water used in the production and curing of concrete shall be clean and free from injurious amounts of oils, acids, alkalis, organic materials, or other substances that may be deleterious to concrete or steel.

2.5 CONCRETE ADMIXTURES

A. Provide admixtures produced by established reputable manufacturers and use in compliance with the manufacturer's printed instructions. All admixtures shall be compatible and by a single manufacturer capable of providing qualified field service representation. Admixtures shall not contain thiocyanates nor more than 0.05 percent chloride ion and shall be non-toxic in the concrete mix after 30 days. Do not use admixtures that have not been incorporated and tested in the accepted mixes, unless otherwise authorized in writing by ENGINEER.

B. Air-Entraining Admixtures: ASTM C 260.
   1. Product and Manufacturer: Provide one of the following:
      a. SIKA AER or SIKA AEA-15, as manufactured by Sika Corporation.
      b. MB-VR, as manufactured by Master Builders, Inc.
      c. Daravair, as manufactured by W.R. Grace & Company.
      d. Or equal.

C. Water-Reducing Admixture: ASTM C 494, Type A.
   1. Proportion all Type "1" and Type "2" concrete with non-air entraining, normal setting, water-reducing, aqueous solution of a modification of the salt of polyhydroxylated organic acids. The admixture shall not contain any lignin, nitrates or chlorides added during manufacture.
   2. Product and Manufacturer: Provide one of the following:
      a. Eucon WR-75, as manufactured by Euclid Chemical Company.
      b. Pozzolith series, as manufactured by Master Builders, Inc.
      c. WRDA-15, as manufactured by W.R. Grace & Company.
      d. Plastocrete 161 or Plastiment NS, as manufactured by Sika Corporation.
      e. Or equal.

D. High Range Water-Reducing Admixture (HRWR): ASTM C 494, Type F/G.
   1. High range water-reducer shall be used in classifications of concrete, where specified, and shall be permitted, at CONTRACTOR'S option, in all other classifications of concrete. It shall be added to concrete in compliance with the manufacturer's printed instructions. The specific admixture formulation shall be as recommended by the manufacturer for the project conditions. Provide one of the following:
      a. Sikament series, as manufactured by Sika Corporation.
      b. Rheobuild series, as manufactured by Master Builders, Inc.
      c. Daracem-100, as manufactured by W.R. Grace & Company.
      d. Eucon 37 or Eucon 537, as manufactured by the Euclid Chemical Company.
      e. Or equal.

E. Set-Control Admixtures: ASTM C 494, as follows:
   1. Type B, Retarding.
   2. Type C, Accelerating.
   3. Type D, Water-reducing and Retarding.
   4. Type E, Water-reducing and Accelerating.
   5. Type F, Water-reducing, high range admixtures.
   6. Type G, Water-reducing, high range, and retarding admixtures.

F. Calcium Chloride: Calcium chloride shall not be used.

G. Shrinkage Reducing Admixture

1. A shrinkage reducing admixture shall be permitted to be used in the mix design where necessary to meet specified shrinkage limitations provided that specified strength requirements are met and there is no reduction in sulfate resistance and no increase in permeability.
2. Shrinkage reducing admixtures shall be one of the following:
   a. Eclipse, as manufactured by Grace Construction Products.
   b. Tetraguard AS20, as manufactured by Master Builders, Inc.
   c. Or equal.

H. If super plasticizers are used in mix designs, the mix shall be slumped at jobsite prior to addition of plasticizer.

I. Colored Cement Pigments
1. Provide the following, where required: commercial iron oxide, manganese dioxide, ultramarine blue, chromium oxide, or carbon black compounded for use in concrete.
2. Do not exceed pigment to cement ratios by weight of 1 to 35 for carbon black and 1 to 7 for other pigments.
3. Pigments shall be manufactured by:
   a. Truetone Mortar Colors by Frank D Davis Company, subsidiary of Rockwood Industries, Inc.
   b. Sonobrite by Sonneborn Building Products, division of Rexnord Chemical Products, Inc.
4. Submit complete selection of manufacturer's standard and custom colors for final selection by ENGINEER.

2.6 PROPORTIONING AND DESIGN OF MIXES

A. Prepare concrete design mixes subject to the following limitations:

Classification	Coarse Aggregate[1]		Minimum	Maximum	Slump[2]	Air	Min. Comp.
	Size A	Size B	Cementious (lbs/cu yd)	W/C		(%)	Strength[3] (psi)
Type “1”	#57	#8	564	0.45	4" Max.	6+/-1	4000
Type “2”	#57 or #67		517	0.50	4" Max.	6+/-1	3000
Type “3”	#57 or #67		564	0.40	4" Max.	3 max	5000
Type “4”	Any ASTM C 33		<----------no requirements---------->			2000	

1 Coarse aggregate size numbers refer to ASTM C 33. Where a size A and B are listed, it is intended that the smaller size B aggregate is to be added, replacing a portion of the coarse and /or fine aggregate, in the minimum amount necessary to make a workable and pumpable mix with a sand content not exceeding 41 percent of total aggregate.

2 The slumps listed are prior to the addition of high range water reducer (super plasticizer)

3 Mix designs shall be made for all but Type “4”, which does not require a trial batch, so that the compressive strength achieved for the laboratory trial batches will be no less than 125 percent of the specified design strength. This is to assure meeting the design strength for all concrete batched during the project.

4 The quantity of water to be used in the determination of the water-cementitious materials ratio shall include free water on aggregates in excess of SSD and the water portion of admixtures.

B. Lightweight Concrete: Proportion the mix as herein specified:
   1. Specified 28-day Compressive Strength: 4,000 psi.
   2. Maximum Water-Cement Ratio by Weight: 0.45.
   3. Maximum Coarse Aggregate Size: 3/4-inch to No. 4.
   4. Minimum Cement Content, pounds per cubic yard: 564.
   5. Percent Air Content: 6 ±1 percent.
   6. Dry weight of not less than 95 pcf or not more than 110 pcf after 28 days.
   7. Limit drying shrinkage to 0.05 percent at 28 days.

C. Use an independent testing facility acceptable to ENGINEER for preparing and reporting proposed mix designs.
   1. The testing facility shall not be the same as used for field quality control testing.

D. Submit written reports of laboratory trial batch test results for proposed mixes of concrete to ENGINEER at least 15 days prior to start of Work. Do not begin concrete production until mixes have been approved by ENGINEER.

E. Adjustment to Concrete Mixes: Mix design adjustments may be requested by CONTRACTOR when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to the OWNER and as accepted by ENGINEER. Laboratory test data for revised mix designs and strength results must be submitted to and accepted by ENGINEER before using the revised mixes.

F. Admixtures:
   1. Use air-entraining admixture in all concrete, unless otherwise shown or specified. Add air-entraining admixture at the manufacturer's prescribed rate to result in concrete at the point of placement having air content within the prescribed limits.
   2. Water reducing or high-range water reducing admixtures shall be used in all Type "1" concrete.
   3. Use amounts of admixtures as recommended by the manufacturer for climatic conditions prevailing at the time of placing. Adjust quantities and types of admixtures as required to maintain quality control.

G. Slump Limits with High Range Water Reducer
   1. Slump shall not exceed 3-inches prior to adding high range water-reducer and shall not exceed 7.5 inches, measured at point of placement, after adding high range water reducer.

H. Shrinkage Limitation
   1. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age or at 28-day drying age shall be 0.039 percent or 0.045 percent, respectively. Only use a mix design for construction that has first met the trial batch shrinkage requirements. Shrinkage limitations apply only to Type "1" concretes.

2. If the trial batch results fail to meet the shrinkage limitation, the mix shall be redesigned to reduce shrinkage. Alternately, CONTRACTOR may use a higher shrinkage mix when acceptable to the ENGINEER provided that the amount of shrinkage reinforcement in the structures is increased as determined by the ENGINEER to resist the higher levels of shrinkage stresses. The additional reinforcing shall be provided at CONTRACTOR'S expense.

I. Color: Provide colored concrete where shown on the Drawings and specified. Incorporate pigments into the concrete mix according to manufacturer's written instructions. Match sample color approved by ENGINEER.

2.7 BONDING AGENT

A. Provide epoxy and epoxy-cement bonding agents as specified in Section 03251, Concrete Joints.

2.8 CONCRETE CURING MATERIALS

A. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 10 ounces per square yard and complying with AASHTO M 182, Class 3.

B. Curing Mats: Curing mats shall be heavy carpets or cotton mats, quilted at 4-inches on center. Curing mats shall weigh a minimum of 12 ounces per square yard when dry.

C. Moisture Retaining Cover: One of the following, complying with ASTM C 171.
1. Waterproof paper.
2. Polyethylene film.
3. White burlap-polyethylene sheet.

D. Curing Compound: ASTM C 309 Type 1-D (water retention requirements):
1. Product and Manufacturer: Provide one of the following:
a. Super Aqua Cure VOX, as manufactured by The Euclid Chemical Company.
b. Sealtight 1100, as manufactured by W.R. Meadows, Incorporated.
c. MasterKure, as manufactured by Master Builders, Inc.
d. Or equal.
2. Provide fugitive dye.
3. Curing compound must be applied by roller or power sprayer.

2.9 FINISHING AIDS

A. Evaporation Retardant:
1. Product and Manufacturer: Provide one of the following:
a. Confilm, as manufactured by Master Builders.
b. Eucobar, as manufactured by Euclid Chemical Company.

c. SikaFilm by Sika Corporation.
d. Or equal.

2.10 CRACK INJECTION MATERIALS

A. Epoxy:
1. Epoxy for injection shall be a low viscosity, high modulus moisture insensitive type.
2. Products and Manufacturers: Provide one of the following:
a. Sikadur 35, Hi-Mod L.V. and Sikadur 31, Hi-Mod Gel, as manufactured by Sika Corporation.
b. Eucopoxy Injection Resin, as manufactured by The Euclid Chemical Company.
c. Or equal.

B. Hydrophilic Resin
1. Hydrophilic resin shall be an acrylic-ester based resin with a maximum viscosity of 50 cps. It shall cure into a flexible rubber-like material that has the potential for unrestrained increase in volume in excess of 100 percent in the presence of water.
2. Products and Manufacturers: Provide one of the following:
a. Duroseal Inject, as manufactured by BBZ USA, Inc.
b. Sika Injection 29, by Sika Corporation.
c. Or equal.

2.11 CONCRETE REPAIR MATERIALS

A. Concrete repair mortar shall be a prepackaged polymer-modified cementitious repair mortar with the following minimum properties:
1. Compressive strength at one day: 2000 psi (ASTM C 109).
2. Compressive strength at 28 days: 6000 psi (ASTM C 109).
3. Bond strength at 28 days: 1800 psi (ASTM C 882 modified).

B. Concrete repair mortar shall be:
1. Five Star Structural Concrete, manufactured by Five Star Products, Inc. The formulation recommended by the manufacturer for the specific application conditions shall be used.
2. SikaTop 122 Plus, SikaTop 123 Plus, SikaTop 111 Plus, or Sikacem 133, manufactured by the Sika Corporation. The formulation, among those listed, recommended by the manufacturer for the specific application conditions shall be used.
3. Emaco S88-CA or S66-CR, manufactured by Master Builders Inc. The formulation, among those listed, recommended by the manufacturer for the specific application conditions shall be used.

4. Verticoat, Verticoat Supreme, or Euco SR-VO, manufactured by the Euclid Chemical Company. The formulation, among those listed, recommended by the manufacturer for the specific application conditions shall be used.
5. Or equal.

C. Cement Mortar: Cement mortar shall consist of a mix of one part cement to 1 1/2 parts sand with sufficient water to form a trowelable consistency. Minimum compressive strength at 28 days shall be 4000 psi. Where required to match the color of adjacent concrete surfaces, white portland cement shall be blended with standard portland cement so that, when dry, the patching mortar shall match the color of the surrounding concrete.

2.12 CHEMICAL HARDENER

A. Provide a clear chemical hardener of the fluosilicate family.

B. Product and Manufacturer: Provide one of the following:
1. Lapidolith, as manufactured by Sonneborn ChemRex Inc.
2. Hornolith, as manufactured by A.C. Horn, Inc.
3. Or equal.

2.13 SHAKE-ON METALLIC HARDENER

A. Provide a metallic hardener formulated, processed and packaged under stringent quality control at the manufacturer's owned and controlled factory. The hardener shall be a mixture of specially processed and graded aggregate, selected portland cement and plasticizing agents.

B. Product and Manufacturer: Provide one of the following:
1. Euco-Plate H.D., as manufactured by the Euclid Chemical Company.
2. Masterplate 200, as manufactured by Master Builders, Inc.
3. Or equal.

2.14 MOISTURE BARRIER

A. Moisture Barrier: ASTM E 154:
1. Provide moisture barrier cover over prepared base material where shown on the Drawings. Use polyethylene membrane not less than 8 mils thick, lapping at least 9-inches at joints.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and the conditions under which Work is to be performed and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 CONCRETE MIXING

A. General:
   1. Concrete may be produced at batch plants or it may be produced by the ready-mixed process. Batch plants shall comply with the recommendations of ACI 304, and shall have sufficient capacity to produce concrete of the qualities specified, in quantities required to meet the construction schedule. All plant facilities are subject to testing laboratory inspection and acceptance of ENGINEER.
   2. Mixing:
      a. Mix concrete with an approved rotating type batch machine, except where hand mixing of very small quantities may be permitted.
      b. Remove hardened accumulations of cement and concrete frequently from drum and blades to assure acceptable mixing action.
      c. Replace mixer blades when they have lost ten percent of their original height.
      d. Use quantities such that a whole number of bags of cement is required, unless otherwise permitted.

B. Job Site Mixing: When job site mixing of concrete is permitted, mix all materials for concrete in an acceptable drum type batch machine mixer. For mixers of one cubic yard, or smaller capacity, continue mixing at least 1-1/2 minutes, but not more than five minutes after all ingredients are in the mixer, before any part of the batch is released. For mixers of capacity larger than one cubic yard, increase the minimum 1-1/2 minutes of mixing time by 15 seconds for each additional cubic yard, or fraction thereof. Do not exceed the catalog rating or Manufacturer nameplate capacity for the total volume of materials used per batch. Equip the mixer with automatic controls, or semi-automatic controls if acceptable, for proportioning materials and the proper measured quantities. Do not exceed 45 minutes total elapsed time between intermingling of damp aggregates and cement to the discharge of the completed mix.
   1. Provide a batch ticket for each batch discharged and used in the Work, indicating the project identification name and number, date, mix type, mix time, quantity and amount of water introduced.

C. Ready-Mix Concrete:
   1. Comply with the requirements of ASTM C 94, and as herein specified. Proposed changes in mixing procedures, other than herein specified, must be accepted by ENGINEER before implementation.
      a. Plant equipment and facilities: Conform to National Ready-Mix Concrete Association "Plant and Delivery Equipment Specification".

b. Mix concrete in revolving type truck mixers that are in good condition and which produce thoroughly mixed concrete of the specified consistency and strength.
c. Do not exceed the proper capacity of the mixer.
d. Mix concrete for a minimum of two minutes after arrival at the job site, or as recommended by the mixer manufacturer.
e. Do not allow the drum to mix while in transit.
f. Mix at proper speed until concrete is discharged.
g. Maintain adequate facilities at the job site for continuous delivery of concrete at the required rates.
h. Provide access to the mixing plant for ENGINEER at all times.

2. When silica fume is used in the dry compacted form, the following mix requirements shall be followed to ensure full dispersion.
   a. For all types of mixing equipment, mix times shall be increased by 40 percent over the minimum mix time required to achieve mix uniformity as defined by ASTM C 94.
   b. For truck-mixed and central mixed concrete, maximum allowable batch size shall be 80 percent of the maximum in accordance with ASTM C 94.

D. Maintain equipment in proper operating condition, with drums cleaned before charging each batch. Schedule rates of delivery in order to prevent delay of placing the concrete after mixing, or holding dry-mixed materials too long in the mixer before the addition of water and admixtures.

3.3 TRANSPORTING CONCRETE

A. Transport and place concrete not more than 90 minutes after water has been added to the dry ingredients.

B. Take care to avoid spilling and separation of the mixture during transportation.

C. Do not place concrete in which the ingredients have been separated.

D. Do not retemper partially set concrete.

E. Use suitable and approved equipment for transporting concrete from mixer to forms.

3.4 PREPARTION FOR CONCRETING

A. All reinforcement, installation of waterstop and positioning of embedded items shall be inspected and approved by the ENGINEER a minimum of four hours prior to concrete placement.

B. Subgrade surfaces shall be thoroughly wetted by sprinkling, prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the

time of placing concrete thereon. The surface shall be free from standing water, mud, and debris at the time of placing concrete.

C. All reinforcing steel and embedded items shall be completely cleaned of mortar, loose rust, form release compounds, dirt, or any other substance which would interfere with proper bonding with concrete. Protective coatings on embedded aluminum items shall continuously cover the surface to be in contact with concrete. Any defects in the coating shall be repaired.

D. No concrete shall be placed in any structure until all water entering the space to be filled with concrete has been properly cut off or has been diverted by pipes, or other means, and carried out of the forms, clear of the work. No concrete shall be deposited underwater, nor shall CONTRACTOR allow still water to rise on any concrete until the concrete has attained its initial set. Water shall not be permitted to flow over the surface of any concrete in such manner and at such velocity as will injure the surface finish of the concrete. Pumping or other necessary dewatering operations for removing ground water, if required, will be subject to the review of the ENGINEER.

E. Joint surfaces shall be prepared as required by Section 03251, Concrete Joints.

3.5 CONCRETE PLACEMENT

A. General: Place concrete continuously so that no concrete will be placed on concrete that has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as specified in Section 03251, Concrete Joints. Deposit concrete as nearly as practical in its final location to avoid segregation due to rehandling or flowing. Do not subject concrete to any procedure which will cause segregation.
   1. Screed concrete that is to receive other construction to the proper level to avoid excessive skimming or grouting.
   2. Do not use concrete which becomes non-plastic and unworkable, or does not meet the required quality control limits, or which has been contaminated by foreign materials. Do not use retempered concrete. Remove rejected concrete from the job site and dispose of it in an acceptable location.
   3. Do not place concrete until all forms, bracing, reinforcement, and embedded items are in final and secure position.
   4. Unless otherwise approved, place concrete only when ENGINEER is present.
   5. Allow a minimum of three days before placing concrete against a slab or wall already in place.

B. Bonding for Next Concrete Pour:
   1. Prepare for bonding of fresh concrete to new concrete that has set but is not fully cured, as follows:
      a. Thoroughly wet the surface, but allow no free standing water.

b. For horizontal surfaces place a 2-inch layer of mortar, one part sand and one part cement with water added to a flowable consistency, or a 6-inch layer of Construction Joint Grout, as specified in Section 03600, Grout, over the hardened concrete surface.
c. Place fresh concrete before the mortar/grout has attained its initial set.
d. If a high range water reducer is used to increase the concrete slump to at least 6-inches, the mortar/grout layer may be omitted.

2. Bonding of fresh concrete to fully-cured hardened existing concrete shall be accomplished by using a bonding agent as specified in Section 03251, Concrete Joints.

C. Concrete Conveying:
1. Handle concrete from the point of delivery and transfer to the concrete conveying equipment and to the locations of final deposit as rapidly as practical by methods that will prevent segregation and loss of concrete mix materials.
2. Provide mechanical equipment for conveying concrete to ensure a continuous flow of concrete at the delivery end. Provide runways for wheeled concrete conveying equipment from the concrete delivery point to the locations of final deposit. Keep interior surfaces of conveying equipment, including chutes, free of hardened concrete, debris, water, ice and other deleterious materials.
3. Do not use chutes for distributing concrete, unless approved in writing by ENGINEER.
a. Provide sketches showing methods by which chutes will be employed when requesting such approval.
b. Design chutes, if permitted, with proper slopes and supports to permit efficient handling of the concrete.
4. Pumping concrete is permitted, however do not use aluminum pipe for conveying.

D. Placing Concrete into Forms:
1. Deposit concrete in forms in horizontal layers not deeper than 18-inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place concrete at such a rate that concrete that is being integrated with fresh concrete is still plastic.
2. Do not permit concrete to free fall within the form from a distance exceeding four feet. Where high range water reducer is used to extend slump to at least 6- inches, the maximum free fall of concrete may be increased to six feet. If a 12-inch thick layer of construction joint grout, as specified in Section 03251, Concrete Joints, is placed on the horizontal joint, concrete with slump extended by a high range water reducer may free fall up to eight feet in walls that are 24-inches and thicker. Use "elephant trunks" to prevent free fall and excessive splashing on forms and reinforcement. Free falls in excess of four feet shall be discontinued if there is any evidence of segregation.
3. Remove temporary spreaders in forms when concrete placing has reached the elevation of such spreaders.

4. Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with the applicable recommended practices of ACI 309. Vibration of forms and reinforcing will not be permitted, unless otherwise accepted by ENGINEER.
5. Where height of concrete placement in walls exceeds 14 feet, temporary windows shall be installed in the formwork to facilitate vibration. The windows shall be properly closed when the height of concrete approaches the windows. Location, size, and spacing of the windows shall be determined by CONTRACTOR to suit equipment used.
6. Do not use vibrators to transport concrete inside of forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate the layer of concrete and at least 6-inches into the preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit the duration of vibration to the time necessary to consolidate the concrete and complete embedment of reinforcement and other embedded items without causing segregation of the mix.
7. Do not place concrete in beam and slab forms until the concrete previously placed in columns and walls is no longer plastic.
8. Force concrete under pipes, sleeves, openings and inserts from one side until visible from the other side to prevent voids.

E. Placing Concrete Slabs:
1. Deposit and consolidate concrete slabs in a continuous operation, within the limits of construction joints, until the placing of a panel or section is completed.
2. Consolidate concrete during placing operations using mechanical vibrating equipment, so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Consolidate concrete placed in beams and girders of supported slabs, and against bulkheads of slabs on ground, as specified for formed concrete structures.
4. Bring slab surfaces to the correct level. Smooth the surface, leaving it free of humps or hollows. Do not sprinkle water on the plastic surface. Do not disturb the slab surfaces prior to beginning finishing operations.
5. Where slabs are placed in conditions of high temperature or wind that could lead to formation of plastic shrinkage cracks, an evaporation retardant shall be applied in accordance with the manufacturer's recommendations, when required by the ENGINEER.

F. Quality of Concrete Work:
1. Make all concrete solid, compact and smooth, and free of laitance, cracks and cold joints.
2. All concrete for liquid retaining structures, and all concrete in contact with earth, water, or exposed directly to the elements shall be watertight.

3. Cut out and properly replace to the extent directed by ENGINEER, or repair to the satisfaction of ENGINEER, surfaces which contain cracks or voids, are unduly rough, or are in any way defective. Thin patches or plastering shall not be acceptable.
4. All leaks through concrete that exhibit any flowing water, and cracks, holes or other defective concrete in areas of potential leakage, shall be repaired and made watertight by CONTRACTOR.
5. Repair, removal, and replacement of defective concrete as directed by ENGINEER shall be at no additional cost to the OWNER.

G. Cold Weather Placing:
1. Protect all concrete Work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures, in compliance with the requirements of ACI 306 and as herein specified.
2. When the air temperature has fallen to or may be expected to fall below 40°F, provide adequate means to maintain the temperature, in the area where concrete is being placed, at between 50°F and 70°F for at least seven days after placing. Provide temporary housings or coverings including tarpaulins or plastic film. Maintain the heat and protection, if necessary, to ensure that the ambient temperature does not fall more than 30°F in the 24 hours following the seven-day period. Avoid rapid dry-out of concrete due to overheating, and avoid thermal shock due to sudden cooling or heating.
3. When air temperature has fallen to or is expected to fall below 40°F, uniformly heat all water and aggregates before mixing as required to obtain a concrete mixture temperature of not less than 55°F and not more than 85°F at point of placement.
4. Do not use salt and other materials containing antifreeze agents or chemical accelerators, or set-control admixtures, unless approved by ENGINEER, in mix designs.

H. Hot Weather Placing:
1. When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
2. When ambient air temperature is at or above 90°F, cool ingredients before mixing to maintain concrete temperature at time of placement below 80°F when the air temperature is rising and below 85°F when the air temperature is falling. Mixing water may be chilled, or chopped ice may be used to control the concrete temperature provided the water equivalent of the ice is calculated in the total amount of mixing water. In addition, the reduction in time from addition of mix water to placement or the use of a set retarding admixture may be required.
3. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
4. Wet forms thoroughly before placing concrete.

5. Do not place concrete at a temperature so as to cause difficulty from loss of slump, flash set, or cold joints.
6. Do not use set-control admixtures, unless approved by ENGINEER in mix designs.
7. Obtain ENGINEER'S approval of other methods and materials proposed for use.

3.6 FINISH OF FORMED SURFACES

A. Standard Form Finish:
   1. Standard form finish shall be basically smooth and even but shall be permitted to have texture imparted by the form material used. Defects shall be repaired as specified herein.
   2. Use standard form finish for the following:
      a. Exterior vertical surfaces from the foundation up to one foot below grade.
      b. Vertical surfaces not exposed to view.
      c. Other areas shown.

B. Smooth Form Finish:
   1. Produce smooth form finish by selecting form materials that will impart a smooth, hard, uniform texture. Arrange panels in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas as specified herein.
   2. Use smooth form finish for the following:
      a. Exterior surfaces that are exposed to view.
      b. Surfaces that are to be covered with a coating material. The material may be applied directly to the concrete or may be a covering bonded to the concrete such as waterproofing, dampproofing, painting or other similar system.
      c. Interior vertical surfaces of liquid containers.
      d. Interior and exterior exposed beams and undersides of slabs.
      e. Surfaces to receive an abrasive blasted finish.
      f. Surfaces to receive a smooth rubbed or grout cleaned finish.
      g. Other areas shown.

C. Smooth Rubbed Finish:
   1. Provide smooth, Class A, rubbed finish to concrete surfaces, which have received smooth form finish and where all defects have been repaired, as follows:
      a. Rubbing of concrete surfaces not later than the day after form removal.
      b. Moistening of concrete surfaces and rubbing with carborundum brick or other abrasive until a uniform color and texture is produced. Do not apply cement grout other than that created by the rubbing process.
   2. Except where surfaces have been previously covered as specified above, use smooth, Class A, rubbed finish for the following:
      a. Interior exposed walls and other vertical surfaces.

b. Exterior exposed walls and other vertical surfaces down to one foot below grade.
c. Interior and exterior horizontal surfaces, except exterior exposed slabs and steps.
d. Interior exposed vertical surfaces of liquid containers down to one foot below liquid level.
e. Other areas shown on the Drawings.

D. Grout Cleaned Finish:
1. Provide grout cleaned finish to concrete surfaces, which have received smooth form finish and where all defects have been repaired, as follows:
a. Combine one part portland cement to 1-1/2 parts fine sand by volume, and mix with water to the consistency of thick paint. Blend standard portland cement and white portland cement, amounts determined by trial patches, so that the final color of dry grout will closely match adjacent concrete surfaces.
b. Thoroughly wet the concrete surface and apply grout uniformly by brushing or spraying immediately to the wetted surfaces. Scrub surface with cork float or stone to coat surface and fill surface holes. Remove excess grout by scraping, followed by rubbing with clean burlap to remove any visible grout film. Keep grout damp during the setting period by means of fog spray at least 36 hours after final rubbing. Complete any area in the same day it is started, with the limits of any area being natural breaks in the finished surface.
2. Except where surfaces have been previously covered as specified above, use grout cleaned finish for the following:
a. Interior exposed walls and other vertical surfaces.
b. Exterior exposed walls and other vertical surfaces down to one foot below grade.
c. Interior and exterior horizontal surfaces, except exterior exposed slabs and steps.
d. Interior exposed vertical surfaces of liquid containers down to one foot below liquid level.
e. Other areas shown on the Drawings.

E. Abrasive Blasted Finish
1. Provide abrasive blasted finish where shown.
2. Where abrasive blasted finish is indicated, it shall be applied to a smooth formed finish after the end of the curing period, with all defects repaired, to match the approved finish provided on the mock-up panel.
3. Heavy Abrasive Blasted Finish: Abrasive blast to uniformly expose coarse aggregate.
4. Light Abrasive Blasted Finish: Abrasive blast to uniformly expose fine aggregate.

F. Related Unformed Surfaces:

1. At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike off smooth and finish with a texture matching the adjacent formed surfaces. Continue the final surface treatment of formed surfaces uniformly across the adjacent unformed surfaces, unless otherwise shown.

3.7 SLAB FINISHES

A. Float Finish:
   1. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when the surface water has disappeared or when the concrete has stiffened sufficiently. Check and level the surface plane to a tolerance not exceeding 1/4-inch in ten feet when tested with a ten foot straightedge placed on the surface at not less than two different angles. Cut down high spots and fill all low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat the surface to a uniform, smooth, granular texture.
   2. Use float finish for the following:
      a. Interior exposed horizontal surfaces of liquid containers, except those to receive grout topping.
      b. Exterior below grade horizontal surfaces.
      c. Surfaces to receive additional finishes, except as shown or specified.

B. Trowel Finish:
   1. After floating, begin the first trowel finish operation using a power-driven trowel. Begin final troweling when the surface produces a ringing sound as the trowel is moved over the surface.
   2. Consolidate the concrete surface by the final hand troweling operation. Finish shall be free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8-inch in ten feet when tested with a ten foot straight edge. Grind smooth surface defects that would telegraph through applied floor covering system.
   3. Use trowel finish for the following:
      a. Interior exposed slabs, unless otherwise shown or specified.
      b. Slabs to receive resilient floor finishes.

C. Non-Slip Broom Finish:
   1. Immediately after float finishing, slightly roughen the concrete surface by brooming in the direction perpendicular to the main traffic route. Use fine fiber-bristle broom, unless otherwise directed by the ENGINEER. Coordinate the required final finish with ENGINEER before application.
   2. Use Non-Slip Broom Finish for the following:
      a. Exterior exposed horizontal surfaces subject to light foot traffic.
      b. Interior and exterior concrete steps and ramps.
      c. Horizontal surfaces which will receive a grout topping or a concrete equipment base slab.

D. Shake-On Metallic Finish:
   1. All slabs as shown, shall receive an application of shake-on metallic hardener at the rate of two pounds per square foot. The first shake shall comprise 2/3 of the specified amount of hardener. This application shall be made after the initial floating operation, unless climatic conditions dictate earlier application. The shake-on metallic hardener shall be floated in the second application made. The surface shall be floated again sufficiently to properly bond the hardener to the base concrete slab. The surface shall then be troweled, at least twice, to a smooth dense finish.
   2. Field service shall be provided, upon five days notice by the manufacturer of the hardener to assist CONTRACTOR in obtaining the maximum benefits of the product under the prevailing jobsite conditions. In addition, the representative shall attend the Concrete Coordination Meeting.
   3. Use shake-on metallic hardener finish with Type "3" concrete for slabs where noted on Drawings.
   4. Protect slabs against oil and greases. Remove all dripping, flaking or loose substances and any other bonded foreign particles from slab surface that might prevent adhesion of composition.
   5. Do not patch or otherwise work on damaged or imperfect floors without first coordinating with applicator.

3.8 CONCRETE CURING AND PROTECTION

A. General:
   1. Protect freshly placed concrete from premature drying and excessive cold or hot temperature, and maintain without drying at a relatively constant temperature for the period of time necessary for hydration of the cement and proper hardening of the concrete.
   2. Start initial curing after placing and finishing concrete as soon as free moisture has disappeared from the concrete surface. Keep continuously moist for not less than 72 hours.
   3. Begin final curing procedures immediately following initial curing and before the concrete has dried. Continue final curing for at least seven days and in accordance with ACI 301 procedures for a total curing period, initial plus final, of at least ten days. For concrete sections over 30-inches thick, continue final curing for an additional seven days, minimum. Avoid rapid drying at the end of the final curing period.

B. Curing Methods:
   1. Water retaining and below grade structures shall be moist cured by the addition of water to maintain the surface in a continually wet condition. Other concrete shall be cured by moist curing, by moisture retaining cover curing, or by the use of curing compound. Use curing compound at water retaining and below grade structures only in cold weather and only when permitted by ENGINEER.

a. For curing, use water that is free of impurities that could etch or discolor exposed, natural concrete surfaces.

2. Provide moisture curing by any of the following methods:
   a. Keeping the surface of the concrete continuously wet by covering with water.
   b. Continuous water-fog spray.
   c. Covering the concrete surface with curing mats, thoroughly saturating the mats with water, and keeping the mats continuously wet with sprinklers or porous hoses. Place curing mats so as to provide coverage of the concrete surfaces and edges, with a 4-inch lap over adjacent mats. If necessary, the curing cover shall be weighted to maintain contact with the concrete surface.
   d. At the end of the curing period apply one coat of curing compound, unless concrete surface is to receive a topping or coating or application is waived by the ENGINEER.
3. Provide moisture retaining cover curing as follows:
   a. Cover the concrete surfaces with the specified moisture retaining cover for curing concrete, placed in the widest practical width with sides and ends lapped at least 3-inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during the curing period using cover material and waterproof tape.
4. Provide liquid curing compound as follows:
   a. Apply the specified curing compound to all concrete surfaces when permitted by ENGINEER. Slabs to receive terrazzo floors, chemical resistant heavy duty concrete topping or ceramic tile, shall not be cured with liquid curing compound, but shall be moisture cured. The compounds shall be applied immediately after final finishing in a continuous operation by power spray equipment in accordance with the manufacturer's directions. Recoat areas that are subjected to heavy rainfall within three hours after initial application. Maintain the continuity of the coating and repair damage to the coat during the entire curing period. For concrete surfaces that will be in contact with potable water, the manufacturer shall certify that the curing compound meets the requirements of ANSI/NSF 61.
   b. When curing compound is authorized for application to water retaining or below grade members, it shall be applied at the manufacturer's recommended coverage rate and then applied again at the same rate to provide twice the recommended coverage.
   c. At the end of the curing period, curing compound shall be removed where required by the ENGINEER.

C. Curing Formed Surfaces:
   1. Cure formed concrete surfaces; including the undersides of girders, beams, supported slabs and other similar surfaces by moist curing with the forms in place unloosened for the full curing period or until forms are removed. Where wood forms are kept in place, water shall be added to keep the forms wet. If forms are removed, continue curing by methods specified above, as applicable.

D. Curing Unformed Surfaces:
   1. Initially cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by using the appropriate method specified above.
   2. Final cure unformed surfaces, unless otherwise specified, by utilizing methods specified above, as applicable.

E. Temperature of Concrete During Curing:
   1. When the atmospheric temperature is 40°F and below, maintain the concrete temperature between 50°F and 70°F continuously throughout the curing period. When necessary, make arrangement before concrete placing for heating, covering, insulation or housing as required to maintain the specified temperature and moisture conditions continuously for the concrete curing period. Provide cold weather protection complying with the requirements of ACI 306.
   2. When the atmospheric temperature is 80°F and above, or during other climatic conditions which will cause too rapid drying of the concrete, make arrangements before the start of concrete placing for the installation of wind breaks or shading, and for fog spraying, wet sprinkling, or moisture retaining covering. Protect the concrete continuously for the concrete curing period. Provide hot weather protection complying with the requirements of ACI 305, unless otherwise specified.
   3. Maintain concrete temperature as uniformly as possible, and protect from rapid atmospheric temperature changes. Avoid temperature changes in concrete which exceed 5°F in any one hour and 50°F in any 24 hour period.

F. Protection from Mechanical Injury:
   1. During the curing period, protect concrete from damaging mechanical disturbances including load stresses, heavy shock, excessive vibration, and from damage caused by rain or flowing water. Protect all finished concrete surfaces from damage by subsequent construction operations.

3.9 FIELD QUALITY CONTROL

A. The OWNER shall employ a testing laboratory to perform field quality control testing. ENGINEER will direct the number of tests and cylinders required. Make standard compression test cylinders and entrained air tests as specified below, under the direct inspection by ENGINEER. Also, provide all labor, material and equipment required including, scale, glass tray, cones, rods, molds, air tester, thermometer, curing in a heated storage box, and all other incidentals required. Above will be subject to approval by ENGINEER. Furnish all necessary storage and curing, as specified in Section 01450, On-Site Facilities for Testing Laboratory, and transportation required by the testing.

B. Quality Control Testing During Construction:
   1. Perform sampling and testing for field quality control during the placement of concrete, as follows:

a. Sampling Fresh Concrete: ASTM C 172.
b. Slump: ASTM C 143; one test for each concrete load at point of discharge; and one for each set of compressive strength test specimens.
c. Air Content: ASTM C 231; one for every other concrete load at point of discharge, or when required by an indication of change.
d. Compressive Strength Tests: ASTM C 39; one set of compression cylinders for each 50 cubic yards or fraction thereof, of each mix design placed in any one day; one specimen tested at seven days, and three specimens tested at 28 days.
    1) Adjust mix if test results are unsatisfactory and resubmit for ENGINEER'S approval.
    2) Concrete that does not meet the strength requirements is subject to rejection and removal from the Work, or to other such corrective measures as directed by ENGINEER, at the expense of CONTRACTOR.
e. Compression Test Specimens: ASTM C 31; make one set of four standard cylinders for each compressive strength test, unless otherwise directed.
    1) Cast, store and cure specimens as specified in ASTM C 31.
f. Concrete Temperature: Test hourly when air temperature is 40°F and below, and when 80°F and above; and each time a set of compression test specimens is made.

2. The testing laboratory shall submit certified copies of test results directly to ENGINEER and CONTRACTOR within 24 hours after tests are made.

C. Evaluation of Quality Control Tests:
1. Do not use concrete delivered to the final point of placement, which has slump or total air content outside the specified values.
2. When water content testing indicates water-cementitious materials ratio to exceed specified requirements by more than 0.02, remaining batches needed to complete the concrete placement shall have water content decreased in the mix and water reducing admixture dosage increased as needed to bring the subsequently batched concrete within the specified water-cementitious materials ratio. Additional testing shall be done to verify compliance with the specified water-cementitious materials ratio. Concrete production for further concrete placements shall not resume until CONTRACTOR has identified the cause of the excess water in the mix and revised batching procedures and/or adjustments to mix design needed to bring water-cementitious materials ratio into conformance with specified requirements have been accepted by Engineer.
3. Compressive strength tests for laboratory-cured cylinders will be considered satisfactory if the averages of all sets of three consecutive compressive strength tests results equal or exceed the 28 day design compressive strength of the type or class of concrete; and, no individual strength test falls below the required compressive strength by more than 500 psi.
    a. Where questionable field conditions may exist during placing concrete or immediately thereafter, strength tests of specimens cured under field conditions will be required by ENGINEER to check the adequacy of curing

and protecting of the concrete placed. Specimens shall be molded at the same time and from the same samples as the laboratory cured specimens.

1) Provide improved means and procedures for protecting concrete when the 28 day compressive strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders.
2) When laboratory-cured cylinder strengths are appreciably higher than the minimum required compressive strength, field-cured cylinder strengths need not exceed the minimum required compressive strength by more than 500 psi even though the 85 percent criterion is not met.
3) If individual tests of laboratory-cured specimens produce strengths more than 500 psi below the required minimum compressive strength, or if tests of field-cured cylinders indicate deficiencies in protection and curing, provide additional measures to assure that the load-bearing capacity of the structure is not jeopardized. If the likelihood of low-strength concrete is confirmed and computations indicate the load-bearing capacity may have been significantly reduced, tests of cores drilled from the area in question will be required at CONTRACTOR'S expense.

b. If the compressive strength tests fail to meet the minimum requirements specified, the concrete represented by such tests will be considered deficient in strength and subject to replacement, reconstruction or to other action approved by ENGINEER.

D. Testing Concrete Structure for Strength:

1. When there is evidence that the strength of the in-place concrete does not meet specification requirements, employ at CONTRACTOR'S expense the services of a concrete testing service to take cores drilled from hardened concrete for compressive strength determination. Tests shall comply with the requirements of ASTM C 42 and the following:
   a. Take at least three representative cores from each member or suspect area at locations directed by ENGINEER.
   b. Strength of concrete for each series of cores will be considered satisfactory if their average compressive strength is at least 85 percent and no single core is less than 75 percent of the 28 day required compressive strength.
   c. Report test results to ENGINEER, in writing, on the same day that tests are made. Include in test reports, the Project identification name and number, date, name of CONTRACTOR, name of concrete testing service, location of test core in the structure, type or class of concrete represented by core sample, nominal maximum size aggregate, design compressive strength, compression breaking strength and type of break (corrected for length-diameter ratio), direction of applied load to core with respect to horizontal plane of the concrete as placed, and the moisture condition of the core at time of testing.
2. Fill core holes solid with non-shrink, high strength grout, and finish to match adjacent concrete surfaces.

3. Conduct static load test and evaluations complying with the requirements of ACI 318 if the results of the core tests are unsatisfactory, or if core tests are impractical to obtain, as directed by ENGINEER.

3.10 MISCELLANEOUS CONCRETE ITEMS

A. Temporary Openings
   1. Openings in concrete walls and/or slabs required for passage of Work or installation of equipment and not shown on the Drawings shall be provided, but only with approval of the ENGINEER.
   2. All temporary openings made in concrete shall be provided with waterstop in below grade or water retaining members. Continuity of required reinforcement shall be provided in a manner acceptable to the ENGINEER.
   3. Temporary openings left in concrete structures shall be filled with concrete after the Work causing the need for the opening is in place, unless otherwise shown or directed. Mix, place and cure concrete as specified herein, to blend with in-place construction. Provide all other miscellaneous concrete filling shown or required to complete the Work.

B. Equipment Bases:
   1. Unless specifically shown otherwise, provide concrete bases for all pumps and other equipment. Coordinate and construct bases to the dimensions shown, or as required to meet manufacturers; requirements and Drawing elevations. Where no specific elevations are shown, bases shall be 6-inches thick and extend 3-inches outside the metal equipment base or supports. Bases shall have smooth trowel finish, unless a special finish such as terrazzo, ceramic tile or heavy duty concrete topping is required. In those cases, provide appropriate concrete finish.
   2. Include all concrete equipment base work not specifically included under other Sections.
   3. In general, place bases up to 1-inch below the metal base. Properly shim equipment to grade and fill 1-inch void with non-shrink grout as specified in Section 03600, Grout.

C. Curbs:
   1. Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
   2. Exterior curbs shall have rubbed finish for vertical surfaces and a broomed finish for top surfaces.

D. Steel Pan Stairs:
   1. Provide concrete fill for steel pan stair treads and landings and associated items. Screed, tamp, and finish concrete surfaces as shown.
      a. Cast-in safety inserts and accessories as shown.

E. Slabs/Foundations:

1. All mechanical pipe and electrical conduit penetrations through concrete slabs must be sleeved.

3.11 CONCRETE REPAIRS

A. Repair of Formed Surfaces:
   1. The following defects shall be repaired in all types of formed finishes:
      a. Spalls, air bubbles, rock pockets, form depressions, and other defects that are more than 1/4-inch in depth.
      b. Holes from tie rods and other form tie systems.
      c. Fins, offsets and other projections that extend more than 1/4-inch beyond the designated member surface.
      d. Structural cracks, as defined by the ENGINEER.
      e. Non-structural cracks, as defined by the ENGINEER, which are greater than 0.010-inch wide. In water retaining members, elevated slabs subject to rainfall and washdown, and below grade members, any crack that shows any amount of leakage. Where it is not possible to verify that a crack is not leaking, it shall be repaired.
   2. The following defects shall be repaired in smooth finish surfaces, in addition to those listed above:
      a. Spalls, air bubbles, rock pockets, form depressions, and other defects which extend to more than 1/2-inch in width in any direction, no matter how deep.
      b. Spalls, air bubbles, rock pockets, form depressions, and other defects of any size that exceed three in number in a 12-inch square or 12 in number in a three foot square.
      c. Fins, offsets and other projections shall be completely removed and smoothed.
      d. Scratches and gouges in the surface.
      e. Texture and color irregularities. At water retaining surfaces, texture and color irregularities need not be repaired when greater than 12-inches below the minimum normal operating water surface, except where such defects are indicative of reduced durability.
   3. Where a smooth rubbed or grout cleaned finish is specified, minor surface defects repairable by the finishing process need not be repaired prior to the finish application, when approved by the ENGINEER.

B. Method of Repair of Formed Surfaces:
   1. Repair and patch defective areas with cement mortar or concrete repair mortar immediately after removal of forms and as directed by ENGINEER. Repairs made to water bearing and buried surfaces shall be made with repair mortar only. Repairs of form tie holes on water bearing or buried surfaces shall be made with non-shrink grout as specified in Section 03600, Grout.
   2. Cut out honeycomb, rock pockets, voids, and holes left by tie rods and bolts, down to solid concrete but, in no case, to a depth of less than 1-inch for cement mortar and 1/2-inch for repair mortar. Make edges of cuts perpendicular to the concrete surface. Before placing the cement mortar, thoroughly clean and brush-coat the area to be patched with the specified bonding agent. Where

concrete repair mortar is used, bonding agent shall be optional and the surface prepared and mortar placed per manufacturers recommendations.

a. Repairs at exposed-to-view surfaces shall match the color of surrounding concrete, except color matching is not required for the interior surfaces of liquid containers up to one foot below liquid level. Impart texture to repaired surfaces to match texture of existing adjacent surfaces. Provide test areas at inconspicuous locations to verify mixture, texture and color match before proceeding with the patching. Compact mortar in place and strike off slightly higher than the surrounding surface.

3. Structural cracks shall be pressure grouted using an injectable epoxy using a pumped pressure system. Apply in accordance with the manufacturer's directions and recommendations.
4. Non-structural cracks shall be pressure grouted using hydrophilic resin. Apply in accordance with the manufacturer's directions and recommendations.
5. Determination of the crack type shall be made by the ENGINEER.
6. Fill holes extending through concrete by means of a plunger- type gun or other suitable device from the least exposed face, using a flush stop held at the exposed face to ensure completely filling. At below grade and water retaining members, fill holes with concrete repair mortar except use a color matched cement mortar for the outer 2-inches at exposed to view surfaces.
7. Where powerwashing and/or scrubbing is not adequate, abrasive blast exposed-to-view surfaces that require removal of stains, grout accumulations, sealing compounds, and other substances marring the surfaces. Use sand finer than No. 30 and air pressure from 15 to 25 psi.

C. Repair of Unformed Surfaces:
1. Test unformed surfaces, such as monolithic slabs, for smoothness and to verify surface plane to the tolerances specified for each surface and finish. Correct low and high areas as herein specified.
2. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having the required slope. Correct high and low areas as herein specified.
3. Repair finish of unformed surfaces that contain defects that adversely affect the durability of the concrete. Surface defects include crazing, cracks in excess of 0.01-inch wide, spalling, popouts, honeycomb, rock pockets, and other objectionable conditions.
4. Repair structural cracks in all structures and non-structural cracks in water-holding structures. In water-holding structures, where the dry face of the concrete member can be observed, cracks that show any rate of water flow shall be repaired. Where the dry face of the member cannot be observed, all cracks shall be repaired.

D. Methods of Repair of Unformed Surfaces:
1. Correct high areas in unformed surfaces by grinding, after the concrete has cured sufficiently so that repairs can be made without damage to adjacent areas.

2. Correct low areas in unformed surfaces during, or immediately after completion of surface finishing operations by cutting out the low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Where the concrete has already set and repairs are required, sawcut around the perimeter of the area to be repaired to a 1/2-inch depth and remove concrete so that the minimum thickness of the repair is 1/2-inch. Apply specified concrete repair mortar in accordance with the manufacturer's directions and recommendations.
3. Repair defective areas, except random cracks and single holes not exceeding 1-inch diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts, and expose reinforcing steel with at least 3/4-inch clearance all around. The minimum thickness of the repair shall be 1.5-inches. Dampen all concrete surfaces in contact with patching concrete and brush with the specified bonding agent. Place patching concrete while the bonding agent is still tacky. Mix patching concrete of the same materials and proportions to provide concrete of the same classification as the original adjacent concrete. Place, compact and finish as required to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.
4. Repair isolated random non-structural cracks (in members which are not below grade or water retaining), and single holes not over 1-inch diameter, by the dry-pack method. Groove the top of cracks, and cut out holes to sound concrete and clean of dust, dirt and loose particles. Dampen all cleaned concrete surfaces and brush with the specified bonding agent. Place dry-pack before the cement grout takes its initial set. Mix dry-pack, consisting of one part portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched areas continuously moist for not less than 72 hours.
5. Structural cracks shall be pressure grouted using an injectable epoxy. Apply in accordance with the manufacturer's directions and recommendations.
6. Non-structural cracks in below grade and water retaining structures shall be pressure grouted using hydrophilic resin. Apply in accordance with the manufacturer's directions and recommendations.
7. Determination of the crack type shall be made by the ENGINEER.
8. Assure that surface is acceptable for flooring material to be installed in accordance with manufacturer's recommendations.

E. Other Methods of Repair:
   1. Repair methods not specified above may be used if approved by ENGINEER.

+ + END OF SECTION + +

SECTION 03400

PRECAST STRUCTURES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: This Section applies to all plant-precast products, including:
   1. Sitework:
      a. Catch basins
      b. Manholes
      c. Vaults
      d. Lift Stations
   2. Building work:
      a. Hollow-core Slabs
      b. Double-Tees
      c. Precast panels, not elsewhere specified
   3. Products shall be made of Portland cement concrete, except where designated on the drawings to be polymer concrete.

B. Related Sections:
   1. Section 03200 - Concrete Reinforcement
   2. Section 03300 - Cast-In-Place Concrete
   3. Section 05120 - Structural Steel
   4. Section 05500 - Metal Fabrications

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. International Building Code, 2018.
   2. ACI 318-14, Building Code Requirements for Concrete
   3. ACI 350-06, Code Requirements for Environmental Engineering Structures
   4. ACI 350.1, Tightness Testing of Environmental Engineering Concrete Structures
   5. ACI 440.1R-15 Guide for the Design and Construction of Structural Concrete Reinforced with Fiber-Reinforced Polymer (FRP) Bars
   6. ACI 548.6R-96 Polymer Concrete-Structural Applications State-of-the-Art Report
   7. PCI MNL-120: PCI Design Handbook, Precast and Prestressed Concrete
   8. PCI MNL-116: Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products
   9. AWS D1.1-20: Structural Welding Code – Steel
   10. AWS D1.4-18: Structural Welding Code - Reinforcing Steel
   11. ASTM A36M: Structural Steel
   12. ASTM A53: Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
   13. ASTM A108: Steel Bars, Carbon, Cold-Finished, Standard Quality

14. ASTM A184M: Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
15. ASTM A185: Steel Welded Wire Reinforcement, Plain, for Concrete Reinforcement
16. ASTM A307: Carbon Steel Bolts and Studs, 60,000 Tensile Strength
17. ASTM A325M: High-Strength Bolts for Structural Steel Joints
18. ASTM A416M: Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
19. ASTM A497: Steel Welded Wire Reinforcement, Deformed, for Concrete Reinforcement
20. ASTM A500: Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
21. ASTM A615M: Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
22. ASTM A706M: Low-Alloy Steel Deformed Bars for Concrete Reinforcement
23. ASTM C33: Concrete Aggregate
24. ASTM C330: Lightweight Aggregate
25. ASTM C150: Portland Cement
26. ASTM 0260: Air-Entraining Admixtures for Concrete
27. ASTM C 443 (most current) Standard Specification for Joints for Concrete Pipe and Manholes Using Rubber Gaskets
28. ASTM C478: Precast Concrete Manholes
29. ASTM C494: Chemical Admixtures for Concrete
30. ASTM C 497 (most current) Test Methods for Concrete Pipe, Manhole
31. ASTM C580 (most current) Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithihc Surfacings, and Polymer Concretes
32. ASTM C 857 (most current) Standard Practice for Minimum Structural Design Loading for Underground Utility Structures.
33. ASTM C 923 (most current) Standard Specifications for Resilient Connectors between Concrete Manholes Structures and Pipe.
34. ASTM C 990 (most current) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections using Preformed Flexible Joint Sealants
35. ASTM D 648 (most current) Test Method for Deflection Temperature of Plastics Under Flexural Load in Edgewise Position.
36. ASTM D 6783 (most current) Standard Specification for Polymer Concrete Pipe.
37. ASTM D 2584 (most current) Test Method for Ignition Loss of Cured Reinforced

B. System Description
   1. Precast products shall be designed for the indicated service, the loadings specified in the Contract Documents, and all transportation, handling, and erection loads, in accordance with requirements and recommendations of the references.
   2. If precast products are proposed as substitutes for cast-in-place designed structures, such precast products shall meet the above requirements and any other requirements for which the cast-in-place structures were designed by the Engineer. Such products shall be designed by an engineer licensed to practice in the State of ARIZONA.
   3. Items located in or adjacent to traffic areas shall be designed to resist AASHTO H-20-44 loading, unless otherwise indicated.
   4. Lifting inserts shall have a minimum safety factor of 4.

C. Qualifications
   1. Manufacturer: The precast manufacturing plant shall be certified by the Precast/ Prestressed Concrete Institute Plant Certification Program or the International Code Council as an Approved Fabricator for Group C3 or C4. Manufacturer shall comply

with the testing provisions in PCI MNL-116, Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.

2. Installer: Precast Items shall be installed by the Manufacturer or by an installer regularly engaged for at least 5 years in erection of precast products similar to those required on this project.
3. Welders (Shop, Plant and Field): Welders performing work under this specification shall be qualified in accordance with AWS D1.1 and/or D1.4, as required to perform work at all stages of production and erection.

D. In-Plant Quality Control—Portland cement concrete
1. The Manufacturer shall have an established PCI quality control program in effect prior to bidding. If requested, a copy of this program shall be submitted to the Engineer.
2. Testing of materials and inspection of production techniques shall be the responsibility of the Manufacturer's Quality Control Department.
3. Keep quality control records available for two years after final acceptance.
4. Keep certificates of compliance available for five (5) years after final acceptance.

E. In-Plant Quality Control—Polymer concrete
1. Facility Quality Control shall be maintained by adhering to ISO 9001:2018 for manufacturing. All fabricators shall be ISO 9001:2018 Certifiied.
2. All fabrication will take place in an all polymer concrete fabrication facility. At no time will the polymer concrete fabrication facility share the facility with a cementitious precast product production facility.
3. Fabricator is also to provide references of 10 previous projects in the last 5 years performed with both owner and contractor for reference and the scope and review by owner.
4. Keep quality control records available for two years after final acceptance.
5. Keep certificates of compliance available for five (5) years after final acceptance.

1.3 SUBMITTALS

A. Shop Drawings showing:
1. Material specifications;
2. All dead, live and other applicable loads used in the design;
3. Applicable standards (from "References") met by the item(s);
4. Setting plans locating and designating all items furnished by the manufacturer, with all major openings shown and located.
5. Details to indicate quantities, location and type of reinforcing and prestressing steel.
6. Sections and details showing connections, edge conditions, support conditions, and connections of the items.
7. Description of all embeds, including stripping, lifting and erection inserts, with piece mark and location, including those cast into products or sent loose to the job site.
8. Dimensions and special finishes.
9. Shop drawings shall be sealed by an Engineer licensed to practice in the State of Arizona.

B. Portland Cement Concrete: Submit mix designs, including strength history or Trial Batch strength results, for approval. Mix designs shall be prepared by an independent testing facility or qualified employee of the Precast Manufacturer.

C. Polymer Concrete:
   1. Proof of independent chemical resistance testing conducted in accordance with the standard specifications for public works construction (California Greenbook) Section 211-2
   2. Current ISO 9001:2018 Certification
   3. References of 10 previous polymer concrete projects including scope in the last 5 years performed with both owner and contractor for reference and review by owner
   4. 50 Year Corrosion Warranty

D. Weld Procedure Specifications: Submit Welding Procedure Specifications in accordance with AWS D1.1 and/or D1.4 requirements for all welding which will be performed under this Section.

E. Design Calculations: Submit complete design calculations for specified product types and their connections including loads used in design. Calculations shall be prepared and sealed by an engineer registered in the State of ARIZONA.

F. Design Modifications:
   1. Submit design modifications necessary to meet performance requirements and field conditions.
   2. Variations in details or materials shall not adversely affect the appearance, durability or strength of products.
   3. Maintain general design concept without altering size of members, profiles and alignment unless otherwise approved by the Architect/Engineer.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Handle and transport products in a position consistent with their shape and design in order to avoid excessive stresses or damage.

B. Lift or support products only at the points shown on the Shop Drawings.

C. Installer shall be responsible for the repair of damage to items except that which is caused by others.

D. After items are installed in their final positions, the General Contractor shall be responsible for their protection. The General Contractor shall be responsible for the repair of any damage to the items caused by someone other than the Manufacturer/Installer.

PART 2 - PRODUCTS

2.1 PORTLAND CEMENT CONCRETE MATERIALS

A. Portland Cement ASTM C150 Type I, II or III cement.

B. Aggregates:
   1. Fine and coarse aggregate for mix shall conform to ASTM C33 or C330.
   2. Aggregates shall be clean, hard, strong, durable, inert, and free of staining and deleterious materials.

C. Water Potable, free from deleterious material.

D. Admixtures:
   1. Conforming to ASTM C260 and/or ASTM C494.
   2. Calcium chloride or admixtures containing chlorides shall not be used.

E. Concrete Strength: Concrete strength shall be determined by design with a minimum 28 day design strength of 4,000 psi.

2.2 STEEL MATERIALS

A. Products
   1. Structural Shapes, Bars & Plates (1.6mm and thicker): ASTM A36M
   2. Pipe: ASTM A53 Grades A or B
   3. Tube Steel: ASTM A500 Grades A or B
   4. Reinforcing Steel: ASTM A615M Grades 300 & 420 or AS TM A706M
   5. Prestressing Strand: ASTM A416M Grade 270, low relaxation
   6. Deformed Steel Bar Mats: ASTM A184
   7. Deformed Bar Anchors: ASTM A496
   8. Deformed Welded Wire Fabric: ASTMA497
   9. Plain Welded Wire Fabric: ASTM A185
   10. Welded Headed Studs: AWS D1.1 Type B
   11. Standard Machine Bolts: ASTM A307 Grade A or SAE J429 Grade 2
   12. Standard Studs/Threaded Round Stock: ASTM A307 Grade C, ASTM A572M Grade 345
   13. Nuts for Standard Machine Bolts and Threaded Studs: ASTM A563M Grade A Hex Nuts
   14. High Strength Bolts: ASTM A325M Type 1, ASTM A449 Type 1, or SAE J429 Grade 5
   15. Nuts for High-Strength Bolts and Threaded Studs: ASTM A563M Grade DH Heavy Hex Nuts
   16. Coil Rods and Bolts: ASTM A108 - SAE 1016 to 1026, F_u/F_Y = 480/380 MPa minimum
   17. Coil Nuts for Coil Rods and Bolts: Nuts passing a proof load stress of 80 ksi, based on the tensile stress area of the matching coil rods and bolts.
   18. Carbon Steel Castings: ASTM A27M Grade 415-205

B. Protective Coatings:
All connection hardware permanently exposed to weather after completion of building shall be protected. All connection hardware not exposed to weather after completion of building may be uncoated, except as otherwise explicitly required by the contract drawings. Fasteners can have either an electroplated zinc or cadmium coating.
1. Alkyd Rust Inhibitive Primers (shop primers such as red iron oxide) :
   a. Tnemec Series FD88 Azeron Primer
   b. Ameron 5105
   c. Weld-Thru Primer, Red, 2-0101 & Gray, 2-0102
2. Zinc Coatings:
   a. Hot-Dip Galvanizing: ASTM A123, or ASTM A153M
   b. Electroplated Zinc for Steel Products and Steel Hardware: ASTM B633
   c. Zinc Rich Paints: DOD-P-21035
3. Cadmium Coatings:
   a. Electrodeposited Coatings of Cadmium: ASTM B766

2.3 POLYMER CONCRETE MATERIALS

A. Polymer Concrete Mix Design shall consist of thermosetting resin, sand, and aggregate. No Portland cement shall be allowed as part of the mix design matrix. All sand and aggregate shall be inert in an acidic environment

B. Reinforcement – Shall use acid resistant reinforcement (FRP Bar) in accordance with ACI 440.1R-06 as applicable for polymer concrete design.

2.4 MISCELLANEOUS PRODUCTS

A. Grout
1. Cement Grout: Portland cement, sand and water sufficient for placement and hydration.
2. Non-Shrink Grout: Premixed, packaged non-ferrous aggregate shrink resistant.
3. Epoxy Resin Grout: Two-component mineral-filled resin: ASTM C881.

B. Joint Sealing Compound The joint sealing compound shall be a permanently flexible plastic material complying in every detail to Federal Specification SS S-00210 (GSA-FSS) dated July 26, 1965. "Quickseal", or approved equal.

C. Bearing Pads
1. Random oriented fiber reinforced.
2. Duck layer reinforced: Conform to Division II, Section 10.3.12 of AASHTO Standard Specifications for Highway Bridges.

D. Plastic: Multi-monomer plastic strips shall be non-leaching and support construction loads with no visible overall expansion.

E. Frames and Covers: Catch basins, manholes, and vaults shall be provided with fabricated aluminum or steel frames and covers as specified or shown on the drawings

and shall be built up so that the cover is flush with the surrounding surface unless otherwise specified.

2.5 FABRICATION

A. Manufacturing procedures shall be in general compliance with PCI MNL-116.

B. Manufacturer shall provide for those openings 10 in. or larger, round or square as shown on the drawings. Other openings shall be located and field drilled or cut by the trade requiring them after the units have been erected. Openings and/or cutting of prestressing strand shall be approved by Engineer and manufacturer before drilling or cutting.

C. Each component shall be free of all defects, including indentations, cracks, foreign inclusions and resin starved areas that, due to their nature and degree or extent, detrimentally affect the strength and serviceability of the component part. Cosmetic defect shall not be cause for rejection.

D. Site Work joints shall be assembled with a bell/spigot or shiplap butyl mastic and/or gasketed joint so that on assembly, manhole base, riser and top section make a continuous and uniform manhole. Joint sealing surfaces shall be free of dents, gouges and other surface irregularities that would affect joint integrity

E. Minimum clearance between wall penetrations and joints shall be per approved design.

F. Curing: Procedures sufficient to insure specified concrete strength of all products must be employed. Stripping of a panel shall not occur until concrete strength is sufficient to prevent cracking or damage of the panel.

G. Manufacturing Tolerances:
   1. Cross Sectional Dimensions:
      a. Less than 24 inches: ±1/4"
      b. 24 to 36 inches: ±3/8"
      c. Over 36 inches: ±1/2"
   2. Length:
      a. Less than 25 ft: ±1/2"
      b. 25 to 50 ft: ±3/4"
      c. Over 50 ft: ±1"
   3. Variation from square or designed skew (difference in length of two diagonal measurements): Max. ±3/4"
   4. Deviation from straight line, (sweep) 3/16" per 10 feet x total length.
   5. Deviation from mean camber (as installed): ±1/8" per 10 feet x total length.
   6. Prestressing Force Deviation in location from specific c.g.s. 1/8" or 3% of depth of member, whichever is greater, up to a maximum of 1".
   7. Individual tendon force or elongation: ±5%
   8. Total Prestress, force or elongation: ±5%
   9. Longitudinal location of harping points: ±1"

H. Identification:
   1. Mark each item with manufacturer's name or logo.
   2. Mark each item to correspond to identification mark on Shop Drawings for product location.
   3. Mark each precast item with casting date.

PART 3 - EXECUTION

3.1 PREPARATION

A. Access: Clear unloading areas and access roadways to point of component placement shall be provided and maintained by the General Contractor. The General Contractor shall provide all required traffic controls, barricades, warning lights and/or signs to insure a safe installation.

B. Sitework: The General Contractor shall excavate and prepare the subgrade, including 2 inches of clean sand, graded level and to the proper elevation.

C. Building Work: The General Contractor shall:
   1. Provide the control layout grid lines, including grades, at each floor receiving precast products.
   2. Confirm that the dimensions and tolerances of the structure provide for proper installation of the precast products, including true, level, and clean bearing surfaces.
   3. Provide for the accurate placement and alignment of connection hardware.

D. Installer Responsibility: Prior to installation of the precast products, notify the General Contractor of any discrepancies discovered which affect the work under this contract.

3.2 INSTALLATION

A. General: Precast products shall be lifted with suitable lifting devices at points provided by the Manufacturer to prevent excessive stresses or damage to the products. Brace and secure items before unhooking.

B. Sitework:
   1. Openings or "knockouts" shall be located as shown on the drawings and shall be sized sufficiently to permit passage of the largest dimension of pipe and/or coupling flange. Upon completion of installation, all voids or openings in the vault walls around pipes shall be filled with 4,000-psi concrete or mortar, using an approved epoxy for bonding concrete surfaces.
   2. All joints between precast sections shall be made watertight using preformed mastic material. The sealing compound shall be installed according to the manufacturer's recommendations to provide a watertight joint which remains impermeable throughout the design life of the structure. All joints shall be filled with dry-pack non-shrink grout.
   3. Frames and covers shall be built up so that the cover is flush with the surrounding surface unless otherwise specified. The contractor is responsible for placing the

cover at the proper elevation where paving is to be installed and shall make all necessary adjustments so that the cover meets these requirements.

4. After the structure and all appurtenances are in place and approved, and after any required disinfection or testing, backfill shall be placed to the original ground line or to the limits designated on the plans.

C. Building work:
   1. Set bearing strips, where required.
   2. Lift units by means of suitable lifting devices at points provided by the manufacturer and set level and square, keeping units tight and at right angles to bearing walls.
   3. Temporary shoring and bracing, if necessary, shall comply with manufacturer's recommendations.
   4. Erection Tolerances: Per PCI MNL 120.
   5. Connections:
      a. Field welding shall be per approved Shop Drawings, by certified welders using equipment and materials compatible to the base material.
      b. Connection Verification: The Installer shall verify that all connections are made per approved connection details. All modifications made to details shown on Erection Drawings shall be submitted for review.
   6. For hollow core slabs, fill keys with grout. Remove any grout that may seep through to ceiling below before it hardens. Provide suitable end cap or dam in voids as required.
   7. Apply caulk uniformly, using no more than required to fill the joints.

3.3 PATCHES AND REPAIRS:

A. Patching of products, when required, shall be performed to industry standards.

B. Repairs shall be sound, permanent and flush with adjacent surface.

C. Polymer concrete repairs shall be made with resin provided by the manufacturer.

3.4 INSPECTION AND ACCEPTANCE:

A. Immediately after erection is completed, final inspection and acceptance of the erected products shall be made by the Architect, General Contractor, and/or other responsible Owner's representative to verify conformance with plans and specifications.

B. In cases where precast product installation is phased, products shall be inspected and approved at the conclusion of each respective phase.

3.5 WARRANTY:

A. All labor and materials under the Precast Manufacturers contract shall be warranted by the Precast Manufacturer for a period of one (1) year after substantial completion.

B. Polymer concrete items shall be provided with a 50-year corrosion-free warranty.

++ END OF SECTION ++

SECTION 03600

GROUT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install grout.
   2. The types of grout include the following:
      a. Non-Shrink Grout: This type of grout is to be used wherever grout is shown in the Contract Documents, unless another type is specifically referenced. Two classes of non-shrink grout (Class I and II) and areas of application are specified herein.
      b. Non-Shrink Epoxy Grout (Class III).
      c. Grout Fill, Topping Grout.
      d. Construction Joint Grout.

B. Application: The following is a listing of typical applications and the corresponding type of grout which is to be used. Unless indicated otherwise, grouts shall be provided as listed below whether called for on the Drawings or not.

Application	Type of Grout
Beam and column (1 or 2 story) base plates and precast concrete bearing less than 16-inches in the least dimension.	Non-shrink Class II
Column base plates and precast concrete bearing (greater than 2 story or larger than 16- inches in the least dimension).	Non-shrink Class I
Base plates for storage tanks and other non-motorized equipment and machinery less than 30 horsepower.	Non-shrink Class I
Machinery over 30 horsepower and equipment under 30 horsepower but subject to severe shock loads and high vibration.	Non-shrink Class III
Filling blockout spaces for embedded items such as railing posts, gate guide frames, etc.	Non-shrink Class II (Class I where placement time exceeds

	15 minutes)
Toppings and concrete fill less than 4-inches thick.	Grout Fill, Topping Grout
Application	Type of Grout
Toppings and concrete fill greater than 4-inches thick.	Type "1" Concrete in accordance with Section 03300, Cast-In-Place Concrete.
All anchor bolts and reinforcing steel set in grout.	Refer to Section 03200, Concrete Reinforcement, and Section 05051, Anchor Bolts, Toggle Bolts and Concrete Inserts.
Any application not listed above, where grout is called for on the Drawings.	Non-shrink Class I, unless noted otherwise

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ACI 211.1, Practice for Selecting Proportions for Normal, Heavy-Weight and Mass Concrete.
   2. ACI 301, Specification for Structural Concrete (Includes ASTM Standards referred to herein).
   3. ASTM C 33, Specification for Concrete Aggregates.
   4. ASTM C 109, Test Method for Compressive Strength of Hydraulic Cement Mortars (using 2-in. or 50 mm. Cube Specimens).
   5. ASTM C 150, Specification for Portland Cement.
   6. ASTM C 230, Specification for Flow Table for use in Tests of Hydraulic Cement.
   7. ASTM C 531, Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical- Resistant Mortars, Grouts, and Monolithic Surfacings.
   8. ASTM C 579, Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings and Polymer Concretes.
   9. ASTM C 827, Test Method for Early Volume Change of Cementitious Mixtures.
   10. ASTM C 882, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete.
   11. ASTM C 937, Specification for Grout Fluidifier for Preplaced-Aggregate Concrete.

12. ASTM C 939, Text Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
13. ASTM C 1107, Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
14. ASTM C 1181, Test Method for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.
15. ASTM D 696, Test Method for Coefficient of Linear Thermal Expansion of Plastics.

B. Field Tests:
1. Compression test specimens will be taken during construction from the first placement of each type of grout, and at intervals thereafter as selected by the ENGINEER to ensure continued compliance with these specifications. The specimens will be made by the ENGINEER or its representative.
2. Compression tests and fabrication of specimens for non-shrink grout will be performed as specified in ASTM C 109 at intervals during construction as selected by the ENGINEER. A set of three specimens will be made for testing at seven days, 28 days, and each additional time period as appropriate.
3. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C 579, Method B, at intervals during construction as selected by the ENGINEER. A set of three specimens will be made for testing at seven days, and each earlier time period as appropriate.
4. The cost of all laboratory tests on grout will be borne by the OWNER, but CONTRACTOR provide assistance to the ENGINEER in obtaining specimens for testing. However, the cost of any additional tests and investigation on work performed which does not conform to the requirements of the specifications belongs to CONTRACTOR. Supply all materials necessary for fabricating the test specimens.

1.3 SUBMITTALS

A. Shop Drawings, submit for approval the following:
1. For Grout Fill and Construction Joint Grout, copies of grout design mix and laboratory test reports for grout strength tests.

B. Reports and Certificates, submit for approval the following:
1. For proprietary materials, submit copies of manufacturer's certification of compliance with the specified properties for Class I, II, and III grouts.
2. Submit certified testing lab reports for ASTM C 1107, Grade B and Grade C (as revised herein) requirements for Class I and II grouts tested at a fluid consistency for temperatures of 45, 73.4, 90°F with a pot life of 30 minutes at fluid consistency.
3. Submit certification that materials meet specification requirements for nonproprietary materials.
4. Submit certifications that all grouts used on the project are free of chlorides or other chemicals causing corrosion.

5. Manufacturer's specifications and installation instructions for all proprietary materials.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials: Grout materials from manufacturers shall be delivered in unopened containers and shall bear intact manufacturer's labels.

B. Storage of Materials: Grout materials shall be stored in a dry shelter and shall be protected from moisture.

PART 2 - PRODUCTS

2.1 GROUTS

A. General: Non-shrink grout shall be a prepackaged, inorganic, flowable, non-gas-liberating, non-metallic, cement-based grout requiring only the addition of water. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of non-shrink grout specified herein shall be that recommended by the manufacturer for the particular application.

B. Class I Non-Shrink Grout:
   1. Class I non-shrink grouts shall have a minimum 28 day compressive strength of 7000 psi. This grout is for precision grouting and where water tightness and non-shrink reliability in both plastic and hardened states are critical. Refer to areas of application as specified herein.
   2. Shall meet the requirements of ASTM C 1107 Grade C and B (as modified below) when tested using the amount of water required to achieve the following properties:
      a. Fluid consistency (20 to 30 seconds) in accordance with ASTM C 939
      b. At temperatures of 45, 73.4, and 95°F.
   3. The length change from placement to time of final set shall not have a shrinkage greater than the amount of expansion measured at 3 or 14 days. The expansion at 3 or 14 days shall not exceed the 28-day expansion.
   4. The non-shrink property is not based on a chemically generated gas or gypsum expansion.
   5. Fluid grout shall pass through the flow cone, with a continuous flow, one hour after mixing.
   6. Product and Manufacturer: Provide one of the following:
      a. Masterflow 928, as manufactured by Master Builders, Inc.
      b. Five Star Grout, as manufactured by Five Star Products, Inc.
      c. Hi-Flow Grout, as manufactured by the Euclid Chemical Company
      d. Or equal.

C. Class II Non-Shrink Grout:

1. Class II non-shrink grouts shall have a minimum 28 day compressive strength of 7000 psi. This grout is for general purpose grouting applications as specified herein.
2. Shall meet the requirements of ASTM C 1107 and the following requirements when tested using the amount of water required to achieve the following properties:
   a. Flowable consistency (140 percent flow on ASTM C 230, five drops in 30 seconds.)
   b. Fluid working time of at least 15 minutes.
   c. Flowable for at least 30 minutes.
3. The grout when tested shall not bleed at maximum allowed water.
4. The non-shrink property is not based on a chemically generated gas or gypsum expansion.
5. Product and Manufacturer: Provide one of the following:
   a. Set Grout, as manufactured by Master Builders, Inc.
   b. NBEC Grout, as manufactured by Five Star Products, Inc.
   c. NS Grout, as manufactured by the Euclid Chemical Company.
   d. Or equal.

D. Class III Non-Shrink Epoxy Grout:
1. Shall be a pourable, non-shrink, 100 percent solids system. The epoxy grout system shall have three components: resin, hardener, and specially blended aggregate, all premeasured and prepackaged. The resin component shall not contain any non-reactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted, unless specifically recommended by the manufacturer. Manufacturer's instructions shall be printed on each container in which the materials are packaged. The following properties shall be attained with the minimum quantity of aggregate allowed by the manufacturer.
2. Product and Manufacturer: Provide one of the following:
   a. Euco High Strength Grout, as manufactured by The Euclid Chemical Company.
   b. Sikadur 42 Grout Pak, as manufactured by Sika Corporation.
   c. Five Star Epoxy Grout, as manufactured by Five Star Products, Incorporated.
   d. Or equal.
3. The vertical volume change at all times before hardening shall be between 0.0 percent shrinkage and 4.0 percent expansion when measured according to ASTM C 827 (modified for epoxy grouts by using an indicator ball with a specific gravity between 0.9 and 1.1). Alternately, epoxy grouts which maintain an effective bearing area of not less than 95 percent are acceptable.
4. The length change after hardening shall be negligible (less than 0.0006 in/in) and the coefficient of thermal expansion shall be less than 0.00003 in/in/F when tested in accordance to the requirements of ASTM C 531.

5. The compressive creep at one year shall be negligible (less than .001 in/in) when tested under a 400-psi constant load at 140°F in accordance to the requirements of ASTM C 1181.
6. The seven-day compressive strength shall be a minimum of 14,000 psi when tested in accordance to the requirements of ASTM C 579
7. The grout shall be capable of maintaining at least a flowable consistency for a minimum of 30 minutes at 70°F.
8. The shear bond strength to portland cement concrete shall be greater than the shear strength of the concrete when tested in accordance to the requirements of ASTM C 882.
9. The effective bearing area shall be a minimum of 95 percent.

E. Grout Fill, Topping Grout:
1. Grout for topping of slabs and concrete fill for built-up surfaces of tank, channel, and basin bottoms shall be composed of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and mixed as specified herein. All materials and procedures specified for normal concrete in Section 03300, Cast-In-Place Concrete, shall apply except as noted otherwise herein.
2. Topping grout and concrete fill shall contain a minimum of 564 pounds of cement per cubic yard with a maximum water cement ratio of 0.45. Where concrete fill is thicker than 4-inches, Type "1" concrete, as specified in Section 03300, Cast-In-Place Concrete, may be used when accepted by the ENGINEER.
3. Coarse aggregate shall be graded as follows:

U.S. STANDARD SIEVE SIZE	PERCENT BY WEIGHT PASSING
1/2-inch	100
3/8-inch	90-100
No. 4	20-55
No. 8	5-30
No. 16	0-10
No. 30	0

4. Final mix design shall be as determined by trial mix design under supervision of the approved testing laboratory.
5. Strength: Minimum compressive strength of Grout Fill at the end of 28 days shall be 4000 psi.

F. Construction Joint Grout:
1. Construction Joint Grout approximates Type "1" concrete, as specified in Section 03300, Cast-In-Place Concrete, with aggregate coarser than 1/2-inch removed. The mix is to be designed as flowable with a high mortar content. It is intended to be placed over construction joints and mixed with Type "1"

concrete as specified in Section 03300, Cast-In-Place Concrete. The mix requirements are as follows:

a. Compressive Strength: 4,500 psi minimum at 28-days.
b. Maximum Water-Cement Ratio: 0.45 by weight.
c. Coarse Aggregate: ASTM C33, No. 8 size.
d. Fine Aggregate: ASTM C33, approximately 60 percent by weight of total aggregate.
e. Air Content: 8±1 percent.
f. Minimum Cement Content: 752 pounds per cubic yard.

G. Requirements for Grout Fill and Construction Joint Grout

1. Proportion mixes by either laboratory trial batch or field experience methods, using materials to be employed on the Project for grout required. Comply with ACI 211.1 and report to ENGINEER the following data:
   a. Complete identification of aggregate source of supply.
   b. Tests of aggregates for compliance with specified requirements.
   c. Scale weight of each aggregate.
   d. Absorbed water in each aggregate.
   e. Brand, type and composition of cement.
   f. Brand, type and amount of each admixture.
   g. Amounts of water used in trial mixes.
   h. Proportions of each material per cubic yard.
   i. Gross weight and yield per cubic yard of trial mixtures.
   j. Measured slump.
   k. Measured air content.
   l. Compressive strength developed at seven days and 28 days, from not less than three test specimens cast for each seven day and 28-day test, and for each design mix.
2. Submit written reports to ENGINEER of proposed mix of grout at least 30 days prior to start of Work. Do not begin grout production until mixes have been approved by ENGINEER.
3. Laboratory Trial Batches: When laboratory trial batches are used to select grout proportions, prepare test specimens and conduct strength tests as specified in ACI 301, Section 4 - Proportioning. However, mixes need not be designed for greater than 125 percent of the specified strength, regardless of the standard deviation of the production facility.
4. Field Experience Method: When field experience methods are used to select grout proportions, establish proportions as specified in ACI 301, Section 4.
5. Admixtures: Use air-entraining admixture in all grout. Use amounts of admixtures as recommended by the manufacturer for climatic conditions prevailing at the time of placing. Adjust quantities and types of admixtures as required to maintain quality control. Do not use admixtures which have not been incorporated and tested in the accepted design mix, unless otherwise authorized in writing by ENGINEER.

2.2 CURING MATERIALS

A. Curing materials shall be as specified in Section 03300, Cast-in-Place Concrete, and as recommended by the manufacturer of prepackaged grouts.

2.3 CONSISTENCY

A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is such that the grout is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a grout of that consistency; the type of grout to be used shall be as specified herein for the particular application.

B. The slump for topping grout and grout fill shall be adjusted to match placement and finishing conditions, but shall not exceed 4-inches.

C. The slump for Construction Joint Grout shall be 7 ± 1-inches.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and conditions under which grout is to be placed and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. General:
   1. Place grout as shown and in accordance with manufacturer's instructions. If manufacturer's instructions conflict with the Specifications do not proceed until ENGINEER provides clarification.
   2. Manufacturers of proprietary products shall make available upon 72 hours notification the services of a qualified, full time employee to aid in assuring proper use of the product under job conditions.
   3. Placing grout shall conform to temperature and weather limitations in Section 03300, Cast-In-Place Concrete.
   4. Grout shall be cured following manufacturer’s instructions for prepackaged grout and the requirements in Section 03300, Cast-In-Place Concrete, for grout fill and topping grout.

B. Columns, Beams and Equipment Bases:
   1. Epoxy grout: After shimming equipment to proper grade, securely tighten anchor bolts. Properly form around the base plates, allowing sufficient room around the edges for placing the grout. Adequate depth between the bottom of

the base plate and the top of concrete base must be provided to assure that the void is completely filled with the epoxy grout.

2. Non-shrink, non-metallic grout: After shimming columns, beams and equipment to proper grade, securely tighten anchor bolts. Properly form around the base plates allowing sufficient room around the edges for placing the grout. Adequate depth between the bottom of the base plate and the top of concrete base must be provided to assure that the void is completely filled with the non-shrink, non-metallic grout.

C. Handrails and Railings:
   1. After posts have been properly inserted into the holes or sleeves, fill the annular space between posts and sleeve with the non-shrink, non-metallic grout. Bevel grout at juncture with post so that moisture flows away from post.

D. Construction Joints:
   1. Place a 6-inch minimum thick layer of Construction Joint Grout over the contact surface of the old concrete at the interface of horizontal construction joints as specified in Section 03251, Concrete Joints, and Section 03300, Cast-In-Place Concrete.

E. Topping Grout:
   1. All mechanical, electrical, and finish work shall be completed prior to placement of topping grout. The base slab shall be given a roughened textured surface by sandblasting or hydroblasting exposing the aggregates to ensure bonding to the base slab.
   2. The minimum thickness of grout topping shall be 1-inch.
   3. The base slab shall be thoroughly cleaned and wetted prior to placing topping and fill. No topping concrete shall be placed until the slab is complete free from standing pools or ponds of water. A thin coat of neat Type II cement slurry shall be broomed into the surface of the slab and topping or fill concrete shall be placed while the slurry is still wet. The topping and fill shall be compacted by rolling or tamping, brought to established grade, and floated. Grouted fill for tank and basin bottoms where scraping mechanisms are to be installed shall be screeded by blades attached to the revolving mechanism of the equipment in accordance with the procedures outlined by the equipment manufacturer after the grout is brought to the established grade.
   4. Topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement.
   5. The surface shall be tested with a straight edge to detect high and low spots which shall be immediately eliminated. When the topping has hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. An approved type of mechanical trowel may be used as an assist in this operation, but the last pass over the surface shall be by hand-troweling. During finishing, no water, dry cement or mixture of dry cement and sand shall be applied to the surface.

6. Cure and protect the grout topping as specified in Section 03300, Cast-In-Place Concrete.

F. Grout Fill

1. All mechanical, electrical, and finish work shall be completed prior to placement of grout fill. Grout fill shall be mixed, placed, and finished as required in Section 03300, Cast-In-Place Concrete.
2. The minimum thickness of grout fill shall be 1-inch. Where the finished surface of grout fill is to form an intersecting angle of less than 45 degrees with the concrete surface it is to be placed against, a key shall be formed in the concrete surface at the intersection point. The key shall be a minimum of 3-1/2-inches wide by 1-1/2-inches deep.
3. The surface shall be tested with a straight edge to verify that the surface slopes uniformly to drain and to detect high and low spots which shall be immediately eliminated. When the grout fill has hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. During finishing, no water, dry cement or mixture of dry cement and sand shall be applied to the surface.

+ + END OF SECTION + +

SECTION 05051

ANCHOR BOLTS, TOGGLE BOLTS AND CONCRETE INSERTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified, and required to furnish and install anchor bolts, toggle bolts and concrete inserts.

B. This Section includes all anchor bolts, toggles and inserts required for the Work, but not specified under other Sections.

C. The types of Work using the anchor bolts, toggles and inserts include, but are not limited to the following:
   1. Hangers and brackets.
   2. Equipment.
   3. Piping.
   4. Screens.
   5. Grating and floor plate.
   6. Electrical, Plumbing and HVAC Work.
   7. Metal, wood and plastic fabrications.
   8. Structural members and accessories.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown and specified.
   1. ASTM A 36, Specification for Carbon Structural Steel.
   2. ASTM A 123, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   3. ASTM A 153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   4. ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   5. ASTM A 484, Specification for General Requirements for Stainless and Heat-Resisting Steel Bars, Billets and Forgings.
   6. ASTM A 525, Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
   7. ASTM A 536, Specification for Ductile Iron Castings.

8. ASTM A 570, Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.
9. ASTM B 633, Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
10 ASTM F 593, Stainless Steel Bolts; Hex Cap Screws, and Studs.
11. Federal Specification FF-S-325 for Concrete Expansion Anchors.
12. Federal Specifications WW-H-171E for Malleable Iron.
13. ICBO, International Conference of Building Officials.
14. Phoenix Building Code.

B. Inserts shall be ICBO, UL or FM approved.

C. Toggle Bolts: Federal Specification FF-B-588C, Type I, Class A, Style 1.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Setting drawings and templates for location and installation of anchorage devices.
2. Copies of manufacturer's specifications, load tables, dimension diagrams and installation instructions for the devices.
3. Copies of ICBO, UL or FM Reports certifying load carrying capacities and installation requirements for the anchorage devices.
4. Comply with the requirements of Section 01332, Shop Drawing Procedures.

B. Samples: Submit for approval the following:
1. Representative samples of anchor bolts, toggle bolts and concrete inserts as may be requested by ENGINEER. Review will be for type and finish only. Compliance with all other requirements is exclusive responsibility of CONTRACTOR.

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA

A. When the size, length or load carrying capacity of an anchor bolt, toggle bolt, or concrete insert is not shown on the Drawings, provide the following:
1. For anchor bolts (cast-in-place), provide the size, length and capacity required to carry the design load based on the values and requirements given in the Phoenix Building Code for concrete.
2. For concrete anchors (adhesive types) and concrete inserts, provide the size, length, type, and capacity required to carry the design load based on the values and requirements given in the ICBO Evaluation Report, or similar certifications by UL or FM, for the anchor to be used. Alternately the capacity may be based on independent testing lab capacities for tension and shear strength using a

minimum safety factor of four. Consideration of reduced capacity due to spacing and edge distance shall be made.

B. Determine design loads as follows:
   1. For equipment anchors, use the design load recommended by the equipment manufacturer and approved by ENGINEER.
   2. For pipe hangers and supports, use one half of the total weight of: pipe, fittings, and water contained in pipe, plus the full weight of valves and accessories located between the hanger or support in question.
   3. Allowances for vibration are included in the safety factor specified above.
   4. Concrete anchors shall develop ultimate shear and pull-out loads of not less than the following values in 4,000 psi concrete:

Bolt Diameter (Inches)	Min. Shear (Pounds)	Min. Pull-Out Load (Pounds)
1/2	5,000	7,600
5/8	8,000	12,000
3/4	11,500	17,000
7/8	15,700	20,400
1	20,500	28,400

2.2 APPLICATION

A. Where a concrete anchor is shown on the Drawings, install either an adhesive anchor or anchor bolt. In masonry, where a concrete anchor is shown on the Drawings, only anchor bolts and adhesive anchors shall be used. Comply with the requirements of Section 06100, Rough Carpentry, Section 06611, Fiberglass Reinforced Plastic Gratings, Handrails and Railings.

B. Anchor Bolts (cast-in-place):
   1. Shall be used where indicated and may be used where concrete anchors are indicated.
   2. Where an anchor bolt is indicated, only a cast-in-place anchor bolt shall be used, unless another anchor type is accepted by the ENGINEER.
   3. Provide anchor bolts as shown on the Drawings or as required to secure structural steel to concrete or masonry.

C. Adhesive Anchors:
   1. Use wherever concrete anchors are shown on the Drawings.
   2. Use where subject to vibration or where buried or submerged.
   3. Use for pipe supports.
   4. Use in concrete and masonry.
   5. Shall not be used in ceilings.
   6. Shall not be used for pipe hangers.

D. Concrete Inserts:
   1. Use only where indicated on the Drawings.

2. Use for pipe hangers and supports for the pipe size and loading recommended by the insert manufacturer.

E. Toggle Bolts:
1. Use for fastening brackets and other elements onto masonry units.

2.3 MATERIALS

A. Anchor Bolts:
1. Provide stainless steel bolts complying with ASTM F 593, AISI Type 316 headed or non-headed type with nitronic 60 stainless steel nuts and locknuts, unless otherwise indicated.
2. In buried or submerged locations, provide stainless steel bolts complete with washers complying with ASTM F 593, AISI Type 316 and with nitronic 60 stainless steel nuts and locknuts. Other AISI types may be used subject to ENGINEER'S approval.
3. For equipment, provide anchor bolts, which meet the equipment manufacturer's recommendations for size, material, and strength.
4. Provide anchor bolts as shown on the Drawings or as required to secure structural steel to concrete or masonry.
5. Locate and accurately set the anchor bolts using templates or other devices as required.
6. Protect threads and shank from damage during installation of equipment and structural steel.
7. Comply with manufacturer's required embedment length and necessary anchor bolt projection.

B. Adhesive Anchors:
1. Provide stainless steel adhesive anchors complying with ASTM F 593, AISI Type 316 with nitronic 60 stainless steel nuts and locknuts.
2. In buried or submerged locations, provide stainless steel adhesive anchors complying with ASTM F 593, AISI Type 316 with nitronic 60 stainless steel nuts and locknuts.
3. Anchors shall be of the size required for the concrete strength specified.
4. Adhesive anchors shall consist of threaded rods or bolts anchored with an adhesive system into hardened concrete or grout-filled masonry. The adhesive system shall use a two-component adhesive mix and shall be injected with a static mixing nozzle following manufacturer's instructions. The embedment depth of the rod/bolt shall provide a minimum allowable bond strength that is equal to the allowable tensile capacity of the rod/bolt, unless noted otherwise on the Drawings.
5. Product and Manufacturer: Provide one of the following:
   a. Epcon System Ceramic 6, as manufactured by ITW Ramset/Redhead.
   b. HIT HY-150 Injection Adhesive Anchor System, as manufactured by Hilti.
   c. Powerfast, as manufactured by Powers/Rawl.
   d. Or equal.

C. Sleeve Expansion Anchors for Installation in Concrete Masonry:
   1. Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B 633, and meet the requirements of Federal Specification FF-S-325, Group II, Type 4, Class 1 for expansion anchors.
   2. Product and Manufacturer: Provide anchors by one of the following:
      a. Sleeve Anchors, as manufactured by Hilti Fastening Systems, Incor-porated.
      b. Dynabolt Sleeve, as manufactured by ITW Ramset/Red Head, Incor-porated.
      c. Or equal.

D. Concrete Inserts:
   1. For piping, grating, floor plate and masonry lintels, provide malleable iron inserts. Comply with Federal Specification WW-H-171E (Type 18). Provide those recommended by the manufacturer for the required loading.
   2. Finish shall be black.
   3. Product and Manufacturer: Provide inserts by one of the following:
      a. Figure 282, as manufactured by ITT Grinnell.
      b. No. 380, as manufactured by Hohmann and Barnard, Incorporated.
      c. Or equal.

E. Toggle Bolts:
   1. Provide spring-wing toggle bolts, with two-piece wings.
   2. Provide carbon steel bolts with zinc coating in accordance with Federal Specification FF-S-325.
   3. Product and Manufacturer: Provide toggle bolts by one of the following:
      a. The Rawlplug Company, Incorporated.
      b. Haydon Bolts, Incorporated.
      c. Or equal.

F. Powder activated fasteners and other types of bolts and fasteners not specified herein shall not be used, unless approved by ENGINEER.

G. Expansion anchors will not be allowed.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which anchor bolts, toggle bolts and concrete insert Work is to be installed, and notify ENGINEER, in writing, of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. Assure that embedded items are protected from damage and are not filled in with concrete.

B. Use concrete inserts for pipe hangers and supports for the pipe size and loading recommended by the insert manufacturer.

C. Use toggle bolts for fastening brackets and other elements onto masonry units.

D. For the adhesive anchors and adhesive material, comply with the manufacturer's installation instructions on the hole diameter and depth required to fully develop the tensile strength of the adhesive anchor or reinforcing bar. Properly clean out the hole utilizing a wire brush and compressed air to remove all loose material from the hole, prior to installing adhesive capsules or material.

3.3 CLEANING

A. After embedding concrete is placed, remove protection and clean bolts and inserts.

3.4 FIELD QUALITY CONTROL

A. Employ the services of a testing laboratory to perform field quality testing of installed anchors. Field engineer is to determine the level of testing which is required for the various types of adhesive anchors and anchor bolts. A minimum of ten percent of the adhesive anchors and reinforcing bars are to be tested to 50 percent of the ultimate tensile capacity of the adhesive anchor or reinforcing bar.

B. Responsibility for the failure of any adhesive anchors or reinforcing bars will belong to the CONTRACTOR. Should any adhesive anchors or reinforcing bars fail, all costs involved in testing the remaining 90 percent belongs to the CONTRACTOR.

C. Correct improper workmanship, remove and replace, or correct as directed by the ENGINEER, all adhesive anchors or bars found unacceptable or deficient, at no additional cost to the OWNER.

D. Pay for all corrections and subsequent tests required to confirm the integrity of the adhesive anchor or bar.

E. The independent testing and inspection agency shall complete a report on each area. The report should summarize the observations made by the inspector and be submitted to ENGINEER.

F. Provide access for the testing agency to places where Work is being produced so that required inspection and testing can be accomplished.

+ + END OF SECTION + +

SECTION 05501

MISCELLANEOUS METAL FABRICATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown on the Drawings, specified and required to furnish miscellaneous metal fabrications, including surface preparation and shop priming.

B. The extent of miscellaneous metal fabrications Work is shown on the Drawings and includes items fabricated from iron, steel and aluminum shapes, plates, bars, castings and extrusions, which are not a part of the structural steel or other metal systems covered by other Sections of these Specifications.

C. The types of miscellaneous metal items include, but are not limited to the following:
   1. Aluminum ladders.
   2. Aluminum ladder safety cages.
   3. Fall prevention system.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown and specified:
   1. ASTM A 36, Specification for Carbon Structural Steel.
   2. ASTM A 153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   3. ASTM A 240, Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
   4. ASTM A 320, Specification for Alloy Steel Bolting Material for Low Temperature Service.
   5. ASTM B 209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   6. ASTM B 211, Specification for Aluminum and Aluminum-Alloy Bars, Rods and Wire.
   7. ASTM B 221, Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.
   8. ANSI A14.3, Safety Requirements for Fixed Ladders.
   9. AWS D1.1, Structural Welding Code.
   10. NAAMM, Metal Finishes Manual.
   11. OSHA.
   12. Phoenix Building Code.

B. Field Measurements:
   1. Take field measurements where required prior to preparation of Shop Drawings and fabrication to ensure proper fitting of the Work.

C. Shop Assembly:
   1. Preassemble items in the shop to the greatest extent possible, so as to minimize field splicing and assembly of units at the project site. Disassemble units only to the extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
   1. Sets of representative samples of materials including nosings, rungs and other finished products as may be requested by ENGINEER. ENGINEER'S review will be for color, texture, style, and finish only. Compliance with all other requirements is exclusive responsibility of CONTRACTOR.
   2. Refer to and comply with the requirements of Section 01333, Samples.

B. Shop Drawings: Submit for approval the following:
   1. Fabrication and erection details of all assemblies of miscellaneous metal Work. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items. Include setting drawings and templates for location and installation of miscellaneous metal items and anchorage devices.
   2. Copies of manufacturer's specifications, load tables, dimension diagrams, anchor details, and installation instructions for products to be used in miscellaneous metal Work.
   3. Refer to and comply with the requirements of Section 01330, Submittals and Section 16050, General Provisions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Plates, Shapes and Bars: ASTM A 36.

B. Aluminum:
   1. Alloy and Temper: Provide alloy and temper as shown on the Drawings or specified, or as otherwise recommended by the aluminum producer or finisher.
   2. Extruded Shapes and Tubes: ASTM B 221.
   3. Plate and Sheet: ASTM B 209.
   4. Bars, Rods, and Wire: ASTM B 211.

C. Stainless Steel Plates and Sheets: ASTM A 240, Type 304L or Type 316 stainless steel.
   1. Submerged or intermittently submerged: Type 316 stainless steel.
   2. Non-submerged: Type 304L stainless steel.

D. Stainless Steel Fasteners and Fittings: ASTM A 320.

E. Zinc Coated Hardware: ASTM A 153.

F. Surface Preparation and Shop Priming: Refer to Section 09900, Painting. All steel shall be primed in the shop. Surface preparation and shop priming requirements are included herein but are specified in Section 09900.

2.2 MISCELLANEOUS METAL ITEMS

A. Aluminum Ladders:
   1. Fabricate ladders for the locations shown on the Drawings, with dimensions, spacings, details and anchorages as shown on the Drawings, and specified. Comply with the requirements of ANSI A14.3, except as otherwise shown on the Drawings or specified.
      a. Unless otherwise shown on the Drawings, provide 1/2-inch by 2-1/2-inch continuous extruded flat bar side rails, spaced 18-inches apart, minimum.
      b. Provide extruded square rungs, spaced 12-inches on centers, maximum, with non-slip surface on the top of each rung. Adhesive strips for non-slip surfaces will not be allowed.
   2. Fit rungs in centerline of side rails, plug weld and grind smooth on outer rail faces.
   3. Support each ladder at top and bottom and at intermediate points spaced not more than five feet on centers. Use welded or bolted brackets, designed for adequate support and anchorage, and to hold the ladder clear of the wall surface with a minimum of 7-inches clearance from wall to centerline of rungs. Unless otherwise shown on the Drawings or approved by the Engineer, extend rails 42-inches above top rung, and return rails to wall or structure, unless other secure handholds are provided. If the adjacent structure does not extend above the top rung, goose-neck the extended rails back to the structure to provide secure ladder access.
   4. Use extruded aluminum conforming to alloy and temper 6061-T6.

B. Aluminum Ladder Safety Cages:
   1. Fabricate ladder safety cages from extruded flat bars, assembled by welding or riveting. Unless otherwise shown on the Drawings, provide 1/2-inch by 3-inch top, bottom and intermediate hoops spaced not more than five feet on centers; and 3/8-inch by 2-inch vertical bars, secured to each hoop. Space vertical bars approximately 9- inches on centers. Fasten assembled safety cage to ladder rails and adjacent construction as shown on the Drawings. Grind all welds, sharp edges and projections smooth.
   2. Comply with the requirements of ANSI A14.3.
   3. Use extruded aluminum conforming to alloy and temper 6061-T6.

C. Fall Prevention System: All ladders shall be provided with a fall prevention system. The system shall meet OSHA standards.

1. The system shall consist of a rail permanently attached to the ladder to which a harness belt is attached. The rail shall be notched and constructed of aluminum. Ladder attachments shall be provided as required by the manufacturer. A removable extension section shall be provided at the top of the ladder.
2. Product and Manufacturer: Provide one of the following:
   a. Saf-T-Climb by Norton Company.
   b. Or equal.

D. Bollards: Provide 8-inch diameter, Schedule 40 black steel pipe, 4-feet-0-inches above grade, 4-feet-0-inches below grade. Fill with concrete and mound top. Bollards shall be primed in the shop. Surface preparation and painting shall conform to the requirements of Section 09900, Painting.

E. Miscellaneous Framing and Supports:
1. Provide miscellaneous metal framing and supports, which are not a part of the structural steel framework and are required to complete the Work.
2. Fabricate miscellaneous units to the sizes, shapes and profiles shown on the Drawings or, if not shown on the Drawings, of the required dimensions to receive adjacent grating, plates, tanks, doors, or other work to be retained by the framing. Except as otherwise shown on the Drawings, fabricate from structural shapes, plates, and bars, of all welded construction using mitered corners, welded brackets and splice plates and a minimum number of joints for field connection. Cut, drill and tap units to receive hardware and similar items to be anchored to the Work.
3. Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed.
   a. Except as otherwise shown on the Drawings, space anchors, 24-inches on centers, and provide units the equivalent of 1-1/4 by 1/4 by 8-inch strips.
   b. Galvanize exterior miscellaneous frames and supports.
   c. Galvanize miscellaneous frames and supports where indicated.

F. Fasteners and Fittings: Provide Type 316 stainless steel, for all aluminum fabrications, and zinc coated hardware for all galvanized fabrications, unless otherwise shown on the Drawings or specified.

G. Surface Preparation and Shop Priming: All miscellaneous metal fabrications shall be primed in the shop. Surface preparation and shop priming requirements are included herein, but are specified in Section 09900, Painting.

H. Aluminum Finish: Provide an Architectural Class 1 anodized finish, AA-M32C22-A41, gray, as specified in NAAMM Manual.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set miscellaneous metal fabrications accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Brace temporarily or anchor temporarily in formwork where fabrications are to be built into concrete, masonry or similar construction.

B. Anchor securely as shown on the Drawings or as required for the intended use, using concealed anchors wherever possible.

C. Fit exposed connections accurately together to form tight hairline joints. Weld steel connections, which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind steel joints smooth and touch up shop paint coat. Do not weld, cut or abrade the surfaces of exterior units, which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.

D. Protection of Aluminum from Dissimilar Materials:
   1. Coat all surfaces of aluminum in contact with dissimilar materials, such as concrete, masonry and steel conforming to the requirements of Section 09900, Painting.

+ + END OF SECTION + +

SECTION 05522

ALUMINUM HANDRAILS AND RAILINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, tools, equipment, and incidentals as shown on the Drawings, specified and required to furnish and install aluminum handrail and railing systems. The Work also includes:
      a. Providing openings in, and attachments to, aluminum handrail and railing systems to accommodate the Work under this and other Sections and providing for the aluminum handrail and railing systems all items such as anchor bolts, fasteners, studs and all items required for which provision is not specifically included under other Sections.
   2. Extent of aluminum handrail and railing systems is shown on the Drawings and specified.
   3. Types of products required include the following:
      a. Custom fabricated picket railing system.
      b. Custom fabricated top and intermediate horizontal railing system.
      c. Custom fabricated handrail system.
      d. Custom fabricated toe boards.
      e. Anchors and fasteners.
      f. Sleeves, castings, reinforcing inserts, wall brackets, gates, gate latches, stops and hinges, chains, and other miscellaneous accessories.
      g. Custom finished architectural Class I anodized finish for all system components.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the Work that must be installed with or attached to the handrail and railing.
   2. Coordinate all handrail and railing locations as required for Work meeting all governing authorities.

1.2 SYSTEM DESCRIPTION

A. Aluminum handrail and railing system shall be as indicated on the drawings.

B. Aluminum handrail and railing system shall include all components and features shown on the Drawings and specified and all system components and features available from specified manufacturers necessary to provide a complete aluminum handrail and railing system complying with these Specifications.

1.3 QUALITY ASSURANCE

A. Fabricator Qualifications:
   1. Engage a single firm, with undivided responsibility for performance of handrail and railing systems Work.
   2. Engage a firm, which can show five years previous successful experience in the fabrication of handrail and railing systems of scope and type similar to the required Work.
   3. Provide fabricator capable of providing custom details shown on the Drawings.
   4. Materials and fabrication procedures shall be subject to inspection and tests in the mill, shop, and field, conducted by a qualified inspection agency. Such inspections and tests shall not relieve CONTRACTOR of responsibility for providing materials and fabrication procedures in compliance with specified requirements.

B. Installer Qualifications :
   1. Engage a single installer skilled, trained and with a record of successful experience in the installation of aluminum handrail and railing systems and who has a successful record of performing Work in accordance with the approved recommendations and requirements of the fabricator or who can submit evidence in writing of being acceptable to the fabricator; and who agrees to employ only tradesmen with specific skill and successful experience in this type of Work. Submit names and qualification to ENGINEER along with the following information on a minimum of three successful projects:
      a. Names and telephone numbers of owner, architects or engineers responsible for projects.
      b. Approximate contract cost of the handrails and railings.
      c. Amount of area installed.

C. Codes:
   1. Comply with the applicable requirements of OSHA and Phoenix Building Code.
   2. If there is a conflict between the OSHA requirements and the Phoenix Building Code comply with whichever requirement is more stringent.

D. Allowable Tolerances:
   1. Limit variation of cast-in-place inserts, sleeves and field-drilled anchor and fastener holes to the following:
      a. Spacing: ±3/8-inch.
      b. Alignment: ±1/4-inch.
      c. Plumbness: ±1/8-inch.
   2. Minimum Handrails and Railings Systems Plumb Criteria:
      a. Limit variation of completed handrail and railing system alignment to 1/4-inch in 12 feet - 0 inches with posts set plumb to within 1/16-inch in 3 foot - 0 inches.

b. Align rails so variations from level for horizontal members and from parallel with rake of stairs and ramps for sloping members do not exceed 1/4-inch in 12 feet - 0 inches.

3. Provide “pencil-line” thin butt joints.

E. Source Quality Control:
1. Obtain all handrails and railings systems components and accessories from the same manufacturer.

F. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. ASTM B 26, Specification for Aluminum and Aluminum-Alloy Sand Castings.
2. ASTM B 117, Practice for Operating Salt Spray (Fog) Apparatus.
3. ASTM B 136, Method for Measurement of Stain Resistance of Anodic Coatings on Aluminum.
4. ASTM B 137, Test Method for Measurement of Coating Mass Per Unit Area of Anodically Coated Aluminum.
5. ASTM B 210, Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes.
6. ASTN B 221, Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.
7. ASTM B 241, Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.
8. ASTM B 244, Test Method for Measurement of Thickness of Anodic Coatings on Aluminum and of Other Nonconductive Coatings on Nonmagnetic Basis Metals with Eddy-Current Instruments.
9. ASTM B 247, Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings.
10. ASTM B 429, Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
11. ANSI A1264.1, Safety Requirements for Workplace Floor and Wall Openings, Stairs and Railing Systems.
12. The Aluminum Association, AA ASD-1, Aluminum Standards and Data.
13. The Aluminum Association, AA SAA-46, Standards for Anodized Architectural Aluminum.
14. The Aluminum Association, AA DSA-45, Designation System for Aluminum Finishes.
15. Architectural Metal Products Division of The National Association of Architectural Metal Manufacturers, AMP/NAAMM, Pipe Railing Manual.
16. Architectural Metal Products Division of The National Association of Architectural Metal Manufacturers, AMP 501, Finishes for Aluminum.
17. OSHA, Title 29 Code of Federal Regulations Part 1910.23 - Guarding Floor and Wall Openings and Holes.
18. The Americans with Disabilities Act of 1990 (Public Law 101-336), Appendix A to Title 28 Code of Federal Regulations Part 36 (Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities - ADAAG.

19. American National Standard Institute, A117.1, Accessible and Usable Buildings and Facilities.
20. Phoenix Building Code.

G. Field Measurements: Take field measurements, where required, prior to preparation of Shop Drawings and fabrication to ensure proper fitting of the Work.

H. Shop Assembly: Preassemble items in the shop to the greatest extent possible, so as to minimize field splicing and assembly of units at the site. Disassemble units only to the extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinate installation.

1.4 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Drawings for the fabrication and erection of handrail and railing systems with sizes of members, components and anchorage devices, all based on specified requirements. Include copies of manufacturer's specifications, standard and custom detail drawings and installation instructions for handrail and railing systems. Include all plans and elevations identifying the location of all handrail and railing systems, and details of sections and connections. Show all anchorage items.
2. Profiles of handrail and railing systems components, and the details of forming, jointing, sections, connection, internal supports, trim, and accessories. Provide details drawn at 1-1/2-inch scale.
3. All calculations for complete structural analysis of the handrail and railing systems including calculations showing compliance with system performance criteria specified. The calculations shall be prepared, signed and sealed by a Registered Professional Engineer licensed in the State of Arizona.
4. Manufacturer's catalogs showing complete selection of standard and custom components and miscellaneous accessories for selection by ENGINEER.
5. Maintenance Manuals: Upon completion of the Work, furnish copies of detailed maintenance manual including the following information:
    a. Product name and number.
    b. Name, address and telephone number of fabricator and manufacturer’s local distributor.
    c. Detailed procedures for routine maintenance and cleaning, including cleaning materials, application methods and precautions as to use of materials that may be detrimental to finish when improperly applied.

B. Certification: Submit for approval the following:
1. Copies of material purchase receipts indicating actual materials purchased for this job, signed by a certified and licensed Notary Public, verifying that material purchased for the Work complies with material designations specified as confirmed by approved Shop Drawings.

2. Manufacturer's certificate on results of load testing the completed handrail and railing systems, demonstrating compliance with all applicable OSHA, ANSI and Phoenix Building Code requirements and the system performance criteria specified for superimposed loadings and deflection limitations.
3. Finish: Furnish a written certificate confirming specified anodized coating film thickness, coating weight, sealing treatment and stain test performance.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
1. Deliver handrails and railings and all accessories dry and undamaged, with manufacturer's protective coating intact, bearing original intact factory labels identifying component's location and use within the completed systems.
2. Handrail and railing systems components, which are damaged during delivery or while being unloaded, shall not be stored on site. Remove such units from site and replace with new, undamaged material.

B. Storage of Materials:
1. Store handrail and railing systems components and accessory materials in a dry location and in a manner that will protect strippable coating from exposure to sun and condensation; with good air circulation around each piece and with protection from wind blown rain.
2. Store handrail and railing systems components and accessory materials under tarpaulin covers and, in an area, protected from dirt, damage, weather and from the construction activities of all contractors. Do not store outside or allow items to become wet or soiled in any way while on site.
3. Do not store in contact with concrete, earth or other materials that might cause corrosion, staining, scratching or damage to finish. Do not install system components, which become dented, scratched, or damaged in any way. Remove such components from site and replace with new, undamaged material.

C. Handling of Materials:
1. Do not subject handrail and railing systems components and accessory materials to bending or stress.
2. Do not damage edges or handle material in a manner that will cause scratches, warps, or dents.
3. Keep on-site handling to a minimum.
4. Maintain protective covering on railings and handrails. All surface protective coverings such as nonadhesive papers, adhesive papers and strippable plastic films shall be removed after receipt at the site as soon as there is no longer a need for the protection.

1.6 JOB CONDITIONS

A. Protection: Protect cast-in-place sleeves from debris and water intrusion by use of temporary covers or removable foam inserts.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Performance Criteria:
   1. Maintain the visual design concept shown on the Drawings, and the technical requirements specified, including modules, profiles, alignment of components and requirements for finish.
   2. Provide handrail and railing systems that conform to the Phoenix Building Code and OSHA, Part 1910.23, including the 200-pound loading requirement. In addition, the system shall conform to the following requirements:
      a. Completed railing and handrail systems shall withstand a uniform lateral force of 40 pounds per linear foot and a vertical uniform force of 50 pounds per linear foot, both applied simultaneously at the top of the handrail and railing.
      b. Intermediate and bottom rails shall withstand simultaneously applied lateral uniform forces of 40 pounds per linear foot and a vertical load of 50 pounds per linear foot, however, lateral, and vertical loads on intermediate and bottom railings need not be considered in the detailing and fabrication of posts and anchorages.
      c. For railings having panels, the panels shall be detailed and fabricated to withstand a uniform lateral load of twenty pounds per square foot.
      d. Concentrated 200-pound load and uniform force conditions shall not be applied simultaneously.
      e. Other pertinent requirements ceded to ICC/ANSI 117.1, Accessible Building and Facilities, by the City of Phoenix Building Code.
      f. Bending stresses shall not exceed 60 percent of the yield stress of the material. Applied loads shall not produce permanent deflection in the completed Work when loads are removed.
      g. Select schedule of pipe using alloys, minimum diameter, loadings and maximum post spacing specified in order to limit deflection in each single-span of railing and handrail to 1.5-inches maximum and on railing posts to 1.4-inches maximum and with a safety factor of 1.65:1 for all Work.
      h. Load test completed handrail and railing systems and submit results to ENGINEER. Provide written report identifying and documenting the testing methods used, the loads superimposed and how and where they were applied, and the results of such tests on actual complete handrail and railing systems including all anchors and fasteners to be used in the Work. The written report shall be signed and sealed by a Registered Professional Engineer licensed in the State of Arizona. Testing setup shall simulate actual conditions of installation to be used in the Work.
   3. Thermal Control: Provide adequate expansion within fabricated systems that allows for a thermal expansion and contraction caused by a material temperature

change of 140°F to -20°F without warp or bow of system components. Distance between expansion joints shall be based on providing a 1/4-inch wide joint at 70°F, which accommodates a movement of 150 percent of the calculated amount of movement for the specified temperature range.

4. Provide expansion joints in handrail and railing systems where systems cross expansion joints in structure.
5. Provide handrail and railing systems as shown on the Drawings. Where handrail or railing systems are required by either the governing authority or the Occupational Safety and Health Act of 1970, or the Americans with Disabilities Act of 1990, aluminum handrail and railing systems of the type specified herein shall be provided.
6. Configuration of all handrails and railing systems components shall be as shown on the Drawings. Verify dimensions at the site without causing delay in the Work.
7. Dimensions are shown on the Drawings.
8. Where details show post location requirements at or near end of runs, uniformly space intermediate posts as required to meet loading and deflection criteria specified, but not greater than maximum spacing specified. Where posts are shown at straight walkways and other locations where railing is provided on each side, locate railing system posts opposite each other; do not stagger.
9. Comply with custom fabricated handrail and railing systems details shown on the Drawings. Provide fabricator's standard details for conditions not shown on the Drawings and for general system assembly, unless otherwise specified. All details shown are typical; similar details apply to similar conditions, unless specifically otherwise shown on the Drawings.
10. Fabricator is responsible for structural analysis and detailing of handrails and railings systems. Provide complete structural calculations and verification of other system performance criteria and Shop Drawings for all handrail and railing members, anchors and all other support system components prepared, signed and stamped with the seal of a Licensed Professional Engineer licensed to practice in the State of Arizona and recognized as an expert in the specialty involved.

B. Fasteners and Supports:
   1. Provide the size, length and load carrying capacity required to carry the specified loadings required by performance criteria times a minimum safety factor of four.
   2. Where sizes are shown on the Drawings, the sizes shown shall be considered minimum. Increase size to comply with required system performance criteria loadings and minimum safety factor specified.
   3. All railing system posts shall be provided with a circular profile solid reinforcing bar with outside diameter equal to inside diameter of post. Each post shall receive one reinforcing bar.

2.2 MATERIALS

A. Extruded Aluminum Architectural and Ornamental Shapes: ASTM B 221, Alloy 6063-T52.

B. Aluminum Forgings: ASTM B 247.

C. Extruded or Drawn Aluminum Pipe and Tube:
   1. ASTM B 429 or ASTM B 241, Alloy 6063-T5, 6063-T52 or 6063-T832 as required by loadings, deflections, and post spacings specified.
   2. Provide Schedule 40 pipe minimum, unless conditions of detail and fabrication require extra heavy pipe to comply with performance criteria specified.
   3. Provide all rails and posts with minimum outside diameter of 1.900-inches.

D. Reinforcing Bars: Solid, circular profile, 24-inch long, 6061-T6 aluminum reinforcing bars with same outside diameter as inside diameter of post.

E. Toe boards:
   1. Provide extruded ASTM 6063-T5 or T52 alloy aluminum toe boards, unless railing is mounted on curbs or other construction of sufficient height and type to meet the requirements of OSHA 1910.23. Bars or plates are not acceptable.
   2. Unless otherwise specified, toe boards shall meet requirements of OSHA Part 1910.23, Section (e).

F. Anchors and Fastenings:
   1. Type 316 stainless steel; minimum 1/2-inch diameter.
   2. Provide minimum of four bolt fasteners for each post where surface mounted posts are shown on the Drawings. Components shall be in accordance with manufacturer's recommendations and as acceptable to ENGINEER as shown on approved Shop Drawings.
   3. Concrete and Masonry Anchors: As specified in Section 05051, Anchor Bolts, Toggle Bolts and Concrete Inserts.
   4. Bolting Materials: As specified in Section 05051, Anchor Bolts, Toggle Bolts and Concrete Inserts.

G. Castings:
   1. Provide high strength aluminum alloy brackets, flanges and fittings suitable for anodizing as specified.
   2. Aluminum-Alloy Sand Castings: ASTM B 26.

H. Connector Sleeves: Schedule 40, 5-inches long by 1.610-inches diameter.

I. Brackets and Flanges: Provide manufacturer's complete selection of standard and custom brackets and flanges for railing system posts and for handrail supports.

J. Sockets: Provide 6-inch deep by 2-1/2-inch outside diameter aluminum sockets with 3-1/2-inch wide socket cover on bottom of all sockets and on top and bottom of removable post sockets.

K. Hinges: Provide two self-closing aluminum hinges for each railing system gate shown on the Drawings.

L. Latches and Stops: Provide one latch and stop with rubber bumper and 1-inch diameter plastic knob for each railing system gate shown on the Drawings.

M. Chain, Snaps and Eye Bolts: Provide oblong 0.250-inch welded link, Type 316 stainless steel chain weighing 57 pounds per cubic foot, each link 1-1/8-inch by 7/16-inch. Provide stainless steel eyebolts, 1/4-inch stainless steel threaded quick links and heavy-duty swivel snaps with spring-loaded latch.

N. Custom Cover Flanges: 1/4-inch high by 4-inch diameter; aluminum.

O. System Components and Miscellaneous Accessories: Provide a complete selection of manufacturer's standard and custom aluminum handrail and railing systems components and miscellaneous accessories as may be required based on conditions and requirements shown on the Drawings, including, but not limited to, fascia flanges, post brackets, complete selection of one and two-piece handrail brackets for selection by ENGINEER including glass panel handrail mounting brackets, protective inserts, threaded bushing brackets, interlocking panel clips, clamps, channel adapters, end caps, post caps, adapters, glass panel framing sections and accessories, ADA-compliant accessories and similar items. Show the type and location of all such items on Shop Drawings.

P. Adhesive: Two-part waterproof epoxy-type as recommended by handrail and railing systems manufacturer.

Q. Non-Shrink, Non-Metallic Grout:
   1. Pre-mixed non-staining cementitious grout requiring only the addition of water.
   2. Product and Manufacturer: Provide one of the following:
      a. Euco N-S by The Euclid Chemical Company.
      b. Masterflow 713 by Master Builders Company.
      c. Or equal.

2.3 FABRICATION

A. General: Unless otherwise shown on the Drawings or specified in the Contract Documents provide typical non-welded construction details and fabrication techniques as recommended by AMP/NAAMM publications specified.

B. Form exposed Work true to line and level with accurate angles, surfaces and straight edges. Fabricate all corners without the use of fittings.

C. Form bent-metal corners to the radius shown on the Drawings without causing grain separation or otherwise impairing the Work. Use radius bends to form all changes in

direction of handrail and railing systems. Form elbow bends and wall returns to uniform radius, free from buckles and twists, with smooth finished surfaces, or use prefabricated bends. Provide not less than 4-inch outside radius.

D. Provide chains across openings in railings where shown on the Drawings. Attach one end of each chain to a 1/4-inch eye bolt in the post and the other end attached by means of an approved heavy stainless steel swivel eye snap hook to a similar eye bolt in the opposite post.

E. Remove burrs from all exposed edges.

F. Locate intermediate rails equally spaced between top rail and finished floor.

G. Close aluminum pipe ends by using prefabricated fittings.

H. Weep Holes:
1. Fabricate joints, which will be exposed to the weather so as to exclude water.
2. Provide 15/64-inch diameter weep holes at the lowest possible point on all handrail and railing systems posts.
3. Provide pressure relief holes at closed ends of handrail and railing systems.

I. Toe boards:
1. Provide manufacturer's toe board detail, which accommodates movement, caused by thermal change specified without warping or bowing toe boards.
2. Provide manufacturer’s toe board detail, which accommodates storage for removable socket covers.
3. Coordinate and cope toe board as required to accommodate cover flanges at posts.
4. Toe boards shall follow curvature of railing. Where railing is shown on the Drawings to have curved contours at corners, or other locations, the toe board shall likewise be curved to follow line of railing system.

J. Reinforcing Bars: Provide reinforcing bar friction-fitted at all railing system posts. Extend reinforcing bars or tubes 6-inches into cast-in-place sleeves or other types of supporting brackets.

K. Mechanically Fitted Component Pipe Handrail and Railing:
1. Use a nonwelded pipe handrail and railing system with posts, top and intermediate rail(s) and flush joints.
2. Provide a top and intermediate horizontal rail(s), equally spaced.
3. Provide a top and bottom rail with 0.675-inch diameter pickets spaced as indicated on the drawings. Pressure-fit pickets into shop-fabricated channel adapters by hydraulic ram. Loose fit is not acceptable. Fasten picket sections into top and bottom rails by using tubular rivets 12-inches on center maximum, but uniformly spaced between posts beginning 6-inches from center line of post.

4. Blind rivets, pop rivets or other exposed fastening devices shall not be used in the Work. Fasteners used for side mounting fascia flanges where shown on the Drawings or specified may be exposed in the Work. Provide internal threaded tubular aluminum rivets, stainless steel through bolts with lock nuts, stainless steel sheet metal screws with lockwashers and epoxy adhesive for fastening all components of the Work.
5. Product and Manufacturer: Provide one of the following:
   a. Custom Fabricated Connectorail System by Julius Blum & Company, Incorporated.
   b. Custom Fabricated Series 500 Non-Welded Aluminum Pipe Aluminum handrails and railings system by Superior Aluminum Products, Incorporated.
   c. Or equal.

L. Mechanically Fitted Component Pipe Handrail and Railing:
1. Use a non-welded pipe handrail and railing system with posts, top and intermediate rail(s), and flush joints.
2. Provide a top and intermediate horizontal rails, equally spaced.
3. Provide a top and bottom rail with 0.675-inch diameter pickets spaced as indicated on drawings. Pressure-fit pickets into shop-fabricated channel adapters by hydraulic ram. Loose fit is not acceptable. Fasten picket sections into top and bottom rails by using tubular rivets 12-inches on center maximum, but uniformly spaced between posts beginning 6-inches from center line of post.
4. Stainless steel Type 304/305 blind rivets and stainless-steel Type 304/305 self-tapping screws shall be used to assemble all components of the Work.
5. Product and Manufacturer: Provide one of the following:
   a. Wesrail by Moultrie Manufacturing Company.
   b. Alumaguard by Alumaguard A Division of Bettinger West Incorporated.
   c. Or equal.

2.4 ALUMINUM COATINGS

A. General:
1. Prepare surfaces for finishing in accordance with recommendations of the aluminum producer and the finisher or processor.
2. Adjust and control the direction of mechanical finishes specified to achieve the best overall visual effect in the Work.
3. Color and Texture Tolerance: Provide uniform color and continuous mechanical texture for all aluminum components. ENGINEER reserves the right to reject aluminum materials because of color or texture variations, which are visually objectionable, but only where the variation exceeds the range of variations established by the manufacturer prior to fabrication, by means of range samples which have been accepted by ENGINEER.
4. Anodize all aluminum components of the Work.

B. Mechanically finish aluminum by wheel or belt polishing with aluminum oxide grit of 180 to 220 size, using peripheral wheel speed of 6,000 feet per minute: Aluminum Association Designation - M32 Medium Satin Directional Texture.
   1. Hand Rubbed Finish: Where required to complete the Work and provide uniform, continuous texture, provide hand rubbed finish to match medium satin directional texture specified in order to even out and blend in satin finishes produced by other means.

C. Provide non-etching chemical cleaning by immersing the aluminum in an inhibited chemical solution, as recommended by the coating applicator, to remove all lard oil, fats, mineral grease and other contamination detrimental to providing specified finishes.
   1. Clean and rinse with water between steps as recommended by the aluminum manufacturer.

D. Exposed Aluminum Anodic Coating: Provide anodic coatings as specified, which do not depend on dyes, organic or inorganic pigments, or impregnation processes to obtain color. Apply coatings using only the alloy, temperature, current density and acid electrolytes to obtain specified colors in compliance with the designation system and requirements of the Aluminum Association and AMP 501 of AMP/NAAMM. Comply with the following:
   1. Provide Architectural Class I high density anodic treatment by immersing the components in a tank containing a solution of 15 percent sulfuric acid at 70°F with 12 amperes per square foot of direct current for minimum of sixty minutes;
   2. Physical Properties:
      a. Anodic Coating Thickness, ASTM B 244: Minimum of 0.7 mils thick.
      b. Anodic Coating Weight, ASTM B 137: Minimum of 32 mg/sq. in.
      c. Resistance to Staining, ASTM B 136: No stain after five minutes dye solution exposure.
      d. Salt Spray, ASTM B 117: 30,000 hours exposure with no corrosion or shade change.
   3. Seal finished anodized coatings using deionized boiling water to seal the pores and prevent further absorption.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and conditions under which the aluminum handrails and railings systems Work is to be performed and notify ENGINEER, in writing, of unsatisfactory tolerances which exceed specified limits and other conditions detrimental to proper and timely completion of the Work. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

B. Verify to ENGINEER gage of aluminum pipe railing posts and rails brought to the site by actual measurement of on-site material in the presence of ENGINEER.

3.2 INSTALLATION

A. General:
   1. Do not erect components, which have become scarred, dented, chipped, discolored or otherwise damaged or defaced. Railing and handrail system components, which have holes, cuts, gouges, deep scratches or dents of any kind, shall be removed from the site before installation. Repairs to correct such Work will not be approved by ENGINEER. Remove and replace with new material.
   2. Comply with installation and anchorage recommendations of AMP/NAAMM publications specified in addition to the requirements specified and approved Shop Drawings.

B. Fastening to In-Place Construction:
   1. Remove protective plastic immediately before installation.
   2. Adjust handrails and railings prior to securing in place, to ensure proper matching at butting joints and correct alignment throughout their length. Plumb posts in each direction. Secure posts and rail end to building construction as follows:
      a. Anchor posts in concrete by means of sockets set and anchored into the concrete floor slab. Provide closure secured to the bottom of sleeve. Before installing posts remove all debris and water from sleeves. Verify that reinforcing bars have been inserted into posts before installation. Do not install posts without reinforcing bar. For all non-removable handrail and railing systems sections, after the posts have been inserted into the sockets, fill the annular space between posts and sockets solid with grout as specified in Section 03600, Grout. Crown grout and slope it to drain away from posts.
      b. Anchor posts to stair stringers with stringer or support flanges, angle type or floor type as required by conditions, shop-connected to posts and bolted to the steel supporting members. Flanges shall be as recommended by manufacturer. Verify that reinforcing bars have been inserted into posts before installation. Do not install posts without reinforcing bar.
      c. Side mount posts by fastening them securely in brackets attached to steel or concrete fascia as shown on the Drawings and in accordance with approved Shop Drawings.
      d. Provide removable railing sections where shown on the Drawings. Removable railing system posts shall be provided with friction fitted reinforcing bar in each post. Provide sockets with socket covers stored in extruded toeboard. Provide aluminum pipe collars for all removable posts. Accurately locate sleeves to match post spacings.
      e. All posts set in concrete shall be provided with an aluminum floor cover flange.

3. Use devices and fasteners recommended by the handrail and railing systems manufacturer and as shown on the approved Shop Drawings.

C. Cutting, Fitting and Placement:
1. Perform cutting, drilling, and fitting required for installation. Set the Work accurately in location, alignment, and elevation, plumb, level, true and free of rack, measured from established lines and levels.
2. Fit exposed connections accurately together to form tight hairline joints. Do not cut or abrade the surfaces of units, which have been finished after fabrication, and are intended for field connections.
3. Permanent field splice connections shall be made using manufacturer's recommended epoxy adhesive and 5-inch minimum length connector sleeves. Tight press-fit all field splice connectors and install in accordance with manufacturer's written instructions. Follow epoxy manufacturer's recommendations for requirements of installation and conditions of use.
4. Permanent field splice connections shall be made using stainless steel blind rivets and 5-inch minimum length connector sleeves. Tight press-fit all field splice connectors and install in accordance with manufacturer's written instructions. Install two blind rivets per joint on 180-degree centers.
5. Make all splices as near as possible to posts but not exceeding 12-inches from nearest post.
6. Field welding will not be permitted. Make all splices using a pipe splice lock employing a single allen screw to lock joint.
7. Provide hinged railings sections as shown on the Drawings. Provide hinges and latch for connection to adjacent railing.
8. Provide chain sections as shown on the Drawings. Provide one chain length with fastening accessories for top and each intermediate rail.
9. Secure handrails to walls with wall brackets and end fittings as shown on the Drawings. Locate brackets as shown on the Drawings.
10. Provide flush-type wall return fittings with the same projection as that shown for wall brackets. Drill wall plate portion of the bracket to receive one bolt, unless otherwise shown on the Drawings.
11. Secure wall brackets to building construction as follows:
    a. For concrete and solid masonry anchorage, use anchor bolt expansion shields and lag bolts.
    b. For hollow masonry anchorage, use toggle bolts having square heads.
12. Securely fasten toeboards in place with not more than 1/4-inch clearance above floor level.
13. Drill one 15/64-inch diameter weep hole not more than 1/4-inch above the top of location of solid reinforcing bar in each post.

D. Fastening to Existing Construction:
1. Provide heavy duty floor flange and anchorage devices and fasteners where necessary for securing handrail and railing systems components to existing construction; including stainless steel threaded fasteners for concrete and

masonry inserts, toggle bolts, through-bolts, lag bolts and other connectors as required.

2. Use devices and fasteners recommended by the handrail and railing systems manufacturer and as shown on approved Shop Drawings.

E. Expansion Joints:
   1. Provide slip joint with internal sleeve extending 2-inches minimum beyond joint on each side.
   2. Construct expansion joints as for field splices, except fasten internal sleeve securely to one side of rail only.
   3. Locate joints within 6-inches of posts.
   4. Submit locations and details of all expansion joints to ENGINEER.

F. Protection from Dissimilar Materials:
   1. Coat all surfaces of aluminum in contact with dissimilar materials such as concrete, masonry and steel as specified in Section 09900, Painting.
   2. Do not extend coating beyond contact surfaces. Remove coating where exposed-to-view in the finished Work.

3.3 CLEANING AND REPAIRING

A. Cleaning: Installer shall clean exposed surfaces of handrail and railing systems of every substance after completion of installation. Comply with recommendations of both the handrail and railing, and finish manufacturer. Do not use abrasives or non-approved solvent cleaners. Test cleaning techniques on an un-used section of railing before employing cleaning technique.
   1. Remove all stains, dirt, grease or other substances by washing handrails and railings systems thoroughly using clean water and soap; rinse with clean water.
   2. Do not use acid solution, steel wool or other harsh abrasives.
   3. If stain remains after washing remove defective sections and replace with new material conforming to the requirements of the Specification.

B. Leave handrails and railings, free from dents, burrs, scratches, holes and other blemishes. Replace damaged or otherwise defective Work with new material that conforms to the Specification requirements at no additional cost to OWNER.

C. At the completion of Work, replace adjacent work, marred by the Work of this Section.

++ END OF SECTION ++

SECTION 05561

CASTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown on the Drawings, specified and required to furnish and install castings.
   2. Castings include metal items, which are not a part of the miscellaneous metal fabrications or metal systems in other Sections of these Specifications.

B. Castings shall be for the following types of construction:
   1. Manholes frames with covers.
   2. Valve boxes.

1.2 QUALITY ASSURANCE

A. Standard Specifications and Details:
   1. Conform to all applicable requirements of Part Nos. 600 and 700 of the Uniform Standard Specifications for Public Works Construction and all applicable requirements of the Uniform Standard Details for Public Works Construction by the Maricopa Association of Governments (MAG) as supplemented by the City of Phoenix. If there is a conflict between MAG Standards as supplemented by the City of Phoenix and these Specifications, the provisions of these Specifications shall govern.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM A 48, Specification for Gray Iron Castings.
   2. ASTM B 26, Specification for Aluminum-Alloy Sand Castings.

C. Shop Assembly:
   1. Preassemble items in the shop to the greatest extent possible, so as to minimize field splicing and assembly of units at the site. Disassemble units only to the extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Fabrication and erection of all casting assemblies. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items.

a. Include setting drawings for location and installation of castings and anchorage devices.

2. Copies of manufacturer's specifications, load tables, dimension diagrams, anchor details and installation instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Gray Iron Castings: ASTM A 48, Class 30A.

B. Aluminum Castings: ASTM B 26, Alloy 713 Temper T5.

C. Manhole Frames with Covers:
1. Roadway standard with 24-inch opening and cast covers conforming to the MAG Uniform Standard Details for Public Works Construction, Detail No. 424, except where otherwise shown on the Drawings.

D. Valve boxes and covers:
1. Valve Box Installation Standard with grade adjustment, 8" CI frame and cover, and the word "SEWER" on cover conforming to the MAG Uniform Standard Details for Public Works constructions, Detail No. 391, except where otherwise shown on the Drawings.

E. Product and Manufacturer: Provide one of the following:
1. Neenah Foundry Company.
2. Flockhart Foundry Company.
3. Or equal.

2.2 DESIGN AND FABRICATION

A. Design round frames and covers to prevent rocking and rattling under traffic.

B. Fabricate castings true to pattern so that component parts fit together.

2.3 FINISH

A. Iron: Coat with asphaltic paint standard with the manufacturer.

B. Aluminum: Provide mill finish.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Follow manufacturer's printed instructions and approved Shop Drawings.

B. Set castings accurately to required location, alignment, and elevation, plumb, level, true and free of rack, measured from established lines and levels. Brace temporarily or anchor temporarily in formwork.

C. Protection from Dissimilar Materials:
   1. Coat all aluminum surfaces in contact with dissimilar materials such as concrete, masonry, steel and other metals as specified in Section 09900, Painting

+ + END OF SECTION + +

SECTION 07920

CAULKING AND SEALANTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, tools, equipment, and incidentals as shown on the Drawings, specified and required to furnish and install caulking and sealants.
   2. Extent of each type of caulking and sealant is shown on the Drawings and includes the following:
      a. All joints between concrete members and masonry.
      b. All concrete to concrete joints.
      c. All metal to metal joints.
      d. All joints between masonry and metal.
      e. All expansion joints in masonry and concrete.
      f. All control joints.
      g. All joints between reglets and flashing.
      h. All sound-sealed and air-sealed joints.
      i. As an exposed-to-view finish on the exposed face of all fire-rated sealants.
      j. On both sides of all terminations of all construction systems, specified to receive caulking and sealants, where construction system remains exposed-to-view in the finished Work.
      k. All isolation joints between equipment and other items.
      l. All joints where construction systems are discontinuous or inherently non-watertight.
      m. All locations whether or not shown on the Drawings, required to render the building watertight, except where a construction system is specified or shown as not relying upon the use of sealants in order to achieve weather and watertightness.
   3. Types of products required include the following:
      a. Two-component, urethane based, non-sag, elastomeric sealant.
      b. Two-component, urethane based, self-leveling, elastomeric sealant.
      c. Polyethylene backer rods.
      d. Miscellaneous materials and accessories.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the caulking and sealants.
   2. Coordinate the final selection of caulking and sealants to be compatible with all calking and sealant substrates specified.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Engage a single installer regularly engaged in caulking and sealant installation and with successful experience in the application of the types of materials required, and who agrees to employ only tradesmen with specific skill and successful experience in this type of Work.

B. Job Mock-ups:
   1. Prior to the installation of caulking and sealant Work, but after ENGINEER'S approval of samples, install sample of each type of caulking and sealant in areas selected by ENGINEER to show a representative installation of the caulking and sealants. Obtain ENGINEER'S acceptance of visual qualities of the mock-ups before start of caulking and sealant Work. Retain and protect mock-ups during construction as a standard for judging completed caulking and sealant Work. Do not alter mock-ups.
   2. Caulking and sealant Work that does not meet the standard approved on the sample areas shall be stopped, removed and replaced with new material.

C. Source Quality Control: Obtain materials from only manufacturers who will, if required:
   1. Send a qualified technical representative to the site, for the purpose of advising installer of proper procedures and precautions for the use of the materials.
   2. Test caulking and sealants for compatibility with the substrates specified for conformance to FS-TT-S-0027, and recommend remedial procedures as required.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM C 510, Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants.
   2. ASTM C 661, Test Method for Identation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
   3. ASTM C 793, Test Method for Effects of Accelerated Weathering on Elastomeric Joint Sealants.
   4. ASTM C 794, Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
   5. Federal Specification, FS TT-S-00227, Sealing Compound: Elastomeric Type, Multi-component for Caulking, Sealing, and Glazing in Buildings and Other Structures.

E. Compatibility: Before purchase of each specified sealant, investigate its compatibility with the joint surfaces, joint fillers, and other materials in the joint system. Provide only materials (manufacturer's recommended variation of the specified materials) which are known to be fully compatible with the actual installation condition, as verified by manufacturer's published data or certification and as shown on approved Shop Drawings.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
   1. Each type of actual cured material samples of each caulking and sealant specified, 3-inches long, in each of the manufacturer's standard colors.
   2. Each size and type of sealant backer rod, 3-inches long, as recommended by the caulking and sealant manufacturer.
   3. Bond breaker tape as recommended by the manufacturer.
   4. Samples will be reviewed by ENGINEER for color and texture only. Compliance with other requirements is the responsibility of CONTRACTOR.
   5. Refer to and comply with the requirements of Section 01333, Samples.

B. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer's specifications, recommendations, and installation instructions for each type of sealant, caulking compound and associated miscellaneous material required. Include manufacturer's published data, indicating that each material complies with the requirements and is intended for the applications shown.
   2. Pre-Installation Meeting report as specified in Paragraph 1.5.A., below.

C. Test Reports: Submit for approval the following:
   1. Compatibility tests for substrates, based on adhesion-in-peel standard test procedures and FS TT-S-0027.
   2. Certified laboratory test reports indicating conformance with the requirements.

D. Guarantee: Submit for approval the following:
   1. Copies of written guarantee agreeing to repair or replace sealants which fail to perform as specified. Refer to paragraph 1.6.A of this Section.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver materials in caulking and sealant manufacturer's original unopened, undamaged containers, indicating compliance with approved Shop Drawings and approved Sample color selections.
   2. Include the following information on the label:
      a. Name of material and supplier.
      b. Formula or specification number, lot number, color and date of manufacture.
      c. Mixing instructions, shelf life and curing time, when applicable.
   3. Failure to comply with these requirements shall be sufficient cause for rejection of the material in question, by ENGINEER. Immediately remove rejected materials from the site and do not offer them again for approval by ENGINEER. Supply new material conforming to the specified requirements, at no additional expense to OWNER.

B. Storage and Handling of Materials:
   1. Store materials so as to preclude the inclusion of foreign materials.
   2. Do not store or expose materials to temperature above 90°F or store in direct sunshine.
   3. Do not use materials which are outdated as indicated by shelf life.
   4. Store sealant tape in a manner which will not deform the tape.
   5. In cool or cold weather, store containers where temperature approximates 75°F for 16 hours before using.
   6. When high temperatures prevail, store mixed sealants in a cool place.
   7. Refer to and comply with the requirements of Section 01661, Storage of Materials and Equipment.
   8. Handle materials carefully to prevent inclusion of foreign materials.
   9. Do not open containers or mix components until necessary preparatory Work and priming has been completed.

1.5 JOB CONDITIONS

A. Pre-Installation Meeting:
   1. Prior to the installation of the caulking and sealants and associated Work, schedule and meet at the job site with; the calking and sealant installer, the calking and sealant manufacturer's technical representative, other trades involved in coordination with the caulking and sealant Work, the ENGINEER, and the OWNER. Record the discussions of the Pre-Installation Meeting and the decisions and agreements (or disagreements) and furnish a copy of the record to each party attending. Review foreseeable methods and procedures related to the caulking and sealant Work, including but not necessarily limited to the following:
      a. Review project requirements, including Drawings, Specifications and other Contract Documents.
      b. Review required submittals, both completed and yet to be completed.
      c. Review status of substrate and similar considerations.
      d. Review each major caulking and sealant application required.
      e. Review availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.
   2. Reconvene the meeting at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.

B. Environmental Conditions:
   1. Do not proceed with installation of caulking and sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.
   2. Proceed with the Work only when forecasted weather conditions are favorable for proper cure and development of high early bond strength.
   3. Wherever joint width is affected by ambient temperature variations, install elastomeric sealants only when temperatures are in the lower third of manufacturer's recommended installation temperature range, so that sealant will

not be subjected to excessive elongation and bond stress at subsequent low temperatures.

4. When high temperatures prevail avoid mixing sealants in direct sunlight.

C. Protection: Do not allow caulking and sealants to overflow or spill onto adjoining surfaces, or to migrate into the voids of adjoining surfaces including rough textured materials. Use masking tape or other precautionary devices to prevent staining of adjoining surfaces, by either the primer/sealer or the caulking and sealant materials.

1.6 GUARANTEE

A. Provide a written guarantee agreeing to repair or replace sealants which fail to perform as air-tight and watertight joints; or fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability; or appear to deteriorate in any other manner not clearly specified by submitted manufacturer's data, as an inherent quality of the material for the exposure indicated. Provide guarantee signed by installer and CONTRACTOR. Provide guarantee period of two years from Final Completion. Refer to paragraph 1.3.D.1 of this Section.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Exterior and Interior Horizontal and Vertical Joints; submerged and intermittently submerged:
   1. Two-Component Polysulfide Sealant:
      a. Polysulfide-based, 2-part elastomeric sealant complying with the following:
         1) Thiokol's Building Trade Performance Specifications: Type II Class A (non-sag).
         2) Adhesion-in-Peel, FS TT-S-00227E and ASTM C 794 (minimum 5 lbs.): Glass, minimum 21 lbs./linear inch; Aluminum, minimum 18 lbs/ linear inch; Concrete, minimum 21 lbs/linear inch.
         3) Hardness (Standard Conditions), ASTM C 661: 15 to 50 (Shore A).
         4) Stain and Color Change, FS TT-S-00227E and ASTM C 510: No discoloration or stain.
         5) Accelerated Aging, ASTM C 793: No change in sealant characteristics after 250 hours in weatherometer.
         6) Rheological Vertical Displacement at 120°F, FS TT-S-00227E: No sag.
      b. Product and Manufacturer: Provide one of the following:
         1) Sonnolastic Two-Part by Sonneborn Building Products, Division of Chemrex, Inc.
         2) Lasto-Meric by Tremco.

3) Or equal.

B. Exterior and Interior Vertical Joints; non submerged:
1. Two-Component Urethane Sealant:
a. Urethane-based, 2-part elastomeric sealant complying with the following:
1) FS TT-S-00227E: Type II (non-sag) Class A.
2) Adhesion-in-Peel, FS TT-S-00227E and ASTM C 794: (Minimum 5 lbs/linear inch with no adhesion failure): 28 lbs.
3) Hardness (Standard Conditions), ASTM C 661: 15 to 50 (Shore A).
4) Stain and color change, FS TT-S-00227E and ASTM C 510: No discoloration or stain.
5) Accelerated Aging, ASTM C 793: No change in sealant characteristics after 250 hours in weatherometer.
6) Rheological Vertical Displacement at 120°F, FS TT-S-00227E: No sag.
b. Product and Manufacturer: Provide one of the following:
1) Sonolastic NP 2 by Sonneborn Building Products, Division of Chemrex, Inc.
2) Dymeric by Tremco.
3) Or equal.

C. Exterior and Interior Horizontal Joints; non submerged:
1. Two-Component Polyurethane Sealant:
a. Polyurethane-based, 2-part elastomeric sealant complying with the following:
1) FS TT-S-00227E, Type I (self-leveling) Class A.
2) Water Immersion Bond, FS TT-S-00227E: Elongation of 25 percent with no adhesive failure.
3) Hardness (Standard Conditions), ASTM C 661: 35 to 45.
4) Stain and Color Change, FS TT-S-00227E and ASTM C 510: No discoloration or stain.
5) Accelerated Aging, ASTM C 793: No change in sealant characteristics after 250 hours in weatherometer.
b. Product and Manufacturer: Provide one of the following:
1) SL_2 Sealant by Sonneborn Building Products, Division of Chemrex, Inc.
2) THC/900 by Tremco.
3) Or equal.

D. Provide colors selected by ENGINEER from caulking and sealant manufacturer's standard and custom color charts. "Or equal" manufacturers shall provide the same generic products and colors as available from manufacturers specified.

E. Miscellaneous Materials:
1. Joint Cleaner: As recommended by the caulking and sealant manufacturer.

2. Joint Primer and Sealer: As recommended by the caulking and sealant manufacturer.
3. Bond Breaker Type: Polyethylene tape or other plastic tape as recommended by the caulking and sealant manufacturer, to be applied to sealant-contact surfaces where bond to the substrate or joint filler must be avoided for proper performance of caulking and sealant. Provide self-adhesive tape, wherever applicable.
4. Sealant Backer Rod: Compressible rod stock polyethylene foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable nonabsorptive material as recommended for compatibility with caulking and sealant by the caulking and sealant manufacturer. Provide size and shape of rod which will control the joint depth for sealant placement, break bond of sealant at bottom of joint, form optimum shape of sealant bead on back side, and provide a highly compressible backer to minimize the possibility of sealant extrusion when joint is compressed.
5. Low Temperature Catalyst: As recommended by the calking and sealant manufacturer.

2.2 MIXING

A. Comply with sealant manufacturer's written instructions for mixing two-component sealants.

B. Thoroughly mix components before use.

C. Add entire contents of activator can to base container. Do not mix partial units.

D. Mix contents for a minimum of five minutes or as recommended by the sealant manufacturer, until color and consistency are uniform.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine joint surfaces, substrates, backing, and anchorage of units forming sealant rabbet, and the conditions under which the caulking and sealant Work is to be performed, and notify ENGINEER, in writing, of any conditions detrimental to the proper and timely completion of the Work and performance of the sealants. Do not proceed with the calking and sealant Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 JOINT SURFACE PREPARATION

A. Clean joint surfaces immediately before installation of sealant compound. Remove dirt, weakly adhering coatings, moisture and other substances which would interfere

with bonds of sealant compound as recommended by sealant manufacturer's written instructions as shown on approved Shop Drawings.

B. Etch concrete and masonry joint surfaces to remove excess alkalinity, unless sealant manufacturer's written instructions, as shown on approved Shop Drawings, indicate that alkalinity does not interfere with sealant bond and performance.
   1. Etch with five percent solution of muriatic acid.
   2. Neutralize with dilute ammonia solution.
   3. Rinse thoroughly with water and allow to dry before sealant installation.

C. If necessary, clean porous materials such as concrete and masonry by grinding, sand blasting or mechanical abrading. Blow out joints with oil-free compressed air, or by vacuuming joints prior to application of primer or sealant.

D. Roughen joint surfaces on vitreous coated and similar non-porous materials, wherever sealant manufacturer's data indicates lower bond strength than for porous surfaces. Rub with fine abrasive cloth or steel wool to produce a dull sheen.

3.3 INSTALLATION

A. Comply with sealant manufacturer's written instructions, except where more stringent requirements are shown on the Drawings or specified and except where manufacturer's technical representative directs otherwise; but only as approved by ENGINEER.

B. Prime or seal the joint surfaces as shown on approved Shop Drawings. Do not allow primer or sealer to spill or migrate onto adjoining surfaces. Allow primer to dry prior to application of sealants.

C. Apply masking tape before installation of primer, in continuous strips in alignment with the joint edge to produce sharp, clean interface with adjoining materials. Remove tape immediately after joints have been sealed and tooled as directed.

D. Do not install sealants without backer rods or bond breaker tape.

E. Roll the back-up rod stock into the joint to avoid lengthwise stretching. Do not twist, braid, puncture or prime backer-rods.

F. Employ only proven installation techniques, which will ensure that sealants will be deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of the joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and a vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.

G. Install sealants to depths as recommended by the sealant manufacturer, but within the following general limitations, measured at the center (thin) section of the bead.
   1. For horizontal joints in sidewalks, pavements and similar locations sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75 percent of joint width, but not more than 5/8-inch deep or less than 3/8-inch deep.
   2. For vertical joints subjected to normal movement and sealed with elastomeric sealants, but not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but not more than 1/2-inch deep or less than 1/4-inch deep.

H. Remove excess and spillage of compounds promptly as the Work progresses.

I. Cure caulking and sealant compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability.

3.4 FIELD QUALITY CONTROL

A. Where questions of compatibility of sealants and substrate arise, the sealant manufacturer shall test the substrate in question for compatibility with the specified sealant and report his findings, along with recommendations, to ENGINEER.

B. Do not proceed with installation of elastomeric sealants over joint surfaces which have been painted, lacquered, waterproofed or treated with water repellent or other treatment or coating unless a laboratory test for durability (adhesion), in compliance with FS TT-S-00227 has successfully demonstrated that sealant bond is not impaired by the coating or treatment. If laboratory test has not been performed, or shows bond interference, remove coating or treatment from joint surfaces before installing sealant.

C. After nominal cure of exterior joint sealants which are exposed to the weather, test for water leaks. Flood the joint exposure with water directed from a 3/4-inch diameter garden hose, without nozzle, held perpendicular to wall face, 2 feet - 0 inch from joint and connected to a water system with 30 psi minimum normal water pressure. Move stream of water along joint at an approximate rate of 20 feet per minute.

D. Test approximately five percent of total joint system, in locations which are typical of every joint condition, and which can be inspected easily for leakage on opposite face. Conduct test in the presence of ENGINEER, who will determine the actual percentage of joints to be tested and the actual period of exposure to water from the hose, based upon the extent of observed leakage, or lack thereof.

E. Where nature of observed leakage indicates the possibility of inadequate joint bond strength, ENGINEER may direct that additional testing be performed at a time when joints are fully cured, and before Substantial Completion of the Work.

3.5 ADJUSTMENT AND CLEANING

A. Repair sealant installation at leaks or, if leakage is excessive, replace sealant installation.

B. Clean adjacent surfaces of sealant and soiling resulting from the Work. Use solvent or cleaning agent recommended by the sealant manufacturer. Leave all finish Work in a neat and clean condition.

C. Protect the sealants during the construction period so that they will be without deterioration, soiling, or damage at the time of Final Completion.

+ + END OF SECTION + +

SECTION 09900

PAINTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. Provide all labor, materials, tools, equipment, and incidentals as shown on the Drawings, specified, and required to furnish and apply paint systems.
2. Provide proper surface preparation and painting of all new and existing interior and exterior items and surfaces.
3. Extent of painting is specified and includes the following:
   a. Painting shown in schedules may not provide a complete indication of all painting work. Check drawings and the coating specifications.
   b. All substrates must be prepared and painted according to their intended location, service environment per the coating manufacturer's current product data sheet for the coating (s) being used, unless specifically identified on the Drawings as a surface not to receive specified painting system.
   c. All new and specifically identified existing surfaces and items except where the natural finish of the material is specified as a corrosion-resistant material not requiring paint; or is specifically shown on the Drawings as indicated by written note or specified as a surface not to be painted. Where items or surfaces are not specifically mentioned, paint them the same as adjacent similar materials or areas, unless otherwise directed by ENGINEER.
   d. Heating, ventilating, and air conditioning items to be painted include, but are not limited to the following:
      1) Piping, pipe insulation, pipe hangers, and supports.
      2) Heat Exchangers.
      3) Tanks.
      4) Ductwork and insulation.
      5) Motors, mechanical equipment, and supports.
      6) Accessory items.
   e. All new and specifically identified existing surfaces and items except where the natural finish of the material is specified as a corrosion-resistant material not requiring paint; or Surface preparation and painting of all new and specifically identified existing items, both interior and exterior, and other surfaces, including items furnished by OWNER, are included in the Work, except as otherwise shown on the Drawings or specified.
   f. Removal of all substances, topcoats, primers, and all intermediate coats of paint and other protective or decorative toppings on those items and surfaces to remain that are identified to receive a painting system under this Section, in order to provide surfaces acceptable for application of painting system specified.

g. Approved stepped-down mock-ups for all coating or lining systems showing all components of the surface preparation and coating or lining system application before the start of any work. Check all dry film thicknesses; demonstrate methods of surface preparation and methods of application in addition to obtaining ENGINEER'S approval of colors and textures to be used in the work. Submit all mockups to the ENGINEER prior to conducting the work.

B. Coordination:
1. Review installation, schedules, removal, and demolition procedures under other Sections and coordinate them with the work specified herein.
2. Coordinate the painting of areas that will become inaccessible once equipment, laboratory furniture, lockers and similar fixed items have been installed.
3. Coordinate primers with finish paint materials in order to provide primers that are compatible with finish paint materials used. Review other Sections and other contracts where primed surfaces are provided, to ensure compatibility of the total painting system for the various surfaces and environment service exposures. Coordinate the compatibility of all shop-primed and field-painted items in other Sections.
4. Furnish information to ENGINEER on the characteristics of the finish materials proposed for use, to ensure that compatible prime coats are used. Provide barrier coats over incompatible primers or remove and repaint as required. Notify ENGINEER, in writing, of anticipated problems using the specified painting systems with surfaces primed by others. Repair and re-prime all equipment primed in the factory and other factory-primed items that are damaged or scratched according to the coating manufacturers current written instructions.
5. All shop primed items shall be re-blasted in the field and re-primed prior to being finish coated. No equipment that has been shop primed and finish coated shall be field painted, unless it has been re-blasted, re-primed and finish coated in the field.

C. Work Not Included: The following categories of Work are not included as part of the painting Work, or are included in other Sections:
1. Shop-Priming: Shop-priming of structural metal, miscellaneous metal fabrications, other metal items and fabricated components such as shop-fabricated or factory-built heating and ventilating and electrical equipment or accessories shall conform to applicable requirements of this Section but are included under other Sections.
2. Pre-finished Items:
   a. Items furnished with such finishes as baked-on enamel, porcelain and polyvinylidene fluoride shall only be remediated at the site according to the manufacturers' written instructions and using the manufacturer's recommended compatible field-applied touchup pain
   b. Items furnished with such finishes as chrome plating or anodizing.
3. Concrete surfaces below wet well floor elevation, unless otherwise shown on the Drawings or specified.
4. Concrete floors
5. Face brick, glazed structural tile and prefaced, ground-faced or split-faced concrete masonry units.
6. Exterior face of architectural precast concrete.

7. Collector bearings, shafts and chains, wood flights, wood stop logs and wood baffles.
8. Corrosion-Resistant Metal Surfaces: Where the natural oxide of the item forms a barrier to corrosion, whether factory- or site-formed, including such materials as copper, bronze, muntz metal, zinc, terne metal and stainless steel.
9. Operating Parts and Labels:
   a. Do not paint moving parts of operating units, mechanical and electrical parts such as valve and damper operators, linkages, sensing devices, interior of motors and fan shafts.
   b. Do not paint over labels required by governing authorities having jurisdiction, or any equipment identification, performance rating, name, or nomenclature plates.
   c. Cover moving parts and labels during the painting Work with protective masking. Remove all protective masking upon completion of Work. Remove all paint, coatings or splatter which comes in contact with such labels.
10. Structural and miscellaneous metals covered with concrete shall only receive a primer compatible with the covering material.
11. Existing structures, equipment and other existing surfaces and items, unless otherwise shown on the Drawings or specified.

D. Description of Colors and Finishes:
   1. Color Selection:
      a. Maximum of 1 different color shall be selected by ENGINEER, in addition to color-coding of all pipelines, valves, equipment and ducts.
      b. ENGINEER reserves the right to select all non-standard colors for all paint systems specified within the ability of manufacturer to produce such non-standard colors. CONTRACTOR shall supply such colors, at no additional cost to OWNER.
   2. Color Coding of Pipelines, Valves, Equipment and Ducts:
      a. In general, all color-coding of pipelines, valves, equipment and ducts shall comply with applicable standards of ANSI A13.1, ANSI Z535.1 and CFR 1910.144. Provide color-coding for pipelines included in Paragraph 1.1.F.3.b, Pipeline Color Table, for specified pipelines.
      b. For equipment located on roofs or where exposed-to-view such as on exterior building facades, or in offices or lobbies, the color shall be selected by ENGINEER.
   3. Color Coding of Pipelines and Equipment:
      a. Finish coats of paint for pipelines and equipment shall be coded in basic colors. Colors shall be brilliant, distinctive shades matching the following safety colors in accordance with ANSI Z535.1 color specifications for safety colors and other primary colors:

TABLE OF STANDARD COLORS

COLOR	DESIGNATION
Black	Black - 35GR
Blue	Safety Blue - 11SF

Brown	Chipmunk - YB23
Charcoal	Graphite - GR32
Gray	Gray-ANSI 61 - 33GR
Green	Safety Green - 09SF
Light Gray	Light Gray - 32GR
Light Green	Misty Jade - GB38
Orange	Safety Orange - 04SF
Red	Safety Red - 06SF
White	White - 00WH
Yellow	Safety Yellow - 02SF
D. Gray	Sinker - 46GR
Lt. Blue	Clear Sky - 26BL
Dk. Blue	KC Blue - 21BL
Medium Green	Linden - 27GN
Dk. Green	Hunter Green - 08SF
Purple	Safety Purple - 14SF

*Color designations are provided as Tnemec Company, Incorporated paint color numbers and are provided as a standard of quality; equivalent colors matching these colors will be acceptable to ENGINEER. Provide ENGINEER with direct color comparisons of color numbers available from manufacturer submitted at time of Shop Drawing submission.

4. General Color Code: Unless otherwise specified, the following color code shall be used:

PIPING AND SIGN COLOR CODE

WATER			
PIPING AND LEGEND	**PIPING COLOR**	**LETTERING COLOR**	**BACKGROUND COLOR**
Spray Water	Red	Black	Red
Potable Water	Lt. Blue/White Bands	Black	Blue
Seal Water	Red	White	Red
Chilled Water Return	Blue	White	Green
Chilled Water Supply	Blue	White	Green
Cold Water	Blue	White	Green
Hot Water Return	Blue/Red Bands	Black	Yellow
Hot Water Supply	Blue/Red Bands	Black	Yellow
Non-Potable Water (Reuse Water)	Red/Black Bands	White	Red

WATER LINES			
PIPING AND LEGEND	**PIPING COLOR**	**LETTERING COLOR**	**BACKGROUND COLOR**
Water - Potable	Lt. Blue	Black	None
Water - Potable (HOT)	Lt. Blue	Black	Red
Water - Deionized	Lt. Blue	Black	None
Water - Raw	Dk. Green	Black	Lt. Gray
Water - Non-Potable (Plant Water)	Lt. Blue	Black	Purple
Water - Non-Potable (Reuse)	Purple	Black	None

AIR AND GAS			
PIPING AND LEGEND	**PIPING COLOR**	**LETTERING COLOR**	**BACKGROUND COLOR**
Process Air	White	Black	White
Chlorine Gas	Yellow/Green Bands	White	Yellow
Natural Gas	Red	Black	Yellow
Digester Gas, H.P.	Red	Black	Yellow
Digester Gas, L.P.	Red	Black	Yellow
High Pressure Air	White/Red Bands	Black	White

WASTEWATER			
PIPING AND LEGEND	**PIPING COLOR**	**LETTERING COLOR**	**BACKGROUND COLOR**
Domestic Wastewater	Gray	Black	None
Process Wastewater	Gray	Black	Lt. Blue

5. After approval by ENGINEER of colors and Shop Drawing submittals and prior to beginning painting Work, ENGINEER will furnish color schedules for surfaces to be painted.
6. Abbreviations and Symbols:
   a. Abbreviations and symbols used in Tables are explained in Article 2.2, below, and provide information on generic composition of the required materials, manufacturers, number of coats and their dry mil film thickness per coat (DMFTPC) and coverage for calculating the required number of gallons for the Work.

1.2 REFERENCE STANDARDS

A. Insure all referenced standards are used according to the standard's most current version.

B. ASTM International (ASTM):
   1. ASTM C 1538/1538M, Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-Off Method
   2. ASTM D 16, Standard Terminology Relating to Paint, Varnish, Lacquer and Related Products
   3. ASTM D 3359, Methods for Measuring Adhesion by Tape Test. Method A.
   4. ASTM D 3960, Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coating
   5. ASTM D 4227, Standard Practice for Qualification of Coating Applicators for Application of Coatings to Concrete Surfaces
   6. ASTM D 4228, Standard Practice for Qualification of Coating Applicators for Application of Coatings to Steel Surfaces
   7. ASTM D 4258, Practice for Surface Cleaning Concrete for Coating.
   8. ASTM D 4259, Practice for Abrading Concrete.
   9. ASTM D 4261, Standard Practice for Surface Cleaning Concrete Unit Masonry for Coating.
   10. ASTM D 4262, Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surface
   11. ASTM D 4263, Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
   12. ASTM D 4285, Test Method for Indicating Oil or Water in Compressed Air.
   13. ASTM D 4417, Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel. Methods B or C
   14. ASTM D 4541, Test Method for Pull-Off Strength of Coatings Using Portable Adhesion-Testers.
   15. ASTM D 6386, Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
   16. ASTM D 7234, Pull-Off Adhesion test of Coatings on Concrete Using Portable Pull-Off Adhesion Testers
   17. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials
   18. ASTM E 797/797M, Measuring Thickness by Manuel Ultrasonic Pulse-Echo Contact Method
   19. ASTM F 22, Hydrophobic Surface Films by the Water Break Test
   20. ASTM F 1869, Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
   21. ASTM F 2170, Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes the Identification of Piping Systems.

C. American National Standards Institute (ANSI)/NSF International (NSF)
   1. ANSI A13.1, Scheme for the Identification of Piping Systems
   2. ANSI Z535.1, Safety Color Code.
   3. ANSI/NSF Standard 60, Drinking Water Chemicals - Health Effects.

4. ANSI/NSF Standard 61, Drinking Water System Components - Health Effects.

D. NACE International (NACE)
1. NACE SP0188, (Standard Practice Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates0
2. NACE SP0892, Standard Practice for Coatings and Linings over Concrete for Chemical Immersion and Containment Service.
3. NACE Publication 6D-173, A Manual for Painter Safety

E. National Bureau of Standards (NBS)
1. Certified Coating Thickness Calibration Standards.

F. National Fire Protection Association (NFPA)

1. 101, Life Safety Code.

G. The Society for Protective Coatings (SSPC)
1. PA 2, Procedure for Determining Conformance to Dry Coating Thickness Requirements (Level 3)
2. SP 1, Solvent Cleaning
3. SP 2, Hand Tool Cleaning
4. SP 3, Power Tool Cleaning
5. SP-15, Commercial Grade Power-Tool Cleaning
6. SSPC Painting Manuel Volume 1, Good Painting Practice Structures
7. SSPC - Volume 2, Systems and Specifications.
8. SSPC - VIS 1, Visual Standard for Abrasive Blast Cleaned Steel.
9. SSPC - VIS 2, Visual Standard for Evaluating Degree of Rusting on Painted Steel Surfaces
10. SSPC VIS 3, Guide and Reference Photographs for Steel Surfaces Prepared By Power and Hand Tool Cleaning
11. SSPC Guide 6, Containing Debris Generated During Paint Removal Operation
12. SSPC Guide 12, Guide for Illumination of Industrial Projects

H. The Society for Protective Coatings/NACE International (SSPC/NACE)
1. SP 5/NACE NO. 1, White Metal Blast Cleaning
2. SP 10/NACE No. 2, Near-White Blast Cleaning
3. SP 6/NACE No.3, Commercial Blast Cleaning
4. SP 7/NACE No. 4, Brush-off Blast Cleaning
5. SP 13/NACE No. 6, Surface Preparation of Concrete

I. National Association of Pipe Fabricators, Inc.
NAPF 500-03 (SURFACE PREPARATION STANDARD FOR DUCTILE IRON PIPE AND FITTINGS IN EXPOSED LOCATIONS RECEIVING SPECIAL EXTERNAL COATINGS AND/OR SPECIAL INTERNAL LININGS
1. 500-03-01, Solvent Cleaning

2. 500-03-02, Hand Tool Cleaning
3. 500-03 -03, Poor Tool Cleaning
4. 500-03-04, Abrasive Blast Cleaning for Ductile Iron Pipe
5. 500-03-05, Abrasive Blast Cleaning for Cast Ductile Iron Fittings

J. The International Organization for Standardization (ISO)
   1. ISO 8502-3, Preparation of steel substrates before application of paint and related products -Tests for the assessment of surface cleanliness - Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)

K. Code of Federal Regulations
   1. 29 CFR 1910.144, Safety Color Code for Marking Physical Hazards

1.3 DEFINITIONS

A. Specific coating terminology used in this Section shall be in accordance with the definitions in ASTM D 16, ASTM D 3960, and the following definitions:
   1. The term "paint" includes pretreatment and all painting system materials, such as primer, emulsion, enamel, organic/inorganic polymer coating, stain sealer and filler, and other applied materials whether used as prime, filler, intermediate or finish coats.
   2. The term “resurfacer” as used herein means an epoxy polymer modified cementitious material used to restore the concrete substrate to provide a contiguous concrete surface for subsequent lining materials.
   3. The term “coating” and “lining” as used herein are considered interchangeable and mean coating systems materials, including any applicable resinous primers and finish coats that function to provide protection of steel or concrete substrates.
   4. The terms “coating system” and “lining system” as used herein are considered interchangeable and mean all total resurfacing and coating materials combined to function as a total system to provide the designed protection
   5. The term "exposed" means all items not covered with cement plaster, concrete or fireproofing. Items covered with these materials shall be provided with specified primer only, except where specified as a surface not to be painted. Exposed-to-view surfaces also include those areas visible after permanent or built in fixtures, convector covers, ceiling tile, covers for finned tube radiation, grilles, etc. are in-place, in areas scheduled to be painted.
   6. Dry Film Thickness (DFT): The thickness of one fully cured continuous application of coating.
   7. Field Coat: The application or the completion of application of the coating system after installation of the surface at the site of the Work.
   8. Shop Coat: One or more coats applied in a shop or plant prior to shipment to the site of erection or fabrication, where the field or finishing coat is applied.
   9. Barrier Coat: A physical barrier, i.e. coating, between the substrate and it’s environment by keeping oxygen, moisture and other chemicals away from the substrate

10. Photochemically Reactive Organic Material: Any organic material that will react with oxygen, excited oxygen, ozone or other free radicals generated by the action of sunlight on components in the atmosphere giving rise to secondary contaminants and reaction intermediates in the atmosphere which can have detrimental effects.
11. Volatile Organic Compound (VOC) Content: The portion of the coating that is a compound of carbon, is photochemically reactive, and evaporates during drying or curing, expressed in grams per liter or pounds per gallon.
12. Touch-Up Painting: The application of a paint on areas of painted surfaces to repair marks, scratches, and areas where the coating has deteriorated to restore the coating film to an unbroken condition.
13. Painter: Installer or applicator is the person or persons actually installing or applying the coating and/or lining in the field at the Project site.
14. The term Independent NACE CCI 3: The inspection body and its staff shall not engage in any activities that may conflict with their independence of judgment and integrity in relation to their inspection activities. In particular they shall not become directly involved in the design, manufacture, supply, installation, user or maintenance of the items inspected, or similar competitive items. They are also a person and/or persons (NACE Certified Coating Inspector) that has satisfactorily completed NACE CIP program and is still actively certified by NACE International.
15. Approved Factory Finish: Finish on a product in compliance with the finish specified in the section where the product is specified.
16. Corrosive Environment: Immersion in, or not more than 6 IN above, or subject to frequent condensation, spillage or splash of a corrosive material such as water, wastewater, or chemical solution; or chronic exposure to corrosive, caustic or acidic agent, chemicals, chemical fumes, chemical mixture, or solutions with pH range of 5 - 9.
17. Highly Corrosive Environment: Immersion in, or not more than 6 IN above, or subject to frequent condensation, spillage or splash of a corrosive material such as water, wastewater, or chemical solution; or chronic exposure to corrosive, caustic or acidic agent, chemicals, chemical fumes, chemical mixture, or solutions with pH range below 5 or above 9.
18. Holiday: A void, crack, thin spot, foreign inclusion, or contamination in the coating film that significantly lowers the dielectric strength of the coating. May also be identified as a holiday or pinhole.
19. Submerged Metal: Steel or iron surfaces below tops of channel or structure walls which will contain water even when above expected water level.
20. Exposed Surface: Any metal or concrete surface, indoors or outdoors that is exposed to view.
21. Dry Film Thickness (DFT): Thickness of fully cured coating, measured in mils (1/1000 inch).
22. Volatile Organic Compound (VOC): Content of air polluting hydrocarbons in uncured coating product measured in units of grams per liter or pounds per gallon, as determined by EPA Method 24.

23. Ferrous: Cast iron, ductile iron, wrought iron, and all steel alloys except stainless steel.

1.4 QUALITY ASSURANCE

A. Applicators' Requirements

1. If any requirements of this specification is in conflict with a referenced standard, the more stringent requirement shall apply.
2. Minimum of 10 (ten) years of experience regularly performing the application of coating and/or lining materials, with documented skill and successful experience in the application of the types of materials.
3. Submit list of projects of similar size and complexity along with names of persons and their work experience. This must include evidence of worker training and qualification programs. Only those submitted and approved persons by the ENGINEER will be permitted to work on the project.
4. Qualifying experience shall include at least three previous projects of similar magnitude and complexity to this project that have been completed not less than 18 months prior to submission of qualifications to ENGINEER.
5. Submit name and qualifications to ENGINEER along with the following information on a minimum of three successful projects:
   a. Name of project
   b. Names and telephone numbers of owners, architects, or engineers responsible for projects.
   c. Approximate contract cost of the paint materials.
   d. Amount of area installed.
6. Submit in writing to the ENGINEER acceptability by the coating manufacturer.
7. Personnel are to be completely trained and experienced in the proper use of all specified/submitted coating and lining materials, surface preparation and application equipment being used for the project. No person shall work on this project unless they have been previously approved by the ENGINEER.

B. Source Quality Control

1. Obtain materials only from manufacturers who will provide the services of a qualified manufacturer's representative at the site at the commencement of painting Work to advise on materials, mock-ups, installation and finishing techniques, at the completion of the Work to advise ENGINEER on the acceptability of completed Work, and during the course of the Work as may be requested by ENGINEER.
2. Certify long-term compatibility of all coatings with intended service exposures.
3. Do not submit products that do not meet or exceed the performance criteria. All submitted coating and/or lining system must be able to provide long-term protection and performance within its intended service environment. Products exceeding current VOC limits will not be approved.
4. ENGINEER may review manufacturer's recommendations concerning methods of installation and number of coats of paint for each painting system.

5. All proposed "or equal" products shall be submitted 20 working days prior to the beginning of work with direct comparison to products specified including information on performance criteria adhesion, color and gloss retention, percent solids, VOC's per gallon, application methods, case histories and re-coat ability after curing etc.
6. "Equal or better" manufacturers shall furnish the same color selection as the manufacturers specified, including intense chroma and custom pigmented colors in all painting systems.
7. Color Pigments: Provide pure, nonfading, applicable types to suit the surfaces and services indicated. Comply with the following:
   a. Lead and Chromate: Lead and chromate content shall not exceed amount permitted by governing authorities having jurisdiction.
   b. Areas subject to hydrogen sulfide fume exposure shall be identified by ENGINEER. Manufacturer shall notify ENGINEER of colors that are not suitable for long-term color retention in such areas.
   c. Comply with manufacturer’s recommendations on preventing coating contact with levels of carbon dioxide and carbon monoxide that may cause yellowing during application and initial stages of curing of paint coatings.
8. Obtain each product from only one manufacturer. Multiple manufacturing sources for the same system component will not be approved by ENGINEER.
9. Certify product shelf-life history for each product source for materials manufactured by the same manufacturer, but purchased and stored at different locations or obtained from different sources.
10. Constantly store materials to be used in the painting according with the manufacturers approved current written recommendations, for not more than six months. Certify to ENGINEER that painting materials have been manufactured within six months of installation and have not, nor will be, subjected to freezing temperatures.
11. Provide the services of a qualified manufacturer's representative to the Project site to observe the initial commencement of surface preparation and each coating's application. Manufacturer’s representative will advise on materials, surface preparation, coating applications and finishing techniques. Once completed the manufacturer’s representative will provide a written report certifying that all observed surface preparation and coating application(s) have been completed according to the manufacturer's current recommendations and requirements. This certification report must be received 7 (seven) calendar days after the last site visit by the manufacturer.
12. Provide in writing that the specified and applied coating or lining system is the correct system for the long-term protection and performance of the environmental exposures it will be subjected.
13. Provide the services of a qualified manufacturer's representative to the Project site at the completion of work to inspect the Work. The qualified manufacturer's representative to provide a manufacturer’s report stating any deficiencies in the coatings system, if any, noted during the final inspection. The report must be submitted to the ENGINEEER 7 (seven) calendar days after the last site visit by the manufacturer.
14. Following the completion of the corrective measures, provide the services of an independent NACE CCI to re-inspect the work. Within 7 (seven) days after re-inspection, the independent NACE CCI will provide a written report to the ENGI

NEEER stating that the coatings have been applied properly and in accordance with the manufacturer's written recommendations and requirements.

C. Testing Qualifications: To qualify for approval, provide all required documented performance criteria and project cases histories of more than 5 (five) years of service in similar or more severe environments. Provided information must clearly demonstrate to ENGINEER'S satisfaction that the submitted coating or lining system performance criteria data and project case histories meets or exceeds the projects intended environmental service requirements.

D. Stepped-Down Mock-Ups
   1. Demonstrate installation of specified coating or lining system(s) on actual surfaces and building components at locations selected by ENGINEER.
   2. Once the ENGINEER has approved in writing all the components of coating or lining system. Provide a 3 foot by 3 foot (minimum) stepped-down sample area for each specified system according to specified manufacturer's most current written application recommendations. Each surface preparation and application step shall remain exposed in order to demonstrate the Work performed by that step. Each step of the mock up must be approved in writing by the ENGINEER and coating manufacturer representative. Continue application procedures until topcoat is provided.
   3. Finished mock-up for each coating or lining system, when completed, shall reveal each step and each coat of paint required for the specified. Mockup standard must be protected and preserved until the application completion and written acceptance of the work for that particular specified system. Use tinted shades differing from coat to coat for each component of each painting system. All mock-up work must be done by person(s) that will actually be doing the work on the project. Utilize ASTM D 4227 Standard Practice for Qualification of Coating Applicators for Application of Coatings to Concrete Surfaces or ASTM D 4228 Standard Practice for Qualification of Coating Applicators for Application of Coatings to Steel Surfaces.
   4. ENGINEER may approve or disapprove each component of each painting system on an individual component basis.
   5. Coating or lining system Work that does not meet the standard approved on the sample areas shall be removed and replaced with new material.
   6. Coating or lining system Work advanced without approved mock-ups shall be stopped, and mock-ups prepared for approval by ENGINEER. If any coatings or linings have been applied before an approved mock up standard has been agreed upon in writing by all parties, the ENGINEER has the authority to have those applied coatings or linings completely removed and reapplied at CONTRACTORS expense.

E. Requirements of Regulatory Agencies: Surface preparation and application of coatings shall be performed in compliance with all applicable federal, state, and local occupational safety and health regulations and Maricopa County Air Pollution Control Regulations. Insure that all required certifications for all regulatory agencies current and readily available upon request.

1. Obtain and comply with all safety precautions recommended by the paint manufacturer in printed instructions or special bulletins and as required by applicable regulations. Provide forced ventilation in all areas where inadequate ventilation exists.
2. Painting systems for surfaces in contact with potable water, or water being treated for potable use, shall be NSF approved and shall not impart any taste or odor to the water or result in any organic or inorganic content in excess of the maximum allowable contaminant level established by governing authorities having jurisdiction. All such painting systems shall be approved by the applicable regulatory agency. Revise painting systems specified herein to provide manufacturer's regulatory agency approved painting system(s) where required.
3. Comply with the regulations of governing authorities having jurisdiction for air quality and material disposal regulations. Revise painting systems specified herein in order to provide manufacturer's regulatory agency approved painting systems, where required.
4. Comply with governing authorities having jurisdiction for blast cleaning operations, confined space entry and disposition of spent abrasive and debris.

F. Pre-Application Meeting:
   1. A pre-application meeting MUST take place at the jobsite or mutually agreed upon site a minimum 3 (three) weeks before the application of any coating or lining work proceeding. Attendance is required of all principal decision making parties directly affecting work of this section, including OWNER, ENGINEER, CONTRACTOR, COATING MANUFACTURER'S REPRESENTATIVE and COATING INSPECTOR etc. Record the discussions of the conference and the decisions and agreements (or disagreements) and furnish a copy of the record to each party attending. Review foreseeable methods and procedures relating to the painting Work, including but not necessarily limited to, the following:
      a. Review Project Coating Specification, Project requirements, including Contract Documents, Project Schedule, approved Shop Drawings, pending and approved Change Orders and requests for information.
      b. Field quality control: Contractor's responsibilities, i.e. providing written daily reports and review required samples and submittals, both completed and yet to be completed.
      c. Review status of surfaces including drying, surface preparations and similar considerations.
      d. Review availability of materials, tradesman, equipment and facilities needed to make progress, avoid delays and protect the Work from damaging conditions.
      e. Coating Inspector's authority and responsibilities, required inspections, testing services, certifications and quality control procedures.
      f. Review weather and forecasted weather conditions, and procedures for coping with unfavorable conditions. Supplemental heating sources, as may be required to continue the Work under low temperature conditions, shall be in operating order and acceptable to paint applicator.

g. Review methods for complying with regulations of governing authorities having jurisdiction, such as compliance with environmental protection, health, safety, fire and similar regulations.
h. Material storage requirements
i. Protection of surfaces not scheduled to be coated.
j. Application requirements and procedures
k. Protection of coating systems

2. Provide meeting minutes to all parties for review and possible clarification. Should any correction to the meeting minutes be required, the minutes should be corrected and resubmitted to all parties.
3. Reconvene the meeting at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.
4. Record any revisions or changes agreed upon, reasons therefore, and parties agreeing or disagreeing with them.

G. Maintain a Paint Application Log containing the information as shown on the log attached at the end of this Section. The Paint Application Log shall be maintained on a daily basis for all areas where the Work is being performed. The Paint Application Log shall be turned over to the ENGINEER by 9:00 a.m. the following day that the work was performed. The log shall include the following:
1. Date.
2. Time.
3. Weather condition (at work location).
4. Air temperature (at work location).
5. Surface temperature (at work location).
6. Dew point (at work location).
7. Humidity (at work location).
8. Material temperature (Before (Separately) and Mixed (Combined)
9. Location/area square footage.
10. Description of Work performed.
11. Materials used, colors and batch numbers, quantity of materials used (not including waste).
12. Application/surface preparation equipment and personnel.
13. WFT/surface profile measurements.
14. Comments, quality control procedures.
15. Signature/title.

1.5 SUBMITTALS

A. Samples: Submit for approval the following:
1. Copies of manufacturer's complete color charts for each coating system.

B. Shop Drawings: Submit for approval the following:

1. Copies of manufacturer's current technical information and test performance data, including paint analysis, VOC content in comparison to current legal maximum limits allowed, and current application instructions for each material proposed for use.
2. Submit Applicator's Qualifications in accordance with 1.4 Quality Assurance. No submittal information will be reviewed until Engineer has received and approved applicator qualifications.
3. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's current written application instructions for submitted coating and/or lining systems.
   c. Manufacturer’s current written repair procedure for the submitted coating and/or lining system.
   d. Manufacturer’s current written repair procedure for the submitted coating and/or lining system.
   e. Manufacturer's current surface preparation instructions for submitted coating and/or lining systems.
   f. Manufacturers current written repair procedures for submitted coating and/or systems.
   g. Written plan of action for containing airborne particles created by blasting operation and location of disposal of spent contaminated blasting media.
   h. Coating manufacturer's recommendation on abrasive blasting or other acceptable surface preparation techniques.
   i. Coating manufacturer's recommendation for universal barrier coat if required.
   j. Coating manufacturer's recommendation for providing temporary or supplemental heat or dehumidification or other environmental control measures.
4. Coating manufacturer's statement regarding applicator instruction on product use.
5. Provide certification that the coating and/or lining systems proposed for use has been reviewed and approved by Senior Technical Service Representative or equivalent employed by the coating manufacturer.
6. Provide a certification from the local coating manufacturer’s representative that they have inspected all surfaces with existing coatings and certify that the products are compatible with the existing coatings and the surface preparation requirements required by this Section where appropriate. This certification will be based upon written documented results of an adhesion test (s) performed by a qualified independent NACE CCI Level 3 or Level 2 if directly supervised by a NACE CCI Level 3.
7. Provide all appropriate air quality permits for abrasive blast operation, if required by local, county, state or federal laws or ordinances.

C. Samples:
   1. Manufacturer's full line of colors for Engineer's preliminary color selection.
   2. After preliminary color selection by Engineer provide two (2) 3 x 5 inch samples of each final color selected.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging,
with labels clearly identifying.
   1. Coating or material name
   2. Manufacture
   3. Color name and number
   4. Batch or lot number
   5. Date of manufacture.
   6. Mixing and thinning instructions.
   7. Federal Specification Number if applicable.
   8. Application and mixing instructions.
   9. Hazardous material identification label
   10. Shelf-life date.
   11. Storage requirements. Submit storage and application temperature requirements for all coating system materials.

B. Storage of Materials:
   1. Store materials in a clean dry area and within temperature range according to the coating manufacturer's current written instructions
   2. Keep containers sealed until ready for use.
   3. Do not use materials beyond manufacturer’s shelf-life limits.
   4. All coating shall be delivered to the shop or job site in original, unopened containers with labels intact. Minor damage to containers is acceptable provided the container has not been punctured or the lid seal broken.
   5. Each container of coating shall be clearly marked or labeled to show coating identification, date of manufacture, batch number, and other information as needed to meet regulatory requirements. Each type of coating shall be accompanied by the manufacturer’s Material Safety Data Sheet (MSDS) and product data sheet containing information such as basic chemical composition, acceptable weather conditions for application, and proper storing and mixing.
   6. All containers of coating shall remain unopened until required for use. No more containers of coating shall be opened than will be applied that day. The label information shall be legible and shall be checked at the time of use.
   7. Coating which has livered, gelled, or otherwise deteriorated during storage shall not be used; however, thixotropic materials which can be stirred to attain normal consistency may be used.
   8. The oldest coating of each kind that is in acceptable condition shall be used first. In every case, the coating is to be used before its shelf life has expired. Materials exceeding storage life recommended by the Manufacturer shall be removed from the site.
   9. Coatings shall be stored in original unopened containers in weather tight spaces where the temperature is maintained between 60 °F and 90 °F unless otherwise recommended in writing by the manufacturer. The coating temperature shall be brought

to the coating manufacturer current written recommended application temperature before use. Materials shall be stored according to the manufacturer's recommendations in enclosed structures and shall be protected from weather and adverse temperature conditions.

10. Flammable materials shall be stored according to state and local codes.
11. Store all materials only in area or areas designated by the ENGINEER. Confine mixing, thinning, clean up and associated operations, and storage of materials related debris before authorized disposal, to these areas. All materials are to be stored on pallets or similar storage handling skids off the ground.
12. Mix all lining materials in an enclosed mixing area designated by the ENGINEER. This enclosed area must protect the mixing operation and materials from direct sunlight, inclement weather, freezing, or other means of damage or contamination. Protect all other concrete and metallic surfaces and finishes from any spillage of material(s) within the mixing area. The material temperature should be between 70o F and 90o F before application, unless noted otherwise on the current product data sheet.
13. Do not use floor drains, dikes or storm drains for disposal of coating system materials. Provide for the safe removal and lawful disposal of all waste materials.
14. Take all precautions and implement all measures necessary to avert potential hazards associated with the resurfacing system materials as described on the pertinent Material Safety Data Sheets or container labels.
15. Deliver all materials to the job site in their original, unopened containers. Each container shall bear the Manufacturer's name and label.
16. Maintain the storage and the environmental climate of that area for all coating materials that they will be using unless otherwise agreed upon.
17. Handling: Protect materials during handling and application to prevent damage or contamination

1.7 SAFETY

A. Conduct the following safety items:
   1. Comply with all federal, state, and local regulations as well as with the provisions outlined in NACE Pub. 6D-173, "A Manual for Painter Safety."
   2. Provide personnel with all safety equipment necessary to protect them during any phase of the work according to all current OSHA Standards.
   3. Adhere to all OSHA requirements with regard to permitted confined space including providing all equipment and personnel necessary.
   4. Erect and maintain scaffolding according to OSHA standards.
   5. No work shall be performed until the appropriate Work Requests and Lockouts are approved by the ENGINEER. The Work Request system provides a mechanism to advise plant staff of a contractor's work activities. The Lock Out /Tag Out system is a safety procedure to prevent unintended equipment activation.
   6. Keep any flammable materials such as cleaning solvents, thinners, or resurfacing materials away from open flames, sparks, or temperatures higher than 150 F. Drums containing flammable materials shall be grounded. Flammable materials not being utilized shall be maintained in their on-site storage area.

7. Power tools are to be in good working order to avoid open sparking. No spark producing tools shall be utilized in restricted areas as indicated herein.
8. Maintain a clean work area and furnish Underwriter's Laboratories approved fire extinguishers on-hand.
9. Workers performing abrasive blasting operations shall wear a fresh air supplied protective helmet and hood and personal protective clothing acceptable to industry standards and all government regulations.
10. Workers performing coating operations shall wear the appropriate personal protective equipment, clothing, and NIOSH approved respirator acceptable to industry standards and all government regulations.
11. Dispose of rags used for wiping up resurfacing materials, solvents, and thinners by drenching them with water and placing in a metal container with a tight-fitting metal cover. Complete this disposal process at the end of each day. Final disposal of these materials is the CONTRACTORS's responsibility.
12. Matches, flames, or sparks resulting from any source including welding, must be removed from the work area during coating work. Smoking is NOT permitted accept for designated areas.

1.8 PROJECT CONDITIONS

A. Site Facilities:
   1. Supplemental heat sources, as may be required to maintain both ambient and surface temperatures within the range recommended by the manufacturer for paint system applications, are not available at the site.
   2. Provide provisions for all supplemental heat energy sources, power, equipment and operating, maintenance and temperature monitoring personnel.
   3. Do not use heat sources, which emit carbon dioxide or carbon monoxide into areas being painted. Properly locate and vent all such heat sources to the exterior such that paint systems are unaffected by exhaust products.

B. Existing Conditions:
   1. Provide lighting (If Required) for all work areas as prescribed in SSPC Guide 12
   2. Existing materials specified to be painted as part of the Work shall have their surfaces prepared to meet the requirements of the painting systems specified. Where existing paint systems will provide the substrate for painting systems specified, provide adhesion testing on existing surfaces to be painted according to the coating manufacturers recommendations. Abrasive blasting, scraping or other abrading or surface film removal, or preparatory techniques as approved by ENGINEER shall be provided as part of the Work.
   3. Before painting is started in any area, all surfaces to be painted and floors shall be cleaned of all dust using commercial vacuum cleaning equipment and dust containment.
   4. Apply coatings to dust free surfaces. Test surfaces for cleanliness according to ISO 8502-3 (Preparation of steel substrates before application of paint and related products - Tests for the assessment of surface cleanliness - Part 3 Assessment of dust on steel surfaces prepared for painting (pressure- sensitive tape method). Randomly test

prepared surfaces at rate of 8 tests for the first 1000 square feet. Afterwards conduct 3 tests for each additional 1000 square feet. Provide 3 additional tests for each failed test or questionable test. Turn in test tapes results with Daily Inspection Reports.

5. After painting operations begin in a given area cleaning shall be done only with commercial vacuum cleaning equipment and dust containment systems.

C. Environmental Requirements

1. If required to maintain project schedule, Provide and utilize dehumidification and ventilation equipment to control humidity, temperature, and vapor levels in from beginning of the surface preparation process through coating application and for seven days after the last coating is applied. System shall maintain vapor concentrations at or below 10 percent of Lower Explosive Limit (LEL). System may incorporate any combination of solid desiccant and direct expansion refrigeration equipment. No liquid, granular, calcium chloride, or lithium chloride drying systems will be accepted. Use only electric, indirect fired combustion, indirect friction, or steam coil auxiliary heaters. System shall be compatible with removal of dust and solvent vapors, and shall have fail-safe measures to ensure reliability during operations.
2. If dehumidification and ventilation equipment is not already being used, ventilate interior areas such as water tanks (potable or non-potable) and other containment service areas according to written procedures outlined by the ENGINEER and/or the coating manufacturer.
3. Provide enclosures for other areas or items that may require protection from the inclement weather or other detrimental effects so the project can continue.
4. Apply water-base paints only when the temperature of surfaces to be painted and the surrounding air temperatures are between 55°F and 90°F, unless otherwise permitted by the paint manufacturer's current printed instructions.
5. Surfaces to be painted shall dry to the touch and at least 5°F above the dew point temperature and rising. Apply paints only when the temperature of surfaces to be painted, paint material, and the surrounding air temperatures are between 65°F and 95°F, unless otherwise permitted by the paint manufacturer's current printed instructions.
6. Apply paint system within the shortest possible time consistent with manufacturer's approved recommended curing instructions for each coat. If chemical, salt, or other contamination contacts paint film between coats, it shall be removed according to the coating manufacturer written recommendation, and the surface restored before applying the remainder of the coatings.
7. Tanks containing water shall not be painted without specific permission of ENGINEER, and only under conditions where "sweating" of the tank outside surface is not likely to occur within 24 hours of application.
8. Epoxy paints shall not be applied if ambient temperature is expected to go below 50°F within 12 hours of application. Where manufacturer's printed recommendations require a higher minimum ambient temperature, this shall be followed.
9. Do not apply paint in rain, fog or mist; or when the relative humidity exceeds 85 percent; to damp or wet surfaces or when surfaces will reach dew point due to falling or rising temperatures and humidity conditions during the course of the paint applica

tion, unless otherwise permitted in writing by the paint manufacturer's printed instructions.

10. Do not paint pipelines and other hot or cold surfaces until such surfaces can be maintained within temperature and dew point ranges acceptable to manufacturer. Arrange for such surfaces to be brought within acceptable temperature and dew point ranges as part of the painting Work.
11. On substrates such as wood, concrete etc., use methods recommended by the specified manufacturer, the measured moisture content of surfaces shall be verified by the ENGINEER as acceptable prior to the commencement of the painting.
12. Painting may continue during inclement weather only if the areas and surfaces to be painted are enclosed and ambient conditions can be maintained continuously as specified by the paint manufacturer during application and drying periods.
13. Provide adequate illumination (SSPC-Guide 12) and ventilation in all areas where painting operations and inspections are in progress.
14. Install piping markers only after all painting and finish work has been completed and cured.

D. Protection:
   1. Cover or otherwise protect finished Work of other trades and surfaces not being painted concurrently or not to be painted.
   2. During surface preparation and painting, the facility shall remain in operation. Employ procedures that prevent contamination of the process or cause facility shutdown.
   3. Coordinate and schedule surface preparation and painting to avoid exposing employees and others not involved with surface preparation and painting. Provide required personnel safety equipment in compliance with the requirements of governing authorities having jurisdiction.
   4. Submit protection procedures to be employed. Do not begin surface preparation and painting Work in any area until ENGINEER approves protection techniques proposed.
   5. Provide fire extinguishers and post caution signs warning against smoking and open flame when working with flammable materials.

E. Spent abrasive containing lead and/or chromate paint resulting from the blasting of the "affected surfaces" is classified as a hazardous waste. "Spent abrasive" shall be understood to mean the abrasive generated during the blasting operation, including the spent water imposed over the abrasive flow, paint residue and any other debris.

F. Care shall be exercised to prevent spent abrasive, water or dust from falling on surrounding buildings, unprotected vegetation, walkways, soils, structures and equipment by covering these areas with non-tearing tarps. Spent abrasive collecting on the ground shall be vacuumed regularly to prevent it from becoming windblown. The site shall at all times be kept as clean as possible. At the end of the Workday, all spent abrasive shall be thoroughly vacuumed and the site left with a neat appearance.

G. Spent abrasive resulting from the blasting of the "affected surfaces" shall be captured. Non-tearing tarps or plastic sheathing, platforms, partial or total enclosures, temporary barriers or structures, or similar containment methods may be employed for this purpose. These methods must be reviewed by the ENGINEER prior to start of the Work. Provide a detailed procedure describing the proposed blast cleaning operation, abrasive capture and containment techniques, and safety measures to avoid the contamination of the natural environment or surrounding structures.

H. Spent abrasive resulting from the blasting of the "affected surfaces" shall be collected and legally disposed of by the CONTRACTOR in a legal and responsible manner. Such disposal shall also be in conformance with all applicable codes, ordinances and regulations for hazardous waste disposal. All other waste, including spent abrasive generated by the blasting of non-affected surfaces, shall be disposed by the CONTRACTOR.

I. All reasonable care shall be taken to protect against paint splatter and overspray. Responsibility for any damage incurred to surrounding property resulting from this work belongs to the CONTRACTOR.

J. Signs shall be posted, as required, to alert the public of any risks associated with sandblasting debris, painting overspray, etc. All efforts shall be made to prevent debris from becoming windblown.

K. Obtain all permits required to perform the Work.

L. Spent water, resulting from the cleaning operation of "affected surfaces" due to wet sandblasting, may contain hazardous particulates, shall be disposed by the CONTRACTOR.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Specification basis of design is Tnemec

B. Approved Equals: Subject to meeting these specifications requirements and system approval the following manufacturers may be acceptable.

C. Submit system proposed as “Equal” for review and approval or revision as required by the ENFINEER
   1. Sherwin Williams
   2. Carboline
   3. Ameron/PPG
   4. International

2.2 PAINTING SYSTEMS

A. Severe Exposure

1. Surfacer/Filler (Epoxy Modified Cementitious Mortar)
   a. Tnemec Series 218 MortarClad; 1 parge coat trowel applied; nominal 1/16-inch minimum DFT (actual DFT to depend on the depth of the profile in the concrete after abrasive blasting.)
2. Primer (Modified Polyamine Epoxy Penetrating Epoxy)
   a. Tnemec Series 201 EpoxoPrime; 1 coat; 6-8 mils DFT
3. Base Coats (Fiberglass Reinforced Polyamine Epoxy)
   a. Tnemec Series 270 Stranlok; 2 coats; 25-40 mils Total DFT
4. Finish Coat (Modified Polyamine Epoxy)
   a. Tnemec Series 280 Tnemec Glaze; 1 coat; 6-8 mils DFT

B. Moderate Exposure

1. Surfacer/Filler (Epoxy Modified Cementitious Mortar)
   a. Coating 1. Tnemec Series 218 MortarClad; 1 parge coat trowel applied; nominal 1/16-inch minimum DFT (actual DFT to depend on the depth of the profile in the concrete after abrasive blasting.)
2. Primer (Polyamidoamine Epoxy)
   a. Tnemec Series L69 Hi-Build Epoxoline II; 1 coat; 4-6 mils DFT
3. Finish Coat (Polyamidoamine Epoxy)
   a. Tnemec Series L69 Hi-Build Epoxoline II; 1 coat; 4-6 mils DFT

G. New and Existing Concrete Masonry Unit Walls; Non-submerged, Interior: (LEED Compliant through Version 3.0)

1. Blockfiller (Inorganic Water Based Epoxy)
   a. Tnemec Series 1254 EpoxoBlock WB; 1 coat; 75-125 square foot per gallon
2. Finish Coats (Polyamidoamine Epoxy)
   a. Tnemec Series L69 Hi-Build Epoxoline II; 2 coats; 4-6 mils DFT per coat

H. New and Existing Exterior Cast-In-Place Concrete, Concrete Masonry Units and Wood; Above-Grade, Exterior:

1. Primer (Waterborne Modified Polyamine Epoxy) (Cast-In-Place Concrete and Wood):
   a. Tnemec Series 151-1051 Elasto-Grip FC; 1 coat; 200-400 square foot per gallon
2. Finish Coats (Styrenated Acrylate)
   a. Tnemec Series 156 Enviro-Crete; 2 Coats; 6-8 mils DFT per coat

I. New and Existing Ferrous Metals, Structural Steel (not protected by sprayed fireproofing), Miscellaneous Ferrous Metals, Exterior Surfaces of Valves, Exterior Surfaces of Ferrous Piping, Above ground Ductile-Iron Piping and Exterior Surfaces of all Ferrous Piping (both exposed and to be later covered with insulation); Non-submerged, Interior: (LEED Compliant through Version 3.0)

1. Primer (Polyamidoamine Epoxy *)
   a. Tnemec Series L69 Hi-Build Epoxoline II; 1 coat; 4-6 mils DFT
2. Finish Coat (Polyamidoamine Epoxy)

a. Tnemec Series L69 Hi-Build Epoxoline II; 1 coat; 4-6 mils DFT

K. New and Existing Ferrous Metals, Non-Ferrous Metals, Fiberglass and Galvanized Metals; Non-Submerged, Exterior:
1. Primer (Polyamidoamine Epoxy*)
   a. Tnemec Series N69 Hi-Build Epoxoline II; 1 coat; 4-6 mils DFT
2. Intermediate Coat (Polyamidoamine Epoxy)
   a. Tnemec Series N69 Hi-Build Epoxoline II; 1 coat; 4-6 mils DFT
3. Finish Coat (Aliphatic Acrylic Polyurethane with UV Absorbers)
   a. Tnemec Series 1075U Endura-Shield II; 1 coat; 2.5-3.5 mils DFT

L. New and Existing Galvanized Metal, Fiberglass and Non-Ferrous Metal; Non-submerged, Interior: (LEED Compliant through Version 3.0)
1. Primer (Polyamidoamine Epoxy*)
   a. Tnemec Series L69 Hi-Build Epoxoline II; 1 coat; 4-6 mils DFT
2. Finish Coat (Polyamidoamine Epoxy)
   a. Tnemec Series L69 Hi-Build Epoxoline II; 1 coat; 4-6 mils DFT

M. New and Existing Aluminum in Contact with Dissimilar Materials:
1. Primer (Polyamidoamine Epoxy)
   a. Tnemec Series N69 Hi-Build Epoxoline II; 1 coat; 4-6 mils DFT
2. Finish Coat (Polyamidoamine Epoxy)
   a. Tnemec Series N69 Hi-Build Epoxoline II; 1 coat; 4-6 mils DFT

N. New and Existing Pipe and Duct Insulation, Cloth, Paper and Canvas Jacketed; Non-submerged, Interior: (LEED Compliant through Version 3.0)
1. Prime Coat (Self-crosslinking Hydrophobic Acrylic)
   a. Tnemec Series 115 Uni-Bond DF; 1 coat; 2-4 mils DFT
2. Finish Coats (HDP Acrylic Polymer)
   a. Tnemec Series 1029 Enduratone; 2 coats; 2-3 mils DFT per coat

O. New and Existing PVC and CPVC Piping and Fiberglass Insulation Covering; Non-submerged, Interior: (LEED Compliant through Version 3.0)
1. Prime Coat (Self-crosslinking Hydrophobic Acrylic)
   a. Tnemec Series 115 Uni-Bond DF; 1 coat; 2-4 mils DFT
2. Finish Coat: (HDP Acrylic Polymer)
   a. Tnemec Series 1029 Enduratone; 1 coat; 2-3 mils DFT

P. New and Existing Exterior Surfaces of Steel Pipe; Buried Exterior:
1. Primer (Polyamidoamine Epoxy)
   a. Tnemec Series N69 Hi-Build Epoxoline II; 1 coat; 6-8 mils DFT
2 Finish Coat (Polyamidoamine Epoxy)
   a. Tnemec Series N69 Hi-Build Epoxoline II; 1 coat; 6-8 mils DFT

R. Where it is determined that abrasive blasting surface preparation is not feasible use Tnemec Series 135 Chembuild as the prime coat.

2.3 SUBSTITUTIONS

A. No products that decrease the film thickness, the surface preparation, VOC's, solids by volume or the generic type of coating specified shall be considered. Approved manufacturers shall furnish the same color selection as the manufacturers specified, including accent colors and custom colors in all coating systems, and shall document satisfactory performance of their coating system for at least two wastewater lift stations that have been in service at least five years each.

2.4 PIPING MARKERS

A. General:
   1. For pipes over 3/4-inch outside diameter: Provide painted pipe markers.
   2. For pipes under 3/4-inch outside diameter: Provide aluminum tags, totally compatible with service conditions, 1-1/2-inch diameter, with depressed 1/4-inch-high black filled letters Above 1/2-inch-high black filled numbers.
   3. Each marker shall consist of at least one legend descriptive of the function of the pipe and a directional arrow.
   4. The size of lettering and marker shall conform to ANSI A13.1.
   5. Location of Markers:
      a. Adjacent to each valve and "T" connection.
      b. At each branch and riser takeoff.
      c. At each pipe passage through a wall, floor, and ceiling.
      d. On all horizontal and vertical pipe runs at 25-foot intervals.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions under which painting Work is to be performed and notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

B. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to the formation of a durable paint film capable of performing in accordance with claims made in manufacturer's product literature for the surfaces and conditions encountered. Do not paint over “UL” or similar labels, including mechanical and electrical Manufacturer nameplates.

C. Do not paint over existing paint where there is no assurance that existing paint will provide an acceptable surface for the long-term adherence and durability of painting systems specified or where the manufacturer requires removal of all existing paint in order to recommend the use of the specified painting system.

D. Provide lighting for all work areas to be inspected as prescribed in SSPC Guide 12. No coating inspections will be conducted until the minimum lighting requirements for inspection is provided.

E. Assure that all surfaces and areas to be inspected will be clean and ready for inspection so the coating and/or lining system can be immediately applied. No inspections will be conducted if areas and/or surfaces have dust and debris floating in the air and/or covering the substrates to be inspected.

F. All expenses due to delays, extra coating inspections etc. is the sole responsibly of the CONTRACTOR

3.2 SURFACE PREPARATION

A. General:
1. Prepare all substrates new or existing according to the coating manufacturers' current written guidelines for the submitted coating system and its intended service environment.
2. Use abrasive blasting equipment of conventional air, force-feed, or pressure type. Maintain a minimum pressure of 650 kPa 95 psig at nozzle. Confirm that air supply for abrasive blasting is free of oil and moisture when tested according to ASTM D 4285. Test air quality at each startup, but in no case less often than every five operating hours.
3. Provide lighting for all work areas as prescribed in SSPC Guide 12.
4. Prior to performing any testing, i.e., soluble salts, adhesion, moisture content or vapor, alkalinity etc. all principle parties shall agree upon in writing methods of testing, quantity of testing, acceptable results, and the proper course of action that will be taken in case the acceptable limits are not or cannot be met. Excessive moisture, or other conditions, may impact the Project Schedule.
5. Prior to any surface preparation covered in this section, all surfaces should meet the acceptable conditions required.
    a. Inspect all surfaces for oil and/or grease contamination using two or more of the following inspection techniques. Reject oil and/or grease contaminated surfaces, clean [using a water based pH neutral degreaser] in accordance with SSPC SP 1, and recheck for contamination until surfaces are free of oil and grease.
        1) Visual Inspection
        2) Water Break Test
        3) Black Light Test
        4) Cloth Rub Test

b. Water Break Test - Spray atomized mist of distilled water onto surface and observe for water beading. If water "wets" surface rather than beading up, surface can be considered free of oil or grease contamination. Beading of water (water forms droplets) is evidence of oil or grease contamination.
c. Black Light Test - Inspect surfaces for oil and grease contamination using the light specified in the paragraph Black Light. Use light no more than 12 inches from surface unless testing indicates that the specific oil or grease found in tank fluoresce at a greater distance. Use light in tank that is completely sealed from light infiltration, under a hood, or at night. Any fluorescing on steel surfaces is an indication of petroleum oil/grease contamination. Use either Water Break Test or Cloth Rub Test to confirm both contaminated and non-contaminated areas detected by Black Light Test. The Black Light Test may not be used during inspection of prepared surfaces for oil and grease contamination unless proven to fluoresce the oil and/or grease found in the specific tank and documented during testing prior to abrasive blasting. Generally, only petroleum oil/grease will fluoresce, however, some may not fluoresce sufficiently to be recognized and other methods, such as the Water Break Test or Cloth Rub Test, must be used to confirm findings of the Black Light Test.
d. Cloth Rub Test - Rub a clean, white, lint free, cotton cloth onto surface and observe for discoloration. To confirm oil or grease contamination in lightly stained areas, a non-staining solvent may be used to aid in oil or grease extraction. Any visible discoloration is evidence of oil or grease contamination.

6. Remove all hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items already in-place and that does not require field painting or provide effective surface-applied protection prior to surface preparation and painting operations.
7. Remove, as necessary, items, which must be field painted where adjacent surfaces cannot be completely protected from splatter or overspray. Following completion of painting of each space or area, the removed items shall be reinstalled by workers skilled in the trades involved. Surfaces to be painted must be clean, dry and sound before applying any painting system components. Should any surface be found in an unsatisfactory condition, remediate by the best means feasible to provide an acceptable coating condition.
8. Coating products shall not be applied until the ENGINEER has inspected the materials and the coating manufacturer's technical representative has instructed CONTRACTOR and ENGINEER in the surface preparation, mixing and application of each coating.

B. Cast In Place Concrete. Precast Concrete and other Masonry Substrates
1. Test for moisture content of concrete surfaces before commencement of painting Work. There are many tests for moisture in concrete such as ASTM D 4263, ASTM F 1869 or ASTM F 2170. Provide from the submitted coating manufacturer in writing as to which standard they want used and what results must be obtained for satisfactory compliance. Report results to ENGINEER before starting Work.

2. Verify that the pH levels, of the cleaned concrete surfaces to be coated, are 10 to 12 or within the coating manufacturers' current written acceptable range. The pH of the concrete substrate will be measured using pH indicating papers. The pH testing is to be performed once every 50 square feet (5 square meters). Acceptable pH values can be measured using color indicating pH paper with readable color calibrations and a scale at whole numbers (minimum). Use Hydrion Insta-Check Jumbo 1-12, or equal. The paper shall be touched to the surface once using moderate gloved finger pressure. The surface shall not be wiped or moved laterally to disturb the surface during pH testing. Following the one touch, lift the paper vertically to not "wipe" the surface. Compare the color indicated with the scale provided and record the pH. Spot check any areas that may be questionable with phenolphthalein solution. Where paint system is used to provide chemical containment barrier protection, repair cracks and expansion joints in concrete and provide 2-inch radius cove base fillets at all equipment pads and containment walls as part of the complete chemical containment paint system Work. Use materials and techniques recommended by the specified Manufacturer.
3. Remove all cast-in-place concrete fins, projections, tie wire, nails, and other surface irregularities, which would protrude above the level of finished intermediate fillers and surfacers by chipping and scarification by mechanical abrasion.
4. Using specified filler and surfacer, patch all cast-in-place concrete and precast concrete surfaces as required to completely fill surface air holes and honeycombing. Level all protrusions and grind filler and surfacing compounds smooth and level with adjacent surfaces.
5. Where concrete masonry unit block filler is specified, spot patch holes and cracks with a putty knife using specified block filler to provide smooth finish for large surfaces coating materials can be applied by airless spray and backroll uniformly using a roller with a synthetic nap cover. While the coating material; is still wet a rubber squeegee can be used to provide a smooth finish.

C. Ferrous Metals:
1. Test surfaces for soluble salts, and wash as required, prior to any surface preparation. This phase is recommended since pre-preparation testing and washing are generally more advantageous than attempting to remove soluble salt contamination after abrasive blasting. Effective removal of soluble salts will require the removal of any barrier to the steel surface, including rust. This procedure may require combinations of wet abrasive blasting, high pressure water washing, and cleaning using a solution of water washing and soluble salts remover. The soluble salts remover shall be an acidic, biodegradable, nontoxic, noncorrosive, and after application, will not interfere with primer adhesion.

   Delays between testing and preparation, or testing and coating application, may allow for the formation of new contamination. Use clean potable water, or clean potable water modified with soluble salt remover, for all washing or wet abrasive blasting. Test methods and equipment used in this phase are selected at the Contractor's discretion.
2. Verify that coating manufacturer recommended anchor profiles have been achieved on prepared surfaces using the submitted coatings current guidelines for its intended

service environment. Report profiles to ENGINEER using Test Method B or C in compliance with ASTM D 4417.

3. All surface imperfections (e.g., sharp fins, sharp edges, weld spatter, burning slag, scabs, and slivers) existing or new shall be removed from submerged or non-submerged ferrous metal surfaces. All edges and corners shall be ground to provide a smooth 1/16" radius. New ferrous metal surface imperfections are the responsibility of the manufacturer. Acceptance of the substrate without having these imperfections being corrected becomes the sole responsibility of the CONTRACTOR. Surface imperfections of previously coated ferrous metal surfaces that are being re-coated are the responsibility of the CONTRACTOR to remove or have re-moved.
4. Submerged or non-submerged ferrous surfaces including structural steel and miscellaneous metal to be shop-primed shall be prepared according to the coating manufacturers current written guidelines for the submitted coating system and its intended service environment.
5. All shop primed items shall be inspected in the shop by an independent NACE CCI. Any shop applied coated pieces that do not or cannot provide documents for Q/C inspection will be re-prepared and re-coated in the field. The shop coating applicator will be solely responsibility for all financial burdens associated with this remediation.
6. Touchup shop applied prime coats which have damaged or have bare areas, according to SSPC-SP11, (Power Tool Cleaning to Bare Metal) at the time of painting system application, SSPC VIS 3 can be used as a comparison, Tightly adhering coating surrounding the bare metal shall be feather edged a minimum of 1 inch back to provide a clean, dry, sound and smooth transition from bare metal to remaining coating.
7. Remove all surface imperfections (e.g., sharp fins, sharp edges, weld spatter, burning slag, scabs, slivers) using SSPC-SP2 (Hand Tool Cleaning) and/or SSPC-SP3 (Power Tool Cleaning) before full surface preparation operations begin.
8. Remove all rust and contamination on existing ferrous metals to sound surfaces by power tool cleaning complying with SSPC SP11 to provide a surface profile of not less than one mil.
9. Non-Ferrous Metal Surfaces: Prepare all substrates new or existing according to the coating manufacturers' current written guidelines for the submitted coating system and its intended service environment.

D. Galvanized (Zinc-Coated) Surfaces: Prepare all substrates new or existing according to the coating manufacturers' current written guidelines for the submitted coating system and its intended service environment.

E. CPVC Piping and Fiberglass: Prepare all substrates new or existing according to the coating manufacturers' current written guidelines for the submitted coating system and its intended service environment.

F. Covering on Pipe Insulation:
   1. Remove all oil and surface contaminants as recommended by manufacturer for surface and application required.
   2. Do not cut or damage the insulation in any way.

G. Gypsum Wallboard and Plaster:
1. Patch, sand and seal all rough spots before applying prime coat. Remove all dust and other contaminants prior to painting.
2. Touch-up all suction spots and hot spots with primer before application of finish coats.

H. Wood:
1. Clean wood surfaces to be painted of all dirt, oil, or other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sandpaper smooth those finished surfaces exposed to view, and dust off.
2. Prime, stain, or seal wood required to be site painted immediately upon delivery to job. Prime edges, ends, faces, undersides, and backsides of such wood, including cabinets, counters, cases, paneling, and similar items.
3. Back prime paneling or interior partitions only where masonry, plaster, or other wet wall construction occurs on backside.
4. Seal tops, bottoms, and cutouts of wood doors with a heavy coat of sealer as recommended by the door manufacturer immediately upon delivery to site.
5. Scrape and clean small, dry, seasoned knots and apply a thin coat of white shellac or other recommended knot sealer, before application of the priming coat.
6. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler as recommended by manufacturer, sandpaper smooth when dried and dust off.

3.3 MATERIALS PREPARATION

A. General:
1. Mix and prepare painting materials in strict accordance with the coating manufacturer's current product literature.
2. Only use coating materials of the submitted coating manufacturer. Do not mix any painting materials produced by different manufacturers.
3. Only use thinners when required in the Work and that are provided by the coating manufacturer for the submitted coating system. Do not use any thinners not documented on its current product data sheet or outside its recommended guidelines.
4. Any deviation of mixing procedures must be approved in writing by the ENGINEER before any procedural change will be allowed.

B. Tinting:
1. Tint each undercoat a lighter shade to facilitate identification of each coat of multiple coat coating and/or lining systems.
2. Tint undercoats to match the color of the finish coat of paint but provide sufficient difference in shade of undercoats to distinguish each separate coat. Provide a code number to identify material tinted by the manufacturer.

C. Mixing:

1. For those products requiring constant agitation, use methods in compliance with manufacturer's product literature, to prevent settling during paint application.
2. Mix only in containers placed in suitably sized nonferrous or oxide resistant metal pans to protect concrete floors from splashes or spills. Provide for cleanup and for any damage associated from splash and/or spills.
3. Mix and apply paint only in containers bearing accurate product name of material being mixed, or applied.
4. Stir all materials before application to produce a mixture of uniform density, and as required during the application of the materials. Do not stir any film, which may form on the surface into the material. Remove the film and, if necessary, strain the material before using.
5. Strain products requiring such mixing procedures. After adjusting mixer speed to break up lumps and after components are thoroughly blended, strain through 35 to 50 mesh screen before application.

3.4 GENERAL APPLICATION REQUIREMENTS

A. General:
   1. Thin, mix and apply coatings by brush, roller, or spray in strict accordance with manufacturer’s installation instructions.
      a. Application equipment must be inspected and approved in writing by coating manufacturer.
   2. Temperature and weather conditions:
      a. Do not paint surfaces when surface temperature is below 50F unless product has been formulated specifically for low temperature application or approved in writing by Engineer and paint manufacturer's authorized representative.
      b. Air and Surface Temperatures: Prepare surfaces, then apply and cure coatings within air and surface temperatures minimum and maximum range according to the Manufacturer’s current instructions.
      c. Avoid painting surfaces exposed to hot sun.
      d. Do not paint on damp surfaces.
   3. Immediately after any surface has been inspected and accepted, coatings must be applied, i.e. concrete, structural steel and miscellaneous steel prime coat.
      a. Finish coats shall be applied in the field.
      b. Prime coat referred to here is prime coat as indicated in this Specification. Structural and miscellaneous steel prime coating applied in factory (shop) as part of Fabricator's standard rust inhibiting and protection coating is not acceptable as replacement for specified prime coating.
   4. Provide complete coverage to dry film thickness range specified.
      a. All paint systems are "to cover." In situations of discrepancy between manufacturer's square footage coverage rates and mil thickness, mil thickness requirements govern. When color or undercoats show through, apply additional coats until paint film is of uniform finish and color.
   5. If so directed by Engineer, do not apply consecutive coats until Engineer has had an opportunity to observe and approve previous coats.

6. Use alternating colors to separate and distinguish the applied coatings.
7. Apply materials under adequate illumination as required under SSPC-Guide 12 Guide for Illumination of Industrial Painting Projects
8. Evenly spread to provide full, smooth coverage. All paint is to be applied in a continuous, monolithic and pinhole free manner.
9. Stripe coat (each coat) with a brush prior before full application. Stripe coats should be applied to edges, corners, crevices, joints, and other difficult to work areas.
10. Avoid degradation and contamination of blasted surfaces and avoid inter-coat contaminate
    a. Clean contaminated surfaces before applying next coat
    b. Final coat shall be contaminate free. Remediated areas shall have the same color and gloss appearance as the surrounding painted area. A patchy appearance is not acceptable. Re-coat until appearance is acceptable by the ENGINEER at no additional cost to the owner.
11. Smooth out runs or sags immediately, or remove and re-coat entire surface.
12. Allow preceding coats to dry before recoating.
    a. Re-coat within time limits specified by coating manufacturer.
    b. If re-coat time limits have expired re-prepare surface according to the coating manufacturer’s current printed recommendations.
13. Allow coated surfaces to cure according to coating manufacturers written recommendations prior to allowing traffic or other work to proceed.
14. Coat all aluminum in contact with dissimilar materials.
15. When coating rough surfaces which cannot be back rolled sufficiently, hand brush coating to work into all recesses.
16. Spray, backroll, spray concrete surfaces if paint coatings are spray applied.

B. Prime Coat Application:
1. Prime all surfaces indicated to be painted. Apply prime coat according to coating manufacturer's written instructions.
2. Ensure new coatings applied over existing coatings are compatible.
    a. Employ services of qualified independent NACE CCI or a coating manufacturer's qualified technical representative
        1) Certify thru material data sheets.
        2) Perform test patch.
        3) Provide written documentation of acceptance or non-acceptance of adhesion and compatibility.
    b. If field-applied coating is found to be not compatible, require the coating manufacturer's technical representative to recommend, in writing, product to be used as barrier coat, thickness to be applied, surface preparation and method of application.
    c. At Contractor's option, coatings may be removed, surface re-prepared and new coating applied using appropriate paint system.
3. All damage to surface as result of coating removal shall be repaired to original condition or better at no additional cost to OWNER.

4. Prepare and prime ferrous metals embedded in concrete to minimum of 1inch below exposed surfaces in accordance with coating manufacturers recommendations.
5. Apply zinc-rich primers while under continuous agitation.
6. Ensure abrasive blasting operation does not result in embedment of abrasive particles in paint film.
7. All abrasive shall be vacuumed cleaned or swept and vacuum cleaned.
8. Brush or spray bolts, welds, edges crevices corners, edges and other difficult access areas with primer prior to primer application over entire surface.
9. Touch up damaged primer coats prior to applying finish coats. Restore primed surface equal to surface before damage.

C. Finish Coat Application:
   1. Apply finish coats according to coating manufacturer's written instructions.
   2. Touch up damaged finish coats using same application method and same material specified for finish coat. Prepare damaged area in accordance with Article 3.4.

3.5 REPAIRS

A. All repairs and corrective work will be done according to the coating manufacturers provide written recommendations. No repairs will be completed without the coating manufacturers written recommendations.

3.6 FIELD QUALITY CONTROL

A. Prior to initiating painting Work (if required), perform adhesion tests on existing coated surfaces, bare concrete substrates or newly/existing patched concrete to be painted. The following test methods are suggested.
   1. ASTM D4541 - Pull-Off Strength of Coatings Using Portable AdhesionTesters
   2. ASTM D7234 - Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers
   3. ASTM C1583/C1583M - Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)

B. Consult with the coating manufacturer to determine if these or other methods are acceptable. Provide written test methods and qualifications for acceptance to ENGINEER. The number and location of tests shall be sufficient for CONTRACTOR to determine the condition of existing coatings and the suitability of existing coatings to remain to provide an acceptable substrate for new coatings. Submit testing plan prior to testing and provide ENGINEER a copy of adhesion test results.

C. Painting Records:
   1. Maintain permanent written records of daily Q/C responsibilities.
   2. Verify and record that the coatings and other materials are as specified (i.e., manufacturer, product name & product batch dates).

3. Verify and record condition of coatings and material along with their storage procedures
4. Verify and record surface preparation and application of coatings are as specified.
5. Verify and record coating mixing and thinning procedures, i.e. batch dates, amount mixed, material temperatures, induction time etc.
6. Verify and record application procedures.
7. Verify and record environmental conditions one half hour before work starting, then every 2 hours afterwards and once upon completion of work that day. Environmental readings must be obtained in the area that the work is taken place. Environmental readings shall not be obtained from computers, TV, or cell phone apps. Readings shall be immediately taken should a sudden change in the climate be observed. Record results using sample forms or similar approved forms.
8. Verify and record WFT and DFT of each coat of the coating system are as specified using new wet film gauges and certified dry film thickness gauges. Dry film thickness readings shall be done according to SSPC-PA 2 (Level 3)

D. Independent NACE Third Party Inspection Responsibilities (Full Time):
1. Maintain permanent written records of daily Q/C responsibilities.
2. Verify and record that the coatings and other materials are as specified (i.e., manufacturer, product name & product batch dates).
3. Verify and record condition of coatings and material along with their storage procedures.
4. Verify and record environmental conditions one half hour before work starting, then every 2 hours afterwards and once upon completion of work that day. Environmental readings must be obtained in the area that the work is taken place. Readings shall not be obtained from computers, TV or cell phone apps. Environmental readings shall be immediately taken should a sudden change in the climate be observed. Record results using sample forms or similar approved forms.
5. Surface Preparation Inspection - Verify and record that the specified surface preparation meets or exceeds specified cleanliness standard and surface profile. Check for characteristics or defects that would adversely affect performance or appearance of coating systems.
6. Verify and record coating mixing and thinning procedures, i.e., batch dates, amount mixed, material temperatures, induction time etc.
7. Verify and record application procedures.
8. Coating Inspection - Verify and record the DFT readings of each coat. Check the applied coating film for characteristics or defects that would adversely affect performance or appearance of coating systems, i.e., runs, sags skippers, inconsistent / poor coverage.
9. Dry film thickness readings of ferrous and non-ferrous substrates shall be done in accordance with SSPC-PA 2 (Level 3).
10. Dry film thickness readings of concrete, wood, CPVC, drywall etc. will be done according to agreed procedures of all parties.
11. Dry film thickness reading equipment to be used must be certified and still within certification during the inspection process.

a. Ferrous and Non-Ferrous substrates - Type 1or Type 2 dry film thickness gauges, manufactured by Elcometer, Defelsko or equal.
b. Concrete, wood, CPVC, drywall - Defelsko Posi-Tector 200 using the correct probe for the substrate and thickness to be verified.

12. Check for discontinuities on concrete and/or steel immersion surfaces using holiday detector (NACE SP0-188). Any discontinuities located shall be corrected in according to with the coating manufacturer's most current written recommendations/guidelines. All corrected discontinuities shall be re-tested according to (NACE SP0-188) until compliant.

E. Verification/ Compliance of Inspection Instruments
1. Only use inspection equipment in good working order and has been certified by the equipment manufacturer on a yearly basis minimum. Certificates of calibration must be provided to the ENGINEER upon request.

3.7 PROTECTION

A. Provide "Wet Paint" signs as required to protect newly painted finishes. Protect surfaces of coating systems from damage from any possible surrounding activity.

B. Remove all temporary protective wrappings provided for protection of this Work and the work of other contractors after completion of painting operations.

3.8 ADJUSTMENT & CLEANUP

A. Correct all damages to the work of other trades by cleaning, repairing or replacing, and repainting, as acceptable to ENGINEER.

B. During the progress of the Work, remove from the site all discarded paint materials, rubbish, cans and rags at the end of each work day.

C. Upon completion of painting, clean all paint spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces. Any damage associated with the cleaning and removal process is the CONTRACTORS responsibility.

D. At the completion of Work of other trades, touchup and restore all damaged or defaced painted surfaces as determined by ENGINEER.

3.9 WARRANTY INSPECTION

A. The OWNER or OWNERS REPERSENTATIVE will conduct a warranty inspection during the eleventh (11th) month following completion of all coating work. All defective work shall be repaired by the CONTRACTOR in strict accordance with coating manufac

turer's instructions, this Specification, and to satisfaction of OWNER and/or the OWNER'S REPRESENTATIVE.

B. Entire interior coating system shall be visually inspected. All defective coating, as well as damaged and rusting spots shall be satisfactorily repaired by and at no cost to the OWNER.

C. Coating Manufacturer's Representative: Shall be present, at no cost to the OWNER, during inspection of work to assist with assessment of condition of interior and exterior coating and make recommendations for methods of repair of coating systems as may be required.

D. Inspection Report: Provide an inspection report covering first anniversary inspection, setting forth number and type of failures observed and percentage of surface area where failures have occurred.

E. Schedule: Upon completion of inspection and receipt of an Inspection Report as noted herein, The OWNER shall establish a date to proceed with remedial work. Any delay to meet schedule established by OWNER shall constitute breach of this Contract and the OWNER may proceed to have defects remedied, with costs involved paid by the CONTRACTOR.

F. Remedial Work: Any location where coating has peeled, bubbled, or cracked and any location where rusting is evident shall be considered to be a failure of coating system. CONTRACTOR shall make repairs at all points where failures are observed by removing deteriorated coating, cleaning surface, and recoating with same coating system. If area of failure exceeds twenty-five percent (25%) of total coated surface, entire coating system may be required to be removed and recoated in accordance with original Specification.

G. Costs: All costs for repair shall be borne by CONTRACTOR.

H. Repairs shall be warranted for an additional period of one (1) year.

SAMPLE DAILY LOG

Engineer:	**GC:**	**Paint Contractor:**
Eng. Contact:	**GC Contact:**	**Supervisor:**
Structure Description:		**Date:**
Specification:	**Project:**	

Hold Point/Inspection Item	**Performed by Contractor's QC**			**Status**		**Action Taken to Resolve UNSAT Conditions**
	YES	**NO**	**N/A**	**SAT**	**UNSAT**	
Adequate access & lighting provided						
Protective coverings in place						
SP-1 performed and grease, oil, & contamination removed						
Sharp edges, fins, slivers removed						
Removal of pack rust						
Ambient conditions						
Nozzle pressure						
Compressed air cleanliness						
Abrasive type & cleanliness						
Surface cleanliness						
Surface profile						
Soluble salt testing						

Soluble salt remediation						

Hold Point/Inspection Item	Performed by Contractor's QC			Status		Action Needed to Resolve UNSAT Conditions
	YES	NO	N/A	SAT	UNSAT	
Coating mixing						
Coating application						
Intercoat cleanliness achieved						
Recoat times observed						
Stripe coat applied						
Caulking applied						
Wet film thickness measurements						
Dry film thickness measurements						
Visual appearance						
Repairs to damaged coatings performed						

Ambient Conditions								
Location	Time	RH%	Air Temp	Surface Temp	Dew Point	Surface / Dew Pt +/-	SAT	UNSAT

QC Testing Performed	N/A	N/P	Location(s)	Specified	Actual	SAT	UNSAT
Compressed Air Cleanliness							
Surface Preparation (Cleanliness)							
Surface Profile							
Soluble Salt Contamination SCAT Chlor*Test Brescle Kitagawa Quantab Other:							
Wet Film Thickness							
Dry Film Thickness							

Coating Materials									
				Component A		Component B		Thinner	
Coating Type	Location Applied	Mix No.	Qty Mixed	Expiration Date (Shelf Life)	Batch No.	Expiration Date (Shelf Life)	Batch No.	Type/Name	Batch No.

Coating Material & Mixing Data										
Mix No.	% Thinner Added		Time of Mix	Mixed Coating Temp	Induction Time (SP)	Pot Life (SP)	Mix		Time from surface preparation/ previous coat to application	Coating Start/Stop Time
	Spec	Actual					SAT	UNSAT		

++ END OF SECTION ++

SECTION 11000

ELECTRIC MOTORS 250 HORSEPOWER OR LESS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section includes alternating current induction motors, 250 horsepower or less, to be provided with the driven equipment. Unless specified otherwise, electric motors shall be provided by the manufacturer of the driven equipment under an assumption of unit responsibility. This Section refers to motors by enclosure type as defined in NEMA MG 1, except as noted.

B. Horsepower Rating:
   1. Motor horsepower ratings noted in individual equipment Specifications are estimates only and it is the responsibility of CONTRACTOR to furnish motors, electric circuits, and other equipment of ample horsepower capacity to operate the equipment furnished without exceeding the manufacturer's nameplate full-load current at rated manufacturer's nameplate voltage. Full-load current information shall be furnished with the individual submittals

1.2 QUALITY ASSURANCE

A. General: Motors shall be built in accordance with UL 674, UL 1004, NEMA Standard MG 1, and to the requirements specified.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
   1. AFBMA 9: Load Rating and Fatigue Life for Ball Bearings.
   2. AFBMA 11: Load Ratings and Fatigue Life for Roller Bearings.
   3. IEEE 112: Standard Test Procedures for Polyphase Induction Motors and Generators.
   4. IEEE 841, Standard for Petroleum and Chemical Industry - Totally Enclosed Fan Cooled (TEFC) Squirrel Cage Induction Motors - Up to and Including 500 HP.
   5. NEMA ICS 2: Industrial Control Devices, Controllers and Assemblies.
   6. NEMA ICS 6: Enclosures for Industrial Controls and Systems.
   7. NEMA 250, Enclosures for Electrical Equipment (1000 volts maximum).

8. NEMA MG 1: Motors and Generators.
9. NEMA MG1-31: Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable- Frequency Controls or Both.
10. UL.674: Electric Motors and Generators for Use in Class I Division I Hazardous Locations
11. UL 1004: Electric Motors.

C. Factory Tests:
The manufacturer's factory motor Prototype Tests per IEEE Standard 112 Appendix-A on motors through 250 horsepower shall be submitted as Product Data for the motor, and actual factory tests for motors are not required:
1. Winding resistance in ohms and converted to 25-degree C.
2. Resistive Unbalance and Quarter Voltage Impedance, as applicable.
3. Locked-Rotor current (Single phase).
4. High Potential.
5. No-Load Excitation (volts, amperes, RPM).
6. Bearing vibration check.
7. Efficiency, Power Factor, Current at 115%, 100%, 75%, 50%, and no load.

D. Warranty:
Motors ½ horsepower and greater shall be warranted against defects in materials and workmanship for a period of 5 years under the specified uses and with normal operation and service. This warranty shall be delivered, in writing, to the Owner and shall include, as a minimum, 100 percent full payment coverage for parts and labor during the first 60 months of operation.

E. Unit Responsibility: Assign Unit Responsibility as specified in Section 01600, General Equipment Provisions, to the manufacturer or supplier for the equipment specified in this Section. A Certificate of Unit Responsibility shall be provided.

1.3 SUBMITTALS

A. Submittals shall include the following:
1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to

a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications.
Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. Manufacture completed IEEE Standard 841 Date Sheet for AC Squirrel Cage Induction Motors with required factory data of motors supplied.
3. Speed-Torque curve per 1.2 C Factory Tests.
4. Factory Test Data: Including Guaranteed Minimum Efficiency for 115% load, 100% load, 75% load, 50% load, and no load.
5. Guaranteed vibration level when measured per MG 1, Figure 7-6:
   a. Displacement: 0.0025 inch peak-to-peak
   b. Velocity: 0.10 inches per second peak
   c. Acceleration: 1g (gravity) peak.
6. Motor heating curve for motors per 1.2 C Factory Tests.
7. Motor outline, dimensions, and weight.
8. Manufacturer's descriptive information relative to motor features.
9. Response curve where a winding over-temperature device is required.
10. For all inverter duty motors: Manufacturer's certification that the motor is compatible with the adjustable frequency drive to be used.
11. Disassembly and repair documentation.

1.4 POWER SUPPLY VARIATIONS

A. Motors shall operate successfully under running conditions at rated load with +/- 10-percent of rated voltage with rated frequency or +/- 5-percent of rated frequency with rated voltage.

1.5 AMBIENT CONDITIONS

A. Unless specified otherwise, motors shall be suitable for continuous operation at an elevation of approximately 1,000 feet above mean sea level. Motors to be installed outdoors, exposed to the weather, shall be suitable for continuous operation in a 50° C ambient temperature; motors to be installed indoors shall be suitable for continuous operation in 50° C ambient temperature, unless otherwise noted.

1.6 NEMA WINDING TEMPERATURES

A NEMA MG 1 Table 12-7 motors insulation system maximum winding temperatures in degrees-Centigrade (C), with the degrees-Fahrenheit (F) insulation system class specified herein.
1. Forty degree-C ambient (104 degree-F) is the basis for temperature rise.
2. For 50 degree C ambient (122F) and above, refer to the driven equipment specifications for additional requirements.

Insulation System Class	Degrees C / F	Temperature Rise by Resistance
A	140 / 284	NA
B	165 / 329	B-rise: 40 + 80 = 120 Degrees C / 248 F
F	190 / 374	F-rise: 40 + 105 = 145 Degrees C / 293 F
H	215 / 419	H-rise: 40 + 125 = 165 Degrees C / 329 F

1.7 NEMA MOTOR TEMPERATURE PROTECTION TYPES

A. The NEMA design shall limit the temperatures of the windings without using a thermal device:
1. Type-1: Winding Running and Locked Rotor Over-temperature Protection.
2. Type-2: Winding Running Over-temperature Protection.

PART 2 - PRODUCTS

2.1 MANUFACTURER'S NAMEPLATES

A. Factory installed manufacturer's nameplates shall be stainless steel with embossed or pre-printed lettering and fastened to the motor frame with Type 316 stainless steel pins. Manufacturer's nameplates shall have stamped on them, the motor manufacturer's name, design voltage; number of hertz and phase; horsepower rating; amperage and temperature rise at rated load, full load speed, NEMA code letter, service factor, minimum guaranteed efficiency, model number, AFBMA bearing number, serial number and maintenance manual number in accordance with NEMA MGI-10.40.1.

B. A separate factory installed manufacturer's nameplate shall provide lubrication instructions and a separate manufacturer's nameplate connection diagram for dual voltage motors.

C. Additionally, factory to provide the following information on manufacturer's nameplates or additional manufacturer's nameplates for:

1. Motors 1/2 horsepower and larger: Indicate the ABMA L-10 rated life for the motor bearings.
2. Motors 2 to 50 horsepower: Indicate the NEMA nominal efficiency.
3. Motors 50 horsepower and larger: Indicate NEMA guaranteed minimum efficiency.
4. Explosion-Proof motors: Indicate UL frame temperature limit code.
5. Space heater information.
6. NEMA MG 1 Over Temperature Protection Type Number.

2.2 CONSTRUCTION

A. Unless specified otherwise, all motors provided under this Section shall have the following features of construction and operation:
   1. Motor voltage, speed and enclosures are specified in the detailed equipment Specifications. Motors furnished with equipment shall comply with this Section.
   2. All motors shall be of the motor manufacturer's premium energy-efficient design, different from manufacturer's standard product through the use of premium materials, design and improved manufacturing process, that reduces motor losses approximately 40 percent from standard efficient designs.
   3. Motor efficiency shall be determined in accordance with NEMA Standard MG1-12.54.1 and guaranteed minimum full load efficiency labeled on manufacturer's motor nameplate in accordance with NEMA Standard MG1-12.54.2 or MG1-10.40.1 below.
   4. Minimum efficiencies shall not be less than those listed in Paragraph 2.4.E., below.
   5. All motors shall successfully operate under power supply variations in accordance with NEMA MG1-14.30.
   6. All motors shall be NEMA Design B with torque and starting currents in accordance with NEMA MG1-12.35 and 12.37, except in special applications requiring higher starting torques where NEMA Design C is permitted.
   7. All motors shall have a 1.15 service factor. Polyphase integral horsepower motors shall be sized so that, under maximum load conditions imposed by the driven equipment, for the conditions specified, the manufacturer's motor nameplate rated horsepower and Class B temperature rise will not be exceeded. Motors with a service factor of 1.15 shall be selected for operation within their full load rating without applying the service factor.
   8. Each motor shall be of the speed and horsepower specified or required to properly operate the driven equipment, torque characteristics as required by the drive load and suitable for direct coupling or V-belt drive, as shown on the Drawings and specified herein. Motors shall be designed for full voltage starting, unless otherwise specified.

9. Frames shall be of corrosion-resistant cast iron with integrally cast feet or bases. End bells, conduit box and cover and bases shall be cast iron, with precision machined bearing fits, ASTM Type A-48, Class 25 or better. UL approved automatic stainless steel breather drains shall be provided in the lowest part of front and back brackets to allow drainage of condensation on TEFC and explosion proof motors.
10. Each stator core assembly shall consist of stacked lamination made from specially selected electrical sheet silicon steel.
11. Insulation materials shall be non-hygroscopic and meet or exceed Class H definition, utilizing materials and insulation systems evaluated in accordance with IEEE 117 classification tests. Motor temperature rating shall not exceed Class B temperature limits as measured by resistance method when the motor is operated at full load at 1.0 service factor continuously in a maximum ambient temperature of 50° C. Windings shall be copper.
12. Rotor cages for motors 50 HP or less shall be die cast aluminum or fabricated copper. Shafts shall be made from carbon steel. Rotor cages for motors larger than 50 HP shall be copper only.
13. Rotors on frames 213T and above shall be keyed shrunk or welded to shaft and rotating assembly dynamically balanced to NEMA limits in accordance with MG1-12.06. Balance weights, if required, shall be secured to the rotor resistance ring or fan blades by rivets. Machine screws and nuts are prohibited. The entire rotating assembly between bearing inner caps shall be coated with a corrosion-resistant epoxy.
14. Bearings shall be ball, open, single row, deep groove, Conrad type, and shall have a Class 3 internal fit conforming to AFBMA Std. 20. For belted duty applications, drive end bearing may be cylindrical roller type. Bearings shall be selected to provide L-10 rating life of 100,000 hours minimum. Calculations shall be based on external loads using NEMA applications limits in accordance with MG1-14.41 and typical sheave weights and internal loads defined by the manufacturer, including magnetic pull and rotating assembly weight.
15. Bearing temperature rise at rated load shall not exceed 60° C. Temperature rise shall be measured by RTD or thermocouple at bearing outer race. Bearing AFBMA identification number shall be stamped on manufacturer's motor nameplate.
16. Motor lubrication system shall consist of a sealed bearing or a grease inlet on motor bracket with capped grease fitting on inlet, grease relief plug 180 degrees from inlet, grease reservoir in bracket and grease reservoir in cast inner cap. Motor shall be greased by manufacturer with a premium moisture resistant polyuria thickened grease containing rust inhibitors and suitable for operation over temperatures from -25° C to 120° C.

17. All bolt and cap screws shall be of high strength, SAE Grade 5 zinc-plated and chromatic steel. Screwdriver slot fasteners are unacceptable.
18. All motor parts including frame, brackets, fan cover and terminal box shall receive a minimum of two coats of high-grade USDA accepted epoxy paint. Motor assembly shall withstand salt spray tests for corrosion in accordance with ASTM B-117 for 96 hours.
19. All motors shall be painted the same color as the driven equipment.
20. Two-speed motors shall be two-winding motors. Two-speed, one-winding consequential-pole motors that require special motor starters are prohibited.

2.3 MOTORS LESS THAN 1/2 HORSEPOWER

A. General:
   1. Unless otherwise specified, motors less than 1/2 horsepower shall be squirrel cage, single phase, capacitor start, induction run type. Construction features listed in Paragraph 2.2, above, shall be as normally supplied by the equipment manufacturer. Single phase motors shall have Class B insulation, minimum. Small fan motors may be split-phase or shaded pole type. Windings shall be copper.

B. Rating:
   1. Unless otherwise specified, motors shall be rated for operation at 115 volts, single phase, 60 Hz, and shall be continuous-time rated in conformance with NEMA Standard MG 1, Paragraph 10.35. Dual voltage (115/230) rated motors are acceptable if all leads are brought out to the conduit box. Motors shall be non-overloading at all points of the equipment operation.

C. Enclosures:
   1. Unless otherwise specified, motors shall have totally enclosed fan cooled or totally enclosed non-ventilated enclosures.

2.4 MOTORS 1/2 HORSEPOWER THROUGH 250 HORSEPOWER

A. General:
   1. Unless otherwise specified, motors 1/2 horsepower through 250 horsepower shall be three phase, squirrel cage, full voltage start induction type. Unless otherwise specified, motors shall have a NEMA MG 1-1.16 design letter B or C torque characteristic as required by the driven equipment’s starting torque requirements.

B. Rating:

1. Unless otherwise specified, motors shall be rated for operation at 460 volts, 3 phase, 60 Hz, and shall be continuous time rated in accordance with NEMA Standard MG 1, Paragraph 10.35.

C. Enclosure and Insulation:
1. General: Motors shall be classified as Type 1 (Process) and Type 2 (Explosion proof). Enclosures and insulation systems shall be as specified in the following paragraphs. Temperature rise for all motor types shall not exceed that permitted by Note II, Paragraph 12.42, NEMA MG 1. The insulation shall be non-hygroscopic.
   a. Type 1 Motors (Process): Type 1 motors shall be premium energy efficient motors, totally enclosed, fan cooled. All motors shall have Class H insulation with Class B temperature rise. Motors shall conform to IEEE 841. All internal surfaces shall be coated with an epoxy paint. Motors shall be rated for corrosive atmosphere duty.
   b. Type 2 Motors (Explosion proof): Explosion proof motors shall be UL listed in accordance with UL 674 for Class I, Group D hazardous atmospheres. The motor shall have Class H insulation and shall conform to IEEE 841. Steel frame motors will not be permitted. A UL-approved Type 316 stainless steel breather/drain device shall be provided in the motor drain hole. The motor shall be provided with a frame temperature thermostat which meets the UL frame temperature limit code T2A (280°C). The thermostat shall contain an automatically reset, normally closed contact rated two amperes at 115 volts AC.

D. Minimum Manufacturer's Nameplate Efficiency: Motor minimum manufacturer's nameplate efficiency, determined in accordance with IEEE 112B testing procedures, when operating on a sinusoidal power source shall conform to the following:

HORSEPOWER RANGE	SPEED, RPM		
	1200	1800	3600
1-2	82.5	84.5	82.5
3-5	89.5	88.5	86.5
7-25	90.2	90.2	89.5
30-60	92.4	92.4	89.8
75-250	94.1	93.7	91.7

F. Vertical Motors:
   1. Unless otherwise specified, vertical motors shall be full voltage with a Type P base specifically designed for vertical installation. Universal position motors are not acceptable. Vertical motors shall have solid shafts, unless otherwise specified. Vertical motors shall conform to either Type 1 or Type 2 motor requirements as specified under Paragraph 2.4.C., above. Thrust bearing rating shall be compatible with the loads imposed by the driven equipment.

G. Conduit Boxes:
   1. CAUTION: External conduit boxes on motors shall be sized to accommodate oversized feeder conductors and as shown on the Drawings shall, in any case, not be less than one size larger than NEMA standards. The conduit boxes shall be diagonally split and rotatable in 90-degree steps. A gasket shall be furnished between the conduit box and frame. Motor leads shall be stranded copper wire, Class H or better insulated, non-wicking, with permanent identifications spaced 1-1/2-inches maximum. Clamp type grounding terminals shall be provided in the conduit boxes.

H. Lifting Eyes:
   1. Motors weighing more than 50 pounds shall be fitted with at least one lifting eye.

I. Current Imbalance:
   1. Current imbalance shall not exceed the values tabulated below when the motor is operating at any load within its service factor rating and is supplied by a balanced voltage system.
      a. Under five horsepower: Ten percent
      b. Five horsepower and above: Ten percent
   2. Imbalance criteria shall be based upon the lowest value measured.

2.5 PRODUCT DATA

A. The following information shall be provided for each motor in accordance with the individual equipment specification.
   1. Motor outline, dimensions and weight.
   2. Manufacturer's general descriptive information relative to motor features.
   3. Where a winding overtemperature device is required, provide a response curve for the temperature device.
   4. Applicable operation and maintenance information specified in Section 01781, Operation and Maintenance Data. Provided overhaul instructions for each motor five HP and over.

2.6 ACCEPTABLE PRODUCTS

A. The following manufacturer's motors generally meet the class and performance requirements of this specification when furnished with appropriate modifications and additional features as specified:
   1. General Electric Inc.
   2. Emerson US Motors
   3. Siemens

PART 3 - EXECUTION

3.1 GROUNDING AND BONDING

A. Verify the circuit ground cable (green) is identified and connected to the grounding lug terminal in the conduit box.

B. Provide supplementary grounding by installing a bond from the motor frame to the grounding electrode system as indicated on the drawings.

3.2 FIELD TESTING

A. Verify breather/drain fittings have been installed as specified herein.

B. Provide winding insulation resistance testing for motors to be witnessed by owner or engineer before connection is complete. Winding insulation resistance shall be not less than 10-megohm measured with a 1000-VAC megohmmeter at 1-minute at or corrected to 40-degree C.

C. Provide motor phases current imbalance testing to be witnessed by owner or engineer.

+ + END OF SECTION + +

SECTION 11212

VERTICAL SUBMERSIBLE WELL PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals required to furnish and install vertical submersible well pumps complete and operational with motors, control equipment, and accessories as shown on the Drawings and as specified. Anchor bolts are included in this Section.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience of producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. All equipment provided under this Section shall be obtained from a single supplier or manufacturer who, with CONTRACTOR, shall assume full responsibility for the completeness of the system. The supplier or manufacturer shall be the source of information on all equipment furnished regardless of the manufacturing source of that equipment.

C. Unit Responsibility: Assign Unit Responsibility as specified in Section 01600, General Equipment Provisions, to the manufacturer or supplier for the equipment specified in this Section. A Certificate of Unit Responsibility shall be provided.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. Standards of the Hydraulic Institute.
   2. National Electrical Code (NEC) current adoption.
   3. City of Phoenix – Amendments to the National Electrical Code.
   4. Standards of National Electrical Manufacturers Association.
   5. Institute of Electrical and Electronic Engineers.
   6. American National Standards Institute.
   7. Standards of American Water Works Association.

E. Shop Tests:
   1. Each pump casing shall be hydrostatically tested to twice the discharge head or 1-1/2 times the shutoff head, whichever is greater.

2. Running Test: Each pump assembly shall be operated from zero to maximum capacity as shown on the approved pump curve. Results of the test shall be shown in a plot of test curves showing head, flow, horsepower, efficiency, current and NPSH. Readings shall be taken at a minimum of five evenly spaced capacity points including shut-off, design point and minimum head for which pump is designed to operate. Curves shall be corrected for column and discharge head losses, shaft friction loss and operating speed to show the anticipated field performance of the complete pump assembly.
3. Each test shall be witnessed by a Registered Professional Engineer who may be an employee of the manufacturer. The Registered Professional Engineer shall sign and seal all copies of curves and shall certify that hydrostatic tests were performed. Tests shall be conducted in conformance with the Standards of the Hydraulics Institute.
4. Pumps shall not be shipped until the ENGINEER has approved the test reports.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Manufacturer's literature, illustrations, paint certification, specifications and engineering data including: dimensions, materials, size, weight, performance data and pump curves showing overall pump efficiencies, required net positive suction head, flow rate, head, brake horsepower, motor horsepower, speed and shut-off head. Supply data on pump head losses, to include entrance, column, pump and valves losses.
2. Provide: Fabrication, assembly, installation and wiring diagrams.
3. Certified pump tests.
4. Motor test results and data.
5. List of all deviations from Contract Documents.
6. Control panels shall be furnished in accordance with the requirements as shown on the Drawings and as specified in Sections 17000 Process Control System General Requirements, 17052 Process Control System Primary Sensors and Field Instruments, and 17053 Process Control System Instrument Index.

B. Operation and Maintenance Manuals:
1. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation and spare parts information.
2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01781 Operation and Maintenance Data Submittal.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of the Work.

B. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the site. Notify ENGINEER if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition, in accordance with manufacturer's instructions.

C. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. Pumps shall be submersible vertical turbine type, suitable for pumping wastewater. The pumps, with appurtenances and cable, shall be designed for continuous operation under submergence, without leakage, in water to a depth of 8 feet.

B. The characteristic curve of the pump shall rise from minimum head condition to shutoff without dips. The complete pumping unit consisting of the pump and respective motor shall be suitable in all respects for continuous, stable performance when operating at any point on the characteristic curve without cavitation or runout and in accordance with the vibration criteria specified herein.

C. Each complete pumping unit, including the motor, shall be capable of safely operating at up to 125 percent of full load speed in reverse rotation without sustaining damage.

D. Pumps shall be specially designed, constructed, and installed for the service specified and shall comply with the design conditions as specified herein.

(The remainder of this page was left blank intentionally.)

Design Conditions	**Pump No. 1**	**Pump No. 2**
Location:	LS76 Wet Well	LS76 Wet Well
Use:	Lift Station	Lift Station
Number Required:	1	1
*Design Flow: gpm	1,736	1,736
*Design TH: ft.	95	95
Min. Bowl Efficiency at Design: %	73	73
Motor: hp	60	60
Max. Operating Speed: rpm	1775	1775
Pump Column Dia.: in.	N/A	N/A
Discharge Size: in.	6	6
**Available NPSH at Design: ft.	Ample	Ample
***Flow at 2nd Design Point: gpm	1702	1702
TH at 2nd Design Point: ft.	94.1	94.1
Shutoff Head: ft.	182.5	182.5
Approx. Static Liquid Elev. in Well: ft	1688.06	1688.06
Elev. of Pump: ft	1679.15	1679.15
Pump Discharge Center-line Elev.: ft	1680.63	1680.63
Liquid Pumped:	Wastewater	Wastewater
Temperature: °F	68	68
Liquid pH:	N/A	N/A
Drive Type:	Constant Speed	Constant Speed
Motor: Volts/Phase/Hertz	460V/3ph/60Hz	460V/3ph/60Hz

* Does not include entrance, pump, column, and discharge head losses.

** Required NPSH shall be for size impeller being furnished. If impeller is trimmed, curve for that impeller shall be submitted.

*** Flow at the 2nd design point TH shall be within ten percent of the value specified.

(The remainder of this page was left blank intentionally.)

LIFT STATION 76 SYSTEM CURVE TABLE				
	C-Value Phase II System Curve (110)		C-Value Phase II System Curve (140)	
	Flow (gpm)	Head (ft)	Flow (gpm)	Head (ft)
System Point No. 1	1,200	81.29	1.200	79.82
System Point No. 2	1,500	86.96	1.500	84.79
System Point No. 3	2,000	98.82	2.000	95.21
System Point No. 4	2,500	113.58	2.500	108.25
System Point No. 5	3,000	131.18	3,000	123.83

2.2 DETAILS OF CONSTRUCTION

A. Pump Materials and Construction:
1. Bowls, guide vanes, strainer, and check valve shall be 300 Series Stainless Steel.
2. The shaft and coupling shall be 300 or 400 series stainless steel.
3. No moving parts should be constructed from plastic or other brittle materials
4. Impellers: The impellers shall be Type 316 stainless steel of the enclosed type, statically and dynamically balanced.
5. Install a 1/4-inch diameter brass sounding tube. Tube shall be Schedule 40 brass in 20-foot lengths connected with threaded brass couplings. The sounding tube shall be strapped to the column pipe every 20 feet using Type 316 stainless steel straps and shall extend from the discharge head to the top of the bowl assembly.
6. Anchor bolts and inserts shall be furnished under this Section and shall be sized and installed in accordance with the manufacturer's recommendations. The anchor bolts shall be Type 316 stainless steel.
7. Stainless steel manufacturer's nameplates giving the manufacturer's model and serial number, rated capacity, head, speed and all other pertinent data shall be attached to the pump.

B. Motors:
1. Motors shall conform to the requirements of Section 11000, Electric Motors.
2. Motor shall be solid shaft of stainless steel, ball bearing type. Motor casing shall be NSF-61 approved liquid-fill with moisture resistant Class F 155°C insulation. Power shall be 460 Volts, 60 Hz, and 3 Phase.
3. Cable entry shall be isolated with an internal terminal board.
4. Pump and motor shall be designed for continuous and intermittent operation up to twelve starts per hour in a submerged condition without damage.
5. Motor shall be non-overloading for the entire pump operating curve.
6. Pump motor cable shall be designed for submersible duty and shall be indicated by code or legend permanently applied to cable. Cable and sizing shall conform

to National Electric Code for pump motors and shall be supplied in sufficient length to extend continuously, without splices, from the motor to the pump control panel. The power cable entry assembly shall be stainless steel and shall be provided with a strain relief element to inhibit leakage in the event the cable is pulled. Motor power cords shall meet the requirements of the Mine Safety and Health Administration for trailing cables.

7. Motor thrust bearings shall be designed for continuous thrust loads under all conditions of pump operation from zero head to shut-off. The kings bearing shall be rated for a B-10 life of 100,000 hours.

C. Submersible Cable:
   1. Conductor Size: Size to limit voltage drop to six percent at the motor.
   2. Cable Clamps:
      a. Large Pumps: Clamps used to secure the cable to the discharge column shall be stainless steel with rubber cable protectors. Place clamps at least every 20 feet, minimum.
      b. Small Pumps: Clamps used to secure the cable to the discharge column shall be electrical wire tie wraps or 20 mil electrical pipe wrap.
   3. Cable Length: Provide as required to connect to pump control panel.
   4. Cable Shield: Cable shield at pump bowls shall be of 300 series stainless steel.
   5. Pump motor cable shall be designed for submersible duty and shall be indicated by code or legend permanently applied to cable.

D. Product and Manufacturer: Provide one of the following:
   1. Flygt, Model NP 3202 HT
   2. Or Approved Equal

E. Spare Parts: Provide one of the following:
   1. One (1) spare pump

2.3 SURFACE PREPARATION AND PAINTING

A. Pumps, motors, drives, appurtenances, etc., shall receive shop primer and shop finish coating conforming to the requirements of Section 09900, Painting. If any damage to the paint system occurs, the equipment shall be repainted as directed by the ENGINEER.

B. Surface preparation and painting shall conform to the requirements of Section 09900, Painting.

C. All gears, bearing surfaces, machined surfaces and other surfaces which are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. This coating shall be maintained during storage and until the equipment is placed into operation.

D. Certify, in writing, that the shop primer and shop coating system conform to the requirements of Section 09900, Painting.

2.4 CONTROLS

A. Provide pump controls as shown on the Drawings and specified in Division 17000, Sections 17051, 17052, and 17053.

B. The pumps are controlled locally from the SCADA PLC.

PART 3 -EXECUTION

3.1 INSPECTION

A. Inspect all equipment immediately upon delivery to site. If damaged, notify ENGINEER and manufacturer immediately.

B. Do not install damaged equipment until repairs are made in accordance with manufacturer's written instructions and approved by the ENGINEER. Only minor repair work shall be permitted in the field. All other damaged items shall be sent to factory for repair or replacement.

3.2 INSTALLATION

A. Equipment shall be installed in accordance with manufacturer's instructions and recommendations and the approved Shop Drawings. The installation shall be certified on Form 01620-A specified in Section 01331, Reference Forms.

B. A check valve and shut-off valve in discharge piping are required for each pump as shown on the Drawings. Coordinate with Division 15, Mechanical.

C. Support piping independent of pump.

3.3 START-UP AND TEST

A. Make adjustments required to place system in proper operating condition. Field test and calibrate the equipment to assure that the system operates in accordance with these Specifications and to the satisfaction of the ENGINEER.

B. After completion of installation, the system shall be completely tested to ensure compliance with the operating requirements as specified, indicated on the Drawings and in accordance with Section 01752, Equipment and System Startup and Performance Testing.

C. CONTRACTOR to discharge the water for pump tests to the existing on-site lift station wet well. Discharge shall be in a controlled manner such that overflow of the wet well will be prevented at all times.

3.3 DISINFECTION

A. The well pumps shall be disinfected by CONTRACTOR conforming to AWWA requirements. To disinfect the pumps, use a sodium hypochlorite (NaOCl) solution to provide a minimum 50 parts per million (ppm) of available chlorine concentration.

B. After introduction of the disinfectant, the solution shall be thoroughly mixed in the well by surging with the new pump. The solution shall remain in the well for at least 24-hours during which time the well shall be surged at two-hour intervals.

C. Responsibility belongs to CONTRACTOR for obtaining proper disinfection as determined by the bacteriological tests made by the OWNER. If additional disinfection is required, repeat disinfection procedures until satisfactory bacteriological samples are obtained, at no additional cost to the OWNER.

3.4 MANUFACTURER'S SERVICES

A. A factory-trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of three visits, minimum four hours on-site for each visit, to the site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation and start-up of the system. The third visit shall be as described under Section 01821, Instruction of Operations and Maintenance Personnel. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the pumps conform to requirements. Representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

B. All costs, including travel, lodging, meals and incidentals, shall be considered as included in CONTRACTOR'S lump sum bid price.

+ + END OF SECTION + +

SECTION 13124

ODOR CONTROL BIOFILTER (GRANULAR MEDIA)

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. Provide all labor, equipment, materials, and incidentals as required to furnish, install, check, calibrate, test, document, start-up, and place in satisfactory operation the Odor Control System Biofilter (Biofilter System) as shown on the Drawings and as specified.
2. The Biofilter System shall include, but not be limited to the following:
   a. Biofilter Containment Structure (CONTRACTOR provided)
   b. Biofilter Flooring System (System Supplier).
   c. Biofilter Media, Plenum Layer, Cover Rock (System Supplier).
   d. Centrifugal Fiberglass Fan and Motor (Blower) (System Supplier).
   e. Dampers (CONTRACTOR provided)
   f. Blower Enclosure (System Supplier)
   g. Liner System (System Supplier)
   h. Grease Filter (System Supplier)
   i. Irrigation System (System Supplier).
   j. Cleanouts (CONTRACTOR Provided)
   k. Interconnecting FRP foul air ductwork, fittings, accessories and supports (CONTRACTOR provided).
   l. Alarm and Monitoring equipment and programming into facility control system (CONTRACTOR provided)
   m. Spare parts specified (System Supplier).
3. Work required under this specification consists of furnishing a complete granular media-based Biofilter System for the control of atmospheric hydrogen sulfide and other foul odors commonly developed in municipal sewers. The system shall consist of one Biofilter System, configured for removal of hydrogen sulfide and other odor causing compounds through biological activity in the system media. All system appurtenances, including but not limited to, blower and irrigation system shall also be provided, in accordance with these specifications.
4. Furnish Biofilter System to meet the following minimum criteria:

Parameter	Value	Units
System Capacity	400	cfm
Average H2S Loading	20	ppm
Peak H2S Loading	200	ppm
Minimum H2S Removal Efficiency (>10 ppm)	99.0	%

Parameter	Value	Units
Maximum H2S Discharge Concentration (<10 ppm)	0.1	ppm
Biofilter Area	120	sf
Media Depth (minimum)	4	ft
Empty Bed Residence Time (minimum)	1.2	min
Sprinkler System Supply Pressure (minimum)	40	psi

5. All components of the biofilter system shall be compatible with the conditions to which they are subjected during the normal operation of the system. Compounds with which the materials must be compatible include, but are not limited to:
   a. Hydrogen sulfide
   b. Acids

B. Process Description
1. The Biofilter System shall remove hydrogen sulfide and other odor causing compounds from the foul air stream produced in municipal wastewater collection systems via break down by microorganisms in granular media. The foul air stream is introduced into the media with a blower drawing the foul air from the wastewater collection system. The Biofilter System shall also be equipped with an irrigation system to maintain the moisture level in the biofilter media, providing a suitable environment for the microorganisms.
2. The foul air shall enter the biofilter through a blower discharge pipe into the void space beneath a raised plenum floor. The plenum floor then spreads the foul air uniformly across the media for treatment. After treatment in the biofilter, the air shall exit the biofilter at the media surface, dispersing into the ambient atmosphere.

C. Service Conditions:
1. The Biofilter System shall be designed to meet the following service conditions:
   a. Temperature Ranges: 30° to 120 °F.
   b. Precipitation: Approximately 11.4 inches per year.
   c. Altitude: Approximately 1899.6 feet above mean sea level (MSL).
2. The Biofilter System shall be designed to treat 400 cfm of continuous foul air flow. The system shall be designed to eliminate vapor phase odorous compounds from foul air as typically produced in municipal wastewater collection systems. The odorous compounds include, but are not limited to, hydrogen sulfide, mercaptans, reduced sulfur compounds, and volatile organic compounds.
3. The Biofilter System design shall utilize a granular bed type media. Compost, wood chips, and other types of pure organic media will not be acceptable.
4. The maximum allowable pressure drop through the biofilter media shall be 2 inches of water column (WC) per foot of media depth.

D. Performance:
   1. Media Life: The biofilter media and the plenum floor materials of construction shall have a minimum useful life of ten (10) years. "Useful life" shall be defined to mean operation under the following conditions: no detectable degradation in the odor removal performance of the biofilter media when operated and maintained in accordance with the System Supplier's written operations and maintenance requirements. If any defects or malperformance occurs in that period, the System Supplier shall be responsible for all necessary alterations, repairs, or replacements at no cost to the OWNER.

E. Regulatory Limitation
   1. The CONTRACTOR shall provide a Biofilter System that is capable of meeting Maricopa County Air Pollution Control Regulations, Regulation III, Rule 320, Section 304 standards, that limit the concentration of hydrogen sulfide beyond the site property boundary to a concentration not to exceed 0.03 parts per million by volume for any averaging period of 30 minutes or more.

1.2 QUALITY ASSURANCE

A. Qualifications: Biofilter System equipment components furnished under this Section shall be supplied by a single System Supplier. System Supplier furnishing equipment under this Section shall have been regularly engaged in the design, manufacture, and supply of this type of equipment in wastewater applications for at least five (5) years. System Supplier shall demonstrate that they have routinely and successfully sourced odor control biofilters of the type specified herein for the previous five (5) years or longer by submitting a list of a minimum of five (5) projects on which they have provided the type specified for application on this project. Submit project names, biofilter size and system components to the ENGINEER for approval.

B. The System Supplier shall maintain regular production facilities at their place of business. These facilities shall be open for an inspection by a representative of the OWNER or ENGINEER at any time during construction and testing of this equipment.

C. The System Supplier for the biofilter shall be:
   1. Bohn Biofilter Corp.
   2. BIOREM Environmental.
   3. ECS
   4. or Pre-Approved Equal.

D. Shop Tests:
   1. Blower Tests:
      a. Performance Testing: Submit certified non-witnessed factory performance test results. Receive favorable review of test results prior to shipping the equipment.

b. All materials, labor and equipment for all tests and retests shall be furnished by CONTRACTOR.

E. Qualifications of CONTRACTOR's Subtrades:
1. CONTRACTOR shall engage a single subtrade contractor for work not self-performed with undivided responsibility for performance and other requirements who is regularly engaged in installation of and experience with installing the types of materials required; and who agrees to employ only tradespersons with specific skill and experience in this type of Work. Submit name and qualifications to ENGINEER.

F. Requirements of Regulatory Agencies: Comply with the applicable provisions of regulatory agencies below and others having jurisdiction.
1. Local and State Building Codes and Ordinances.
a. International Mechanical Code.
b. International Building Code as supplemented by the City of Phoenix, Building Construction Code.
c. International Fire Code.
2. National Fire Protection Association (NFPA)
3. Underwriters' Laboratories, Incorporated (UL)
4. National Electrical Code (NEC) current adoption
5. National Electrical Manufacturers Association (NEMA)
6. Occupational Safety and Health Administration (OSHA)

G. Responsibilities:
1. The System Supplier shall be the source of information on all equipment furnished regardless of the manufacturing of that equipment.
2. The sole responsibility for furnishing, installing and proper operation of the Biofilter System shall rest with CONTRACTOR.
3. Unit Responsibility: Assign Unit Responsibility as specified in Section 01600 GENERAL EQUIPMENT PROVISIONS, to the manufacturer or supplier for the equipment specified in this Section.
4. The complete blower fan and motor, propeller ventilator, and enclosure assembly shall be hazardous location and UL Evaluated by an OSHA and UL approved company. The responsibility of this evaluation is rests with the CONTRACTOR. Copies of the field certification shall be provided to the OWNER and ENGINEER.
5. Programming of the Biofilter System instrumentation and controls into the facility control system shall rest with the CONTRACTOR.

H. Materials Testing:
1. Material employed in items fabricated of fiberglass reinforced plastic and high-density polyethylene (HDPE) shall be capable of withstanding maximum calculated stresses that may occur during fabrication, shipping, unloading, installation and continuous operation, with allowance for an adequate safety factor. To confirm materials properties, tests shall be conducted by an

independent, qualified testing laboratory on representative material samples in accordance with the following latest revision of standards:

a. American Society of Heating, Refrigerating and Air Conditioning Contractors National Association (ASHRAE).
b. Sheet Metal and Air Conditioning Contractors National Association (SMAC-NA).
    1) HVAC Duct Construction Standards.
    2) Fire Damper Guide for Air Handling Systems.
c. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings, Class 125.
d. ANSI B16.5, Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.
e. ASTM C 582, Specification for Contact-Molded Reinforced Thermosetting Plastic Laminates for Corrosion Resistant Equipment.
f. ASTM D 638, Test Method for Tensile Properties of Plastics.
g. ASTM D 695, Test Method for Compressive Properties of Rigid Plastics.
h. ASTM D 746, Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
i. ASTM D 790, Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
j. ASTM D792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
k. ASTM D 883, Terminology Relating to Plastics.
l. ASTM D 1248, Specification for Polyethylene Plastics Molding and Extrusion Materials.
m. ASTM D 1505, Test Method for Density of Plastics by the Density-Gradient Technique.
n. ASTM D 1693, Test Method for Environmental Stress-Cracking of Ethylene Plastics.
o. ASTM D 1777, Standard Test Method for Thickness of Textile Materials
p. ASTM D 2310, Classification for Machine Made Fiberglass Pipe.
q. ASTM D 2563, Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.
r. ASTM D 2583, Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
s. ASTM D 2996, Specification for Filament-Wound, Fiberglass Pipe.
t. ASTM D 3212, Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
u. ASTM D 3299, Specification for Filament-Wound Glass-Fiber-Reinforced Polyester Chemical Resistant Tanks.
v. ASTM D 3350, Specification for Polyethylene Plastics Pipe and Fittings Materials.
w. ASTM D 3786, Standard Test Method for Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method
x. ASTM D 4219, Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.

y. ASTM D 4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity
z. ASTM D 4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles
aa. ASTM D 4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
bb. ASTM D 4751, Standard Test Methods for Determining Apparent Opening Size of a Geotextile
cc. ASTM D 4833, Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
dd. ASTM D 6693, Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes.
ee. ASTM D 5199, Standard Test Method for Measuring the Nominal Thickness of Geosynthetics.
ff. ASTM D 5034, Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)
gg. ASTM D 5035, Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)
hh. ASTM D 5199, Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
ii. ASTM D 5884, Standard Test Method for Determining Tearing Strength of Internally Reinforced Geomembranes
jj. ASTM E 679, Practice for Determination of Odor and Taste Thresholds by a Forced-Choice Ascending Concentration Series Method of Limits.
kk. ASTM F 477, Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
ll. NBS Voluntary Product Standard PS15-69 Custom Contact Molded Reinforced-Polyester Chemical-Resistant Process Equipment.
mm. Society of the Plastics Industry (SPI) Standards of Recommended Practices for Shipping and Installation of Fiberglass Reinforced Plastic Pipe, Duct and Tanks.

2. Test results shall be submitted for review and approved by ENGINEER prior to manufacturer of fiberglass reinforced plastic items.

I. Prior to conducting any Biofilter System testing, demonstrate that all meters and test equipment have been calibrated, charged and are in good operating condition one working day before the test date. CONTRACTOR shall also verify there is sufficient test gas to conduct testing for specified durations at specified concentrations.

J. Provide certifications that all stainless-steel accessories including hangers and supports for FRP and HDPE ductwork are Type 316 stainless steel.

1.3 SUBMITTALS

A. Manufacturers shall submit complete shop drawings and engineering data to the OWNER or ENGINEER, upon request. These submittals shall include, at a minimum:
   1. Product data fully describing all items proposed for use to demonstrate that the equipment conforms to the Specifications.
   2. Motor data.
   3. Fan data sheets; to include fan size, type, arrangement, materials of construction, dimensional data, motor horsepower, motor type, power supply, and motor frame size. For belt driven equipment, provide drive data indicated sheave sizes, belt sizes, number and length. Each submittal shall include fan performance, operating data and a performance curve showing the fan operating point or range.
   4. Blower enclosure factory performance or test data proving that the blower enclosure system meets the noise requirements specified herein. The test method utilized to produce the data shall be submitted for review.
   5. Detailed equipment, and ductwork layout drawings, including equipment dimensions and clear service spaces for motors and drives, as well as access panels and doors.
   6. Elementary and connection wiring diagrams clearly showing external connections to other equipment.
   7. Motor designation and horsepower.
   8. NEMA starter sizes and overload type/sizes.
   9. Control transformer ratings.
   10. Circuit breaker (or fuse) sizes.
   11. Auxiliary contacts.
   12. Control devices being utilized.
   13. Point-to-point wiring diagrams.
   14. Bill of material including spare parts being furnished.
   15. Manufacturer catalog information on major system components, including but not limited to:
      a. Fiberglass Centrifugal Fan (refer to Section 15831 CENTRIFUGAL FAN).
      b. Fiberglass Centrifugal Fan Enclosure.
      c. Media.
      d. Sprinkler System.
   16. Statement of design conditions and performance guarantee.
   17. Statement of warranty.

B. The CONTRACTOR shall submit complete Operation and Maintenance Manuals to the OWNER and ENGINEER. These manuals shall include, at a minimum:
   1. Information on hazards associated with the system and appropriate safety precautions.
   2. Equipment installation instructions.
   3. Equipment startup instructions.
   4. Equipment maintenance procedures.
   5. Troubleshooting guide.

6. Individual operation and maintenance information on major system components, including but not limited to:
   a. Fiberglass Centrifugal Fan (refer to Section 15831 CENTRIFUGAL FAN).
   b. Media.
   c. Irrigation System.

C. The CONTRACTOR shall submit to the OWNER and ENGINEER the following reports and manuals:
1. UL Evaluated report for the Blower and Enclosure Unit.
2. Performance Testing Data.
3. Field Noise Survey.
4. Fence Line Hydrogen Sulfide Boundary Survey.
5. Biofilter System Operations and Maintenance (O&M) Manual.

1.4 SUBSTITUTIONS

A. Any substitutions or deviations in equipment or arrangement from that shown on the drawings or specified herein shall be the responsibility of the System Supplier or CONTRACTOR. Any deviations must be accompanied by detailed structural, mechanical, and electrical drawings and data for review by the ENGINEER. All costs associated with review of substitutions or deviations and costs associated with project drawing changes as a result of approval of such shall be borne by the CONTRACTOR. There shall be no additional costs to the OWNER due to substitutions or deviations.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of the Work.
1. Responsibility belongs to CONTRACTOR for safe transportation, including all freight costs for delivery to the job site, procuring any necessary permits, handling, and open air storage of the blower and other materials purchased as specified in this Section.
2. Duct sub-assemblies shall be unloaded with care and stored in a location where they will be free from damage. Impact of a tool or other heavy object may result in a fracture of the inner lining and affect the service life of the duct or other equipment.
3. Large sub-assemblies shall be supported during unloading to prevent excessive deflection and overstressing.
4. The blower shall come completely assembled and protected against entry of foreign objects.
5. Suction and discharge ports shall be protected against entry of foreign objects.
6. Store equipment and materials so as to keep free from moisture, damage, and deterioration.

7. Openings shall be covered to protect flange surfaces and to prevent foreign materials from entering.
8. Ductwork shall be protected, by padding or bracing, from banding or ropes used in shipment.
9. Biofilter media delivery, storage, and handling shall comply with System Supplier's instructions.

B. All boxes, crates and packages shall be inspected immediately by CONTRACTOR upon delivery to the site. Notify ENGINEER if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

C. Store materials to permit easy access for inspection and identification. Keep all materials off ground, using pallets, platforms or other supports. Protect steel members and packaged materials from corrosion and deterioration.

1.6 EQUIPMENT INSPECTIONS

A. Inform OWNER and ENGINEER, four weeks prior to when specific equipment (e.g., blower, and ductwork) goes into production, so that OWNER and ENGINEER, at their option, may visit premises prior to shipment of any equipment for approval of various items of major equipment. System Supplier of major equipment shall not ship any equipment until OWNER or ENGINEER has had the opportunity to inspect and approve equipment, or System Supplier receives written permission from ENGINEER to ship equipment.

B. Factory inspection by ENGINEER shall not be construed to relieve CONTRACTOR of responsibility for accuracy of the fabrication and assembly, or the quality of workmanship.

C. Any damage incurred in transit shall be immediately repaired by respective equipment fabricator's personnel only, not a sales representative.

1.7 GENERAL REQUIREMENTS

A. The Drawings show general arrangement and extent of Work to be done, but the exact location and arrangement of all parts shall be determined as the Work progresses, to conform in the best possible manner with its surroundings. The exact location of all parts of the Work must be governed by the intent of the Contract Documents and the actual site and construction conditions. Piping, equipment, ducts, etc. found to interfere with the construction of the biofilter, plumbing apparatus and piping, electrical wiring or other obstructions, etc. shall be located in advance to clear such obstructions. Connections shown to the various units are an indication only. The actual connections shall be made to best suit each particular case and provide for expansion, circulation and minimize the amount of space required.

B. Drawings do not show all offsets, fittings, accessories and details, which may be required. Examine all the Contract Documents for conditions, which may affect the installation of his Work accordingly. Provide all required items to provide a complete operable biofilter odor control system as required by the Contract Documents.

C. If piping or ductwork can be run to better advantage, CONTRACTOR, before proceeding with the Work, shall prepare and submit complete Shop Drawings showing all details of the proposed rearrangement for written approval by the ENGINEER.

1.8 EQUIPMENT DEFECTS

A. Equipment, which have mechanical defects and do not meet vibration requirements will be rejected and shall be replaced at CONTRACTOR'S full expense for removal, and furnishing, and installing the replacement.

B. Mechanical defects include excessive vibration, improper balancing of rotating parts, improper tolerances, binding, excessive bearing heating, defective materials, improper fitting of parts, and any other defect which will in time damage the equipment or impair its operation.

C. Requirements shall be met concerning minimum and maximum dimensions and the specifications for materials. If it is found upon delivery that materials do not agree with the requirements of the Specifications as to size, type, quality, or metallurgy, they will be rejected as unfit for use in this Work.

PART 2 – PRODUCTS

2.1 BIOFILTER MEDIA

A. Soil Media.
   1. Plenum Layer (Rock): Coarse gravel as approved by System Supplier.
   2. Soil Media:
      a. The media shall be soil type.
      b. The media shall be as tested and approved by the System Supplier.
      c. Media development: blending, amendment components and quantities, and laboratory analysis, shall be the responsibility of the System Suppler.
      d. Media shall be random placed.
      e. If media is stockpiled upon delivery, it shall be placed on top of plastic and covered for protection.
      f. The media shall be delivered moist; if stockpiled greater than 1 week, the CONTRACTOR shall make efforts to wet the material.
      g. Media shall be placed in a uniform manner that will prevent aggregation and compaction of materials and prevent displacement of the air piping.
   3. Cover Rock: Coarse gravel as approved by System Supplier.

2.2 FOUL AIR PIPING

A. Foul air piping within the Biofilter and above grade shall conform to the requirements of Section 15108 FIBERGLASS REINFORCED PLASTIC PROCESS PIPE.

B. Foul air piping outside the Biofilter and below grade shall conform to the requirements of the Contract Documents.

C. Flanged ports shall be installed on the suction side and discharge side of the blower fan foul air piping. The flanged port on the discharge side shall be installed prior to entering the media bed. The flanged ports shall be capable of providing a means of inspections and permit air flow to bypass the blower for emergency odor treatment with negligible impact to system capacity.

2.3 IRRIGATION SYSTEM

A. The biofilter shall include an irrigation system for moisture control of the biofilter media. The sprinkler system shall include irrigation sprinkler nozzles, sprinkler system timer, and solenoid control valve. The sprinkler system nozzles and piping shall be contained within the biofilter bed with the exception of the piping supplying water to the sprinkler system.

B. The layout of the irrigation system and the number of sprinkler system zones shall be determined by the System Supplier.

C. Irrigation system piping buried in media shall consist of Schedule 80 CPVC.

D. Sprinkler Nozzle: the sprinkler nozzles shall be suitable for providing a part-circle pattern. The sprinkler shall be a Rainbird Model 1800, SAM-PRS, or equal. Sprinkler nozzles shall have an adjustable radius to 12 feet at 45 psi water pressure.

E. Control Valve: The sprinkler control valve shall be a 1-inch Rain Bird PESB valve or equal. Valve shall be supplied with 24V ac coil and fail closed on a loss of power.

F. Irrigation Control System: The irrigation control system shall consist of a Rain Bird Model ESP-4Me sprinkler timer or equal. Electrical input required: 120 VAC ± 10%, 60 Hz. Electrical output: 24-26.5 VAC. Provide a NEMA 4X, 316 stainless steel junction box for the installation of the sprinkler timer. The irrigation control system shall be located 3 feet from any potential leak point to comply with NFPA 820.

G. Irrigation System Monitoring: A pressure indicating transmitter or flow meter monitoring system shall be installed by the CONTRACTOR to alert OWNER of potential failure of the irrigation system.

H. Water Supply: A minimum 1-inch water supply with backflow preventer shall be installed as shown on the Contract Drawings. Water supply shall be designed for a minimum of 40 psi continuous pressure.

2.4 BIOFILTER CONTAINMENT PROTECTION SYSTEM

A. Liner System

1. Impermeable Liner: Impermeable Liner shall be a commercially available reinforced polyethylene composite LDPE and HDPE liner material with a nominal thickness of 40 mil. The composite liner shall have the following minimum specifications.

Parameter	ASTM Test Method	Value
Thickness (mils nominal)	D1777	40
Thickness (mils minimum)	D1777	36
Tensile Strength Grab Method (lbs)	D5034	MD 680 TD 680
Tensile Strength Strip Method (lbs)	D5034	MD 460 TD 460
Tear Strength (lbs)	D5884	MD 140 TD 135
Puncture Resistance (lbs)	D4833	350
Black Carbon Content (%)	D4218	2.5-3.5

a. Product and Manufacturer: Provide one of the following:
   1) BTL-40, Double Scrim RPE, as manufactured by BTL Liners.
   2) Or approved equal.

2. Protective Liner: Protective Liner shall be a commercially available polypropylene, nonwoven geotextile. The protective liner shall be installed above the Impermeable Liner to protect from abrasive or sharp material. The Protective Liner shall have the following minimum specifications.

Parameter	ASTM Test Method	Value
Grab Strength (lbs)	D4632	90
Grab Tensile Elongation (%)	D4632	50%
Puncture Strength (lbs)	D4833	55
Mullen Burse Strength (psi)	D3786	185
Trapezoidal Tear Strength (lbs)	D4533	40
Apparent Opening Size (US Sieve)	D4751	50
Permittivity (sec^{-1})	D4491	2.0
Flow Rate (gpm/ft^2)	D4632-91	150

a. Product and Manufacturer: Provide one of the following:
   1) N035, Polypropylene NonWoven Fabric Scrim RPE, as manufactured by ACF Environmental.
   2) Or approved equal.

2.5 BIOFILTER FLOORING SYSTEM

A. The biofilter interior floor shall be of continuous construction and maintain a minimum 1-percent slope towards the Biofilter Drain Discharge as shown in the Contract Drawings.

B. Raised Floor Plenum:
   1. The raised floor plenum system shall consist of composite plastic panels that cover the entire biofilter interior floor area. The panels shall be interlocking on all sides and supported by interlocking structural columns supporting the panel floor deck from the biofilter interior floor. The support column length shall be in accordance with Contract Drawings. The raised floor plenum deck shall be capable of supporting all biofilter media and biofilter component loads above the biofilter interior floor.
   2. Raised floor plenum system suppliers shall be:
      a. hanit® Biofilter Raised Flooring System by Hahn Plastics.
      b. BacTee Systems. A trench system in the biofilter floor will be required as indicated in the Contract Drawings to provide air flow distribution for the BacTee System.

C. Perforated Panels: Perforated Panels shall be placed on top of the raised floor plenum. The panels shall have a gauge thickness of 0.1196" (11 gauge), a hole size of 3/16", hole centers of 5/16" on center, and a bar size of 1/8". The hole arrangement shall be 60 degrees with staggered centers and round. The material shall be plastic. The perforated panels shall be McNichols Plastiperf or approved equal.

2.6 GREASE FILTER

A. Grease filters shall be designed for a maximum of 3/4 inch water gauge static pressure resistance at a design capacity of 400 cfm.

B. Grease filter shall be single stage horizontal type constructed in fiberglass reinforced plastic with polypropylene filter and shall have a 99% removal efficiency at 12 microns.

C. Grease filter housing shall be fabricated in accordance with NBS PS-15-69, from premium grade fire-retardant vinyl ester resin and fiberglass cloth. Resin shall be AOC Vipel K022, Flame Retardant, Corrosion Resistant, Epoxy Vinyl Ester Resin or equal. The resin system shall meet ASTM Class 1 flame spread requirements, when

tested per ASTM E 84 tunnel test. The resin shall not contain any fillers except as required for viscosity control.

D. Grease filter housing shall be constructed using a single layer Nexus synthetic "C" surfacing veil for all parts in contact with the air stream. No cracks or delaminating will be permissible.

E. Grease filter shall be provided with an FRP drain coupling and CPVC ball valve.

F. Grease filters housing shall have both a flanged inlet and discharge and be provided with EPDM gaskets. Flanged connection shall be a minimum of 3/8 inch thick and are to be shop drilled.

G. Grease filter housings shall be a minimum of 3/16 inch thickness and shall have an adequately sized access panel for inspection and removal of filters or filter media trays. Access panels shall be provided with EPDM gaskets and Type 316 stainless steel fasteners. Access panels shall have plastic quick turn thumb screws and EPDM gaskets.

H. Grease filter pad elements shall be manufactured from polypropylene.

I. Grease filter shall be provided with a [Dwyer A-3000 Series Photohelic Switch/Gauge or Dwyer 2000 Series Pressure Differential Gauge] with red pointer flag high low indicators and range of 0 – 5 inches or 0 – 10 inches of water column. Gauge shall be factory installed with two Each, manufacturer recommended pressure Tips, Type 316 stainless steel bushings, Type 316 stainless steel ball valves and 3/8-inch Type 316 stainless steel tubing to the gauge. Pressure gauge and switch shall be with FRP bracket.

J. Grease filter housing shall be sanded smooth, inspected for cracks, or loose fibers and receive a final coat of 10 Mils (minimum) Gel coat with UV stabilizers.

K. Grease filter shall be suitably packaged for shipment. Wood skids shall be used with protective covers placed over intake and discharge flanges.

L. Grease filters shall be manufactured by FanAir Company, Orange County, California, or approved equal.

M. Grease filter pads shall be manufactured by Agilis Tech or approved equal.

2.7 BIOFILTER CLEANOUTS

A. Cleanouts: Cleanouts shall be installed through the biofilter media at locations shown on the Contract Drawings and extend into the plenum floor void space. The cleanouts shall be constructed in accordance with Contract Drawings.

2.8 BLOWER FAN

A. Fiberglass centrifugal fan shall conform to Section 15831 CENTRIFUGAL FAN.

B. Fan motor shall conform to Section 11000 ELECTRIC MOTORS 250 HORSEPOWER OR LESS.

2.9 BLOWER ENCLOSURE

A. The enclosure shall be manufactured from FRP and be designed with adequate ventilation to prevent fan overheating under all operating conditions. The enclosure shall be equipped with a sufficient quantity of removable panels or doors, or as a split enclosure to allow access to all sides and top of the fan(s) and motor. Panels, door, or split enclosure shall be of sufficient size to allow removal of blower, housing, and other elements. Panels shall incorporate handles and a maximum of 4 hand knobs for ease of loosening and removing each panel. Doors shall incorporate hinges and a locking hasp and latches to allow for swing entry. Inlet and outlet ducted blower connections shall be plain end and connected to the ductwork via flexible expansion couplings. Custom escutcheon plates manufactured from the same material as the enclosure shall be provided to block any gaps between the piping the enclosure. The enclosure shell shall be constructed of fire-retardant vinyl ester resin. Enclosures shall have acoustic ventilation louver(s) w/insect screens.

B. Enclosures shall have a ventilation system installed for heat dissipation. Ventilation systems shall be as follow based on heat dissipation requirements.

1. Gravity Ventilation System: Enclosure shall be installed with a gravity ventilation system sized to provide proper heat dissipation. The vent unit shall be of welded and bolted construction utilizing corrosion resistant fasteners. The spun aluminum components shall be constructed of heavy-duty aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners for added strength and maximum leak protection at the interface with the blower enclosure. The unit base shall have pre-punched mounting holes for ease of installation. Spun aluminum domes shall have a rolled bead for added strength. Birdscreen constructed of 1/2” galvanized mesh shall be mounted across the full throat perimeter. The fan shall bear a permanently attached nameplate displaying model and serial number of the unit for future identification.

   CONTRACTOR shall install a 1-inch CPVC bulkhead fitting in the shell to provide a connection means to route flexible vinyl tubing from the enclosure to the suction side FRP ductwork where a bulkhead fitting is to be installed by the CONTRACTOR to allow for removal of vapor buildup in the enclosure. A 1-inch CPVC ball valve shall be installed at the enclosure bulkhead fitting to connect to the flexible vinyl tubing for isolation.

C. The blower enclosure shall have acoustic lining for sound attenuation. At a minimum, the fan(s) shall be provided with a sound attenuating enclosure. The noise level of the complete

enclosure system operating at the installation location shall not exceed 50 dBA overall sound pressure level (referenced to 20-micro pascals) at any point 30 feet from the equipment. The CONTRACTOR shall be responsible for providing a system meeting the noise level requirement. Following system substantial completion, the CONTRACTOR shall provide a field noise survey from a professional Third-Party licensed noise consultant and submit certified results to the ENGINEER for approval and compliance with the noise level requirement of this paragraph.

2.10 DAMPERS

A. DAMPERS:
   1. Fiberglass Heavy Duty Industrial Round Damper:
      a. Service: Air systems up to 30 inches water column; up to 6,000 feet per minute and up to 72 inches diameter.
      b. Size and installation: Size as indicated on Contract Drawings suitable for flange mounting in round ducting.
      c. Frame: Vinyl ester resin fiberglass conforming to ASME RTPI with 30 mil resin rich interior corrosion layer; flanges integral to web layup.
      d. Blade: Vinyl ester resin fiberglass, stiffened as required; provide 30 mil resin rich corrosion layer on both sides; provide Viton elastomer edge seal.
      e. Blade axel: Viny ester resin fiberglass rod with PTFE bearings and axle seal.
      f. Manufacturers:
         1. Ruskin Swartwout Series, Model 914
         2. Or Equal.

2.11 DRAINS

A. DRAINS:
   1. Blower Drain: A minimum 1-inch CPVC gravity drain to the Biofilter drain shall be required.
   2. Suction Foul Air Drain: A minimum 1-inch CPVC gravity drain to the Biofilter drain shall be required.
   3. Grease Filter Drain: A minimum 1-inch CPVC gravity drain to the biofilter drain shall be required
   4. Drain Discharge Line: A 4” CPVC drain discharge shall be coordinated with system layout.

2.12 EMERGENCY MOBILE ODOR CONTROL SYSTEM POWER RECEPTICLE

A. CONTRACTOR shall provide permanent electrical system to connect an OWNER’s mobile odor control system. The location of the electrical system shall be located on as shown on Contract Drawings. The electrical system shall consist of the following components and be connected to the main electrical site system per the Contract Drawings.

1. One (1) 480-volt power interlocked receptacle with enclosed safety switch service outlet as specified in Section 16141 RECEPTACLES. Power receptacle will be used for emergency mobile odor control trailer.
   a) Receptacle shall be a 3 wire, 4 pole, 600 volt, 60 amp.
   b) Receptacle shall be Type WSR, and Type APJ 6485 plugs by Eaton Crouse Hinds.

2.13 SPARE PARTS

A. Spare Parts: One (1) set of replacement sprinkler heads shall be furnished.

B. Spare Parts: One (1) centrifugal blower motor.

C. Spare Parts: One (1) set of polypropylene grease filter pad replacements.

PART 3 – EXECUTION

3.1 SITE AND UTILITIES

A. The blower and other appurtenances shall be located on a foundation as shown in Drawings.

3.2 EQUIPMENT SHOP TESTING

B. Before shipping the equipment, the System Supplier shall perform shop tests. These tests shall include at a minimum:
   1. Visual inspection of all equipment.
   2. Complete assembly and functional operation testing of equipment.

3.3 INSTALLATION GENERAL

A. The system shall be installed in accordance with the System Supplier's instructions. Installation personnel shall be trained and qualified in the areas of mechanical work, plumbing, electrical work, and instrumentation as required to complete the installation.

3.4 BIOFILTER INSTALLATION

A. General:
   1. Elevations shall be surveyed at the biofilter floor, top of raised flooring system, top of plenum layer, top of soil media, and top of gravel cover to establish correct slope and correct thickness of each layer.
   2. Do not compact materials per Section 3.5.

3.5 PLACING MEDIA/GRAVEL MATERIALS

A. Media Placement Into Bed:
   1. Plenum layer gravel shall be placed in a manner that will limit impact to the raised flooring system.
   2. Use placement devices as approved by System Supplier; for example, front end loaders, excavators, and/or concrete conveyors.

B. Hot Weather:
   1. Make provisions for windbreaks, shading, fog spraying, sprinkling, wet cover, or other means to maintain media with a wet surface.
   2. Addition of chemical wetting agents or other additives is not allowed.

C. Layer, Media, Cover Rock:
   1. Place in layers as specified below:

Gravel Layer	Layer Thickness	Size Limits
Plenum Layer (rock)	6 inches	¾ inch – ½ inch
Media Layer	4 feet	Per System Supplier
Cover Rock	3 inches	¾ inch – ½ inch

   2. Complete each layer before next layer above is stated.
   3. Use only clean gravel. Contractor shall be responsible to avoid contamination of materials by native fill dirt or other.

3.6 BLOWER AND ENCLOSURE UL EVALUATION

A. UL Evaluation: CONTRACTOR shall provide a Third-Party UL Evaluated assessment of the Blower and Enclosure installation. The evaluation will be required to document the installation, procedures, and equipment as a system to verify compliance with codes and standards.
   1. The Third-Party evaluation company providing the UL Evaluation shall complete a report to document the inspection and code compliance. The System Supplier shall provide a copy of the report to the OWNER and ENGINEER.
   2. The System Supplier and CONTRACTOR shall make any necessary corrections should the Third-Party evaluator note any deficiencies.
   3. The Third-Party evaluation company shall affix a UL Evaluated tag to the enclosure to document the unit was evaluated and that installation, procedures, and equipment installed are acceptable.

3.7 FOUL AIR DUCTWORK INSTALLATION

A. Examination: Verify size, material, joint types, elevation, horizontal location, and service of existing pipelines to be connected to new pipelines or new equipment.

B. Preparation: Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from interior.

C. Installation – General:
   1. Joint pipe and fittings in accordance with System Supplier's and manufacturer's instructions, unless otherwise shown or specified.
   2. Remove foreign objects prior to assembly and installation.

D. Flanged Joints:
   1. Install perpendicular to pipe centerline.
   2. HDPE flanged joints shall be joined with split back rings.
   3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
   4. Use flat-face flange when joining with flat-faced FRP flange. Use minimum 1/4" thick neoprene gaskets.

3.8 FOUL AIR FAN

A. Inspection:
   1. Examine Pads to Receive Fans for:
      a. Proper anchor bolt locations.
      b. Unevenness, irregularities and incorrect dimensions.

B. Installation:
   1. Installation shall be in accordance with the manufacturer's instructions and recommendations.
   2. Installation shall include furnishing and applying an initial supply of grease as recommended by the manufacturer.
   3. Ductwork shall be supported independently of fan.
   4. Check and align fan and motor.

C. Start-Up Adjustment and Testing:
   1. Grease bearings, if required, prior to starting fans.
   2. Check for proper rotation.
   3. Adjust fans for proper air flow.
   4. Leave fans in working order.

D. Cleaning:
   1. Clean dirt and marks and other debris from exterior of fans.
   2. Remove debris and waste material resulting from installation.

3.9 EMERGENCY MOBILE ODOR CONTROL POWER RECEPTICLE INSTALLATION

A. Install power receptacle at location as shown on the Contract Drawings in non-hazardous locations. Where not indicated on the Contract Drawings, install receptacle on equipment rack at +36" above finished grade near the permanent odor control fan, but outside of the hazardous location.

B. Provide 480-volt, 15 amp, 3 phase circuit to power receptacle.

3.10 TESTING AND STARTUP

A. Test Procedures: Test times and detailed test procedures shall be submitted for approval prior to testing period. In the event hydrogen sulfide levels are below anticipated levels, the CONTRACTOR shall provide verifiable test data demonstrating system can remove design concentration levels.

B. Performance Testing:
   1. General:
      a. To demonstrate that the biofilter system furnished is installed and performs in accordance with the provisions of these Specifications. The System Supplier shall conduct a four (4) hour performance test in accordance with an approved testing protocol. The performance test shall not commence until a test plan has been reviewed and approved by OWNER and ENGINEER, and CONTRACTOR's functional testing has been completed.
      b. Adjust odor control fans, dampers pumps, controllers and control panel components for proper operating conditions in accordance with the flow rates specified herein. The air flow to each odor control device shall be balanced.
      c. The System Supplier shall provide, install, and maintain, if required, all temporary metering or analytical equipment necessary to measure the performance parameters.
      d. The System Supplier shall inform the ENGINEER at least 14 days prior to the start of any performance testing. The ENGINEER shall have the right to observe, sample, and make any parallel determinations during the performance test.
      e. Within 10 days after the conclusion of the test period, the System Supplier shall submit a Performance Test Report, including all laboratory and field test data, stating the conclusions of the test with regard to the performance criteria.
      f. The System Supplier shall obtain a third-party provider to conduct fence line testing to demonstrate compliance with Maricopa County Air Pollution Control Regulations.
   2. Test Conditions:
      a. Prior to commencing performance testing, the biofilter shall be fully functional and receive odorous air from the facility for a minimum of 14 consecutive days.

b. Prior to commencing performance testing, CONTRACTOR's functional testing, adjusting, and balancing shall be completed and approved.
c. The actual performance testing day shall be chosen to limit weather interference.

3. Sampling and Data Measurement: During the performance test period, at a minimum, the following data and measurements shall be taken at the frequency indicated:
   a. Fan airflow rate: At start-up.
   b. Fan discharge pressure in inches of WC: At start-up.
   c. Unit airflows (cfm/ft2) shall be taken at four (4) locations across the biofilter; two corners and two equally spaced locations in the interior of the bed. These measurements shall be taken before gas sampling.
   d. Hydrogen sulfide concentrations (ppb) at the inlet to the biofilter: Every hour.
   e. Hydrogen sulfide concentrations (ppb) at two locations on the biofilter bed using a flux chamber: Every hour. The results will then be calculated by:
      1) Percent Removal = (Average Inlet – Average Outlet)/Average Inlet
         Note: Percent Removal only applies when the biofilter inlet sample's concentrations of hydrogen sulfide are greater than 10 ppmv. For concentrations less than 10 ppmv, all Average Biofilter Outlet samples must be less than 100 ppbv to meet performance verification requirements.
   f. A photographic record of the sampling technique and bed sampling location will be completed for each type of sampling.
   g. Sampling Log: A sampling log shall be maintained that will include:
      1) A photograph or hand-drawn map showing the approximate locations of all bed sampling locations.
      2) Date, time, location, sampler, and results of each sample.
      3) A description of each photograph taken.
      4) Weather conditions for the sampling day.
      5) A description of any exceptions from the sampling plan.
   h. Hydrogen Sulfide Sampling: Hydrogen sulfide sampling shall be completed using a newly calibrated Jerome Analyzer with a detection limit of 1 ppbv. The analyzer shall be operated in compliance with manufacturer's instructions. A copy of the instructions and last calibration date shall be submitted with the final report. The results of the hydrogen sulfide sampling shall be recorded in the sampling log.

4. Results: A description of the performance tests shall be submitted. The hydrogen sulfide compound removal efficiency shall be as specified in the design and performance requirements. Should the biofilter performance not meet any of the specified requirements, the system shall have failed the performance tests. The CONTRACTOR shall make any additions or modifications to the biofilter system as may be necessary, at no additional cost to the OWNER, and the performance tests for the system shall be repeated in its entirety.

C. Start-up: The services of a System Supplier representative shall be provided as specified to insure proper installation and start-up of the biofilter system.
   1. A representative for the System Supplier specified herein shall be present at the jobsite for the minimum person-days listed for the services hereinunder, travel time excluded:
      a. Three person-days for installation assistance, inspection, and certification of the installation. Provide certificate.
      b. Two person-days for the functional testing, performance testing, and operator training.

D. Alarms and Monitoring Equipment: The Contractor shall test all biofilter alarm and monitoring equipment to verify the equipment is operational and functioning in accordance with Contract Documents and properly integrated into the facility control system.

E. Maricopa County Emissions Permit Compliance:
   1. The biofilter testing methods are specified in the appendices to 40 CFR Part 60 and the MCAQD Rules and Regulations (Rules) which shall include fence line testing to demonstrate compliance with Maricopa County Rule 320, Section 304 Limitations-Hydrogen Sulfide.
   2. CONTRACTOR shall provide a fence line testing survey conforming to the Maricopa County requirements from Emissions Consultant and submit results to the OWNER and ENGINEER demonstrating compliance with the fence line testing requirement of this paragraph.
   3. The testing shall confirm the odor control biofilter has achieved a minimum of 99.0 percent hydrogen sulfide removal. The testing will be conducted as specified herein and will be witnessed by the Maricopa County Air Quality Department (MCAQD). A minimum 30-day advance notice of testing is usually required by the County in order to schedule their personnel. At least 60 days prior to biofilter testing, submit six copies of detailed testing protocol for review by the ENGINEER. CONTRACTOR shall address ENGINEER's comments. After the document has been corrected by CONTRACTOR according to ENGINEER's comments, CONTRACTOR and ENGINEER will meet with the County and will review the protocol as requested by the County.
   4. Provide the services of an independent professional Third-Party consultant (Emissions Consultant) experienced in testing Odor Control System emission air quality for compliance testing for the requirements of MCAQD. The Emissions Consultant shall have a minimum of five (5) years of odor control experience in emissions air quality testing in Maricopa County, Arizona. Submit the Emission's Consultant's statement of qualifications and experience to ENGINEER for approval.
   5. The Emissions Consultant shall perform all required testing and prepare a final report to demonstrate that the Odor Control System performs to meet the emissions requirements established by MCAQD.
   6. The Emissions Consultant shall be responsible for all testing procedures, to furnish, install, and operate and maintain all testing and recording equipment,

instruments, and controls and to perform on-site calibration of all testing equipment. The Emissions Consultant shall prepare the protocol for a testing plan, secure testing plan approval from MCAQD, provide written notice of the testing schedule to MCAQD at least 30 days prior to initiating testing, conduct all tests (allowing the ENGINEER, OWNER, and Maricopa County the option to witness the testing) and prepare a test report of the results. In the event that the Odor Control System, as constructed, does not meet the specified performance criteria of Maricopa County, CONTRACTOR shall make the required adjustments to the Odor Control System to bring the system into compliance. The Emissions Consultant shall retest the system as often as necessary to meet specified performance requirements.

7. CONTRACTOR shall provide a final report suitable for submittal to MCAQD.

PART 4 – WARRANTY

A. CONTRACTOR's System Supplier shall guarantee that the biofilter system will perform as described in these Specifications. The System Supplier shall warrant centrifugal fan, biofilter, and sprinkler system, to be free from defects in materials or workmanship for a period one (1) year after installation. The System Supplier shall warrant the biofilter media for a period of ten (10) years after start of initial operation. The media shall be capable of meeting the minimum criteria outlined in this specification during the warranty period. The System Supplier shall repair or provide replacement for any defective components under this warranty.

B. CONTRACTOR shall submit a warranty certificate from the System Supplier to OWNER and ENGINEER.

+ + END OF SECTION + +

SECTION 15050

PIPING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section specifies systems of process piping and general requirements for piping systems. Detailed Specifications for the components listed on the Piping System Specification Sheets are found in the applicable Sections of Division 15, Mechanical. This Section shall be used in conjunction with those Sections.
   2. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish, install and test all piping, fittings and specials. The Work includes, but is not limited to, the following:
      a. All types and sizes of piping, except those specified under other Sections.
      b. Piping beneath, embedded or within structures.
      c. Supports, restraints and thrust blocks.
      d. Pipe encasements.
      e. Work on or affecting existing piping.
      f. Testing.
      g. Cleaning and disinfecting.
      h. Installation of all jointing and gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods and all other Work required to complete the piping installation.
         1) Gasket materials shall comply with National Sanitation Foundation (NSF-61) and Arizona Administration Code requirements as stated in Specification Section 01420 – References.
      i. Incorporation of valves, meters and special items shown on the Drawings or specified into the piping systems as required and as specified in the appropriate Division 15, Mechanical, Sections.
      j. Unless otherwise specifically shown on the Drawings, specified, or included under other Sections, all buried piping Work required begins at the outside face of structures or structure foundations and extending away from structure.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work that is related to this Section.

C. Definitions:
   1. Pressure terms used in this Section and elsewhere in Division 15, Mechanical, are defined as follows:

a. Maximum: The greatest continuous pressure at which piping system operates.
b. Test: The hydrostatic pressure used to determine system acceptance.

1.2 QUALITY ASSURANCE

A. Conform to all applicable requirements of Parts 600 and 700 of the Uniform Standard specifications for Public Work Construction by the Maricopa Association of Governments (MAG). If there is a conflict between MAG Standard specifications and these Specifications, the Provisions of these Specifications shall govern.

B. Requirements of Regulatory Agencies:
1. Comply with requirements of NFPA Standard No. 24 for "Outside Protection" where applicable to water pipe systems used for fire protection.
2. Comply with applicable requirements of NFPA Standard No. 14 for "Standpipe and Hose Systems" used for fire protection.
3. Comply with requirements of UL, FM and other jurisdictional authorities, where applicable.
4. Refer to the General and Supplementary Conditions regarding permit requirements for this Work.
5. Comply with requirements of Phoenix Construction Code.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. AASHTO M36/M36M, Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts and Underdrains.
2. ANSI A13.1, Scheme for the Identification of Piping Systems.
3. ANSI B1.20.1, Pipe Threads, General Purpose (Inch).
4. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800.
5. ANSI B16.3, Malleable Iron Threaded Fittings Class 150 and 300.
6. ANSI B16.5, Pipe Flanges and Flanged Fittings.
7. ANSI B16.9, Factory-Made Wrought Steel Buttwelding Fittings.
8. ANSI B16.11, Forged Steel Fittings, Socket Welding and Threaded.
9. ANSI B16.12, Cast Iron Threaded Drainage Fittings.
10. ANSI B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
11. ANSI B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
12. ANSI B31.1, Power Piping.
13. ANSI B31.3, Chemical Plant and Petroleum Refinery Piping.
14. ASME SECTION IX, Boiler and Pressure Vessel Code; Welding and Brazing Qualifications.
15. ASTM A 47, Specification for Ferritic Malleable Iron Castings.
16. ASTM A 53, Specification for Pipe, Steel, Black and Hot Dipped, Zinc-Coated Welded and Seamless.

17. ASTM A 74, Specification for Cast Iron Soil Pipe and Fittings.
18. ASTM A 105/A105M, Specification for Carbon Steel Forgings for Piping Components.
19. ASTM A 106, Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
20. ASTM A 126, Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
21. ASTM A 197, Specification for Cupola Malleable Iron.
22. ASTM A 234/A234M, Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
23. ASTM A 312/A312M, Specification for Seamless and Welded Austenitic Stainless Steel Pipe.
24. ASTM A 403/A403M, Specification for Wrought Austenitic Stainless Steel Piping Fittings.
25. ASTM A 536, Specification for Ductile Iron Castings.
26. ASTM A 570/A570M, Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.
27. ASTM B 88, Specification for Seamless Copper Water Tube.
28. ASTM C 76, Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
29. ASTM C 296, Specification for Asbestos-Cement Pressure Pipe.
30. ASTM C 443-REV A, Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
31. ASTM C 564, Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
32. ASTM D 1248, Specification for Polyethylene Plastics Molding and Extrusion Materials.
33. ASTM D 1784, Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
34. ASTM D 2241, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR).
35. ASTM D 2513, Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
36. ASTM D 2665, Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
37. ASTM D 2996, Specification for Filament-Wound Reinforced Thermosetting Resin Pipe.
38. ASTM D 3034, Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
39. ASTM D 3261, Specification for Butt Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
40. ASTM D 3262, Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe.
41. ASTM D 4174, Practice for Cleaning, Flushing, and Purification of Petroleum Fluid Hydraulic Systems.

42. ASTM D 4101, Specification for Propylene Plastic Injection and Extrusion Materials.
43. ASTM F 441, Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
44. AWWA C105, Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids.
45. AWWA C110, Ductile-Iron and Gray-Iron Fittings, 3 Inch Through 48 Inch, for Water and Other Liquids.
46. AWWA C111, Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
47. AWWA C115, Flanged Ductile-Iron and Gray-Iron Pipe with Threaded Flanges.
48. AWWA C151, Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
49. AWWA C200, Steel Water Pipe 6 Inches and Larger.
50. AWWA C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe--4 In. and Larger--Shop Applied.
51. AWWA C206, Field Welding of Steel Water Pipe.
52. AWWA C207, Steel Pipe Flanges for Waterworks Services--Sizes 4 In. through 144 In.
53. AWWA C208, Dimensions for Fabricated Steel Water Pipe Fittings.
54. AWWA C209, Cold-Applied Tape Coating for special sections, Connections, and Fittings for Steel Water Pipelines.
55. AWWA C210, Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipe.
56. AWWA C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
57. AWWA C301, Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids.
58. AWWA C303, Reinforced Concrete Pressure Pipe-Steel Cylinder Type, Pretensioned, for Water and Other Liquids.
59. AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances.
60. AWWA C651, Disinfecting Water Mains.
61. AWWA C900, Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches, for Water.
62. AWWA M11, Steel Pipe-A Guide for Design and Installation.
63. CISPI 301, specification Data for Hubless Cast Iron Sanitary System with No-Hub Pipe and Fittings.
64. FEDSPEC L-C-530B(1), Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy.
65. MIL-H-13528B, Hydrochloric Acid, Inhibited, Rust Removing.
66. MIL-STD-810C, Environmental Test Methods.
67. SAE J1227, Assessing Cleanliness of Hydraulic Fluid Power Components and Systems.
68. Phoenix Plumbing Code.
69. Phoenix Construction Code.

70. National Sanitation Foundation (NSF-61) and Arizona Administration Code requirements as stated in Specification Section 01420 – References.

D. Fitting and Coupling Compatibility:
   1. To assure uniformity and compatibility of piping components, fittings and couplings for grooved end piping systems shall be furnished by the same manufacturers.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Detailed drawings and data on pipe, fittings, gaskets and appurtenances. Submit these with Shop Drawings required under Section 15050, Piping Systems, Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.

B. Certificates: Submit certificates of compliance with Referenced Standards.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. General:
   1. Deliver materials to the site to ensure uninterrupted progress of the Work.
   2. Handle all pipe, fittings, specials and accessories carefully with approved handling devices. Do not drop or roll material off trucks. Do not otherwise drop, roll or skid piping.
   3. Store pipes and fittings on heavy wood blocking or platforms so they are not in contact with the ground.
   4. Unload pipe, fittings and specials opposite to or as close to the place where they are to be installed as is practical to avoid unnecessary handling. Keep pipe interiors completely free from dirt and foreign matter.
   5. Inspect delivered pipe for cracked, gouged, chipped, dented or other damaged material and immediately remove defective pipe from site.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Unless otherwise specified, piping materials, including pipe, gaskets, fittings, connection and joint assemblies, linings and coatings, shall be selected from those listed on the Piping System Specification Sheets. Piping materials shall conform to detailed Specifications for each type of pipe and piping appurtenances specified in the applicable Sections of Division 15, Mechanical.
B. Materials or products which can contact drinking water as part of a water treatment process or water supply system including but not limited to pipe, gaskets, fittings, linings, coatings, etc., must comply with National Sanitation Foundation (NSF-

61) and Arizona Administration Code requirements as stated in Specification Section 01420 – References.

2.2 PIPING IDENTIFICATION

A. Marking Piping:
   1. Clearly mark each piece of pipe or fitting with a designation conforming to that shown on the approved Shop Drawings.
   2. Cast or paint material, type and pressure designation on each piece of pipe or fitting 4-inches in diameter and larger.
   3. Pipe and fittings smaller than 4-inches in diameter shall be clearly marked by manufacturer as to material, type and rating.
   4. Markers bearing the legends on the background colors specified in Section 09900, Painting, and shall be provided in the following letter heights:

Outside Pipe Diameter,[a] (inches)	Letter Height, (inches)
Less than 1-1/2	1/2
1-1/2 through 3	1-1/8
Greater than 3	2-1/4

[a] Outside pipe diameter shall include insulation and jacketing.

In addition, pipe markers shall include uni- and bi-directional arrows in the same sizes as the legend. Legends and arrows shall be white on blue or red backgrounds and black on other specified backgrounds.

B. Plastic Tracer Tape: Tracer tape shall be 6-inches wide, colored the same as the background colors as specified in Section 09900, Painting, and made of inert plastic material suitable for direct burial. Tape shall be capable of stretching to twice its original length and shall be as manufactured by Allen Systems, W. H. Brady Co., Seton Name Plate Corporation, Marking Services Inc., or equal.

Two messages shall be printed on the tape. The first message shall read "CAUTION CAUTION CAUTION _____ PIPE BURIED BELOW" with bold letters approximately 2-inches high. The blank shall be filled with the particular system fluid such as chlorine, oxygen or sulfur dioxide. The second message shall read, "CALL _____" with letters approximately 3/4-inch high. The blank shall be filled in with the plant telephone number provided by OWNER. Both messages shall be printed at maximum intervals of two feet.

C. Magnetic Tracer Tape: Polyethylene magnetic tracer tape shall be as manufactured by Allen Systems, W.H. Brady Co., Seton Name Plate Corporation, Marking Services, Inc., or equal. Tape shall be acid and alkali-resistant, 3-inches wide, 0.005-inch thick, and have 1500-psi strength and 140 percent elongation value. The tape shall be colored the same as the background colors as specified in Section

09900, Painting, and shall be inscribed with the word "CAUTION – PIPE BURIED BELOW" and the name of the piping system.

2.3 VALVES

A. Valves of the same size and service shall be provided by a single valve manufacturer. Packing shall be non-asbestos material. Actual length of valves shall be within 1/16-inch (plus or minus) of the manufacturer's specified length. Flanges shall meet the requirement of ANSI B16.5. Push-on and mechanical joints shall meet the requirements of AWWA C111 and conform to the requirements of Section 15051, Buried Piping Installation.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Location:
   1. Piping shall be provided as specified, except for adjustments to avoid architectural and structural features and shall be coordinated with electrical construction.

B. Piping Sizes:
   1. Where the size of piping is not shown on the Drawings or specified, provide piping of the sizes required by UPC. Unless specified otherwise, small piping (less than 1-inch in diameter) required for services not described by UPC shall be 1/2-inch.

C. Pipe Support, Anchorage and Seismic Bracing:
   1. Piping shall be supported by anchor brackets, guides, saddles or hangers. Acceptable types of supports, guides, saddles, hangers and structure attachments for general pipe support, expansion/contraction and for seismic bracing, as well as anchorage details, are shown on the Drawings. Minimum spacing shall be as specified for supports and for seismic bracing. Where a specific type of support or anchorage is shown on the Drawings, then only that type shall be used there. Piping shall be vertically supported by anchor brackets, guides, saddles or hangers and shall be seismically braced where indicated to resist lateral load. Supports shall be provided on each run at each change of direction. Pipe supports, components and hardware shall be Type 304L stainless steel. Unless otherwise specified, existing pipes and supports shall not be used to support new piping.
   2. Pipe shall be supported, alignment and installed in such a way so as not to impose undue stress/forces to couplings, connections, supports, valves, equipment, and instruments.

D. Thrust Restraint:

1. General: All plugs, caps, tees and bends in buried pressure piping systems shall be anchored by means of reaction backing or restrained joints as specified.
2. Restrained Pipe Joints: Pipe joints shall be restrained by means suitable to the type of pipe being installed.
   a. Ductile-iron push on joints and mechanical joints shall be restrained utilizing a proprietary restrained joint system such as:
      1) American Loc-Ring or Flex-Ring
      2) Clow Super-Lock Joint
      3) EBBA Iron Sales Inc. Megalug
      4) U.S. Pipe TR Flex Joint
      5) Or Equal
   b. Steel pipe shall have welded joints, flanged joints, or flexible or mechanical coupling connectors as specified in Section 15102, Steel Pipe. Tie rods connected to ears welded to the steel pipe shall be provided for restraint at all flexible coupling connectors.
   c. Thermoplastic and copper piping shall generally be installed with soldered, solvent weld, threaded, flanged, or similar type joints. Where push-on type or other non-restrained joints are provided, provide tie rods or other suitable joint restraint system for these joints, subject to the approval of ENGINEER.
   d. Harnessed lengths for pipe shall be determined by the pipe manufacturer in accordance with the formula in Section 15051, Buried Piping Installation, for determination of harnessed lengths.
   e. Restrain ductile iron pipe connected to flexible couplings or flanged coupling adapters by harnessing across the coupling or adapter using tie rods or extended bolts connecting between flanges.
3. Concrete Thrust Blocks and Anchor Blocks:
   a. Thrust blocks and anchors shall be constructed of Class B concrete.
   b. Blocks shall be placed against undisturbed soil and sized as shown on the Drawings or as directed by the ENGINEER. Concrete shall be placed so that pipe joints and fitting joints will be accessible for repair.

E. Manufacturer's Installation Specialist:
1. Provide the services of a competent installation specialist of the pipe manufacturer when pipe laying begins, if CONTRACTOR is not experienced in laying and jointing a particular type of pipe.
2. Retain installation specialist at the site for a minimum of two days or until competency of the pipe laying crew has been satisfactorily demonstrated.

F. Bedding and Backfill:
1. Bedding and backfill for buried piping shall conform to the requirements of Section 15051, Buried Piping Installation.

3.2 PIPING IDENTIFICATION

A. Pipe Coding:

1. After application of the specified coating and insulation systems, exposed piping, interior and exterior, and piping in ceiling spaces, pipe trenches, pipe chases and valve boxes shall be identified with painted bonding and lettering as specified in Article 2.2, above. Legend markers and directional arrows shall be located at each side of walls, floors and ceilings, at one side of each piece of equipment, at piping intersections, and at approximately 25-foot centers.

B. Plastic Tracer Tape:
1. A single line of tape as specified in Paragraph 2.2.B., above, shall be provided 2.5 feet above the centerline of buried ferrous pipe. For pipelines buried eight feet or greater below finished grade, provide a second line of tape 12-inches below finished grade, above and parallel to each buried pipe. Tape shall be spread flat with message side up before backfilling.

C. Magnetic Tracer Tape: Polyethylene magnetic tracer tape shall be buried 12 to 18-inches below finished grade and shall be above and parallel to buried non-ferrous, plastic and reinforced thermosetting resin pipelines. For pipelines buried eight feet or greater below finished grade, provide a second line of tape 2.5 feet above and parallel to each buried pipe.

3.3 VALVE IDENTIFICATION

A. Provide CMMS Tags for valves as specified under Section 01630, Computerized Maintenance Management System Tags, and as shown on the drawings.

3.4 WORK AFFECTING EXISTING PIPING

A. Location of Existing Piping:
1. Locations of existing piping shown on the Drawings should be considered approximate.
2. Determine the true locations of existing piping to which connections are to be made, and locations of other facilities which could be disturbed during earthwork operations, or which may be affected by CONTRACTOR'S Work already installed.
3. Conform to applicable requirements of Division 1, General Requirements, pertaining to cutting and patching and connections to existing facilities.

B. Taking Existing Pipelines Out of Service:
1. Do not take pipelines out of service, unless specifically listed below, or approved by ENGINEER.
a. Refer to Section 01143, Coordination with OWNER'S Operations.
2. Notify ENGINEER at least 48 hours prior to taking pipeline out of service.

C. Work on Existing Pipelines:
1. Cut or tap pipes as shown on the Drawings or required, with machines specifically designed for this Work.

2. Install temporary plugs to prevent entry of mud, dirt, water and debris.
3. Provide all necessary adapters, fittings, pipe and appurtenances required to complete the Work.
4. Existing pipelines which are cut and abandoned shall be adequately capped or filled with grout.

3.5 TESTING

A. General:
1. Upon completion of piping, but prior to application of insulation on exposed piping, test the piping systems. Pressures, media and test durations shall be as specified in Article 3.7, below. Equipment which may be damaged by the specified test conditions shall be isolated. Testing shall be performed using calibrated test gages and calibrated volumetric measuring equipment to determine leakage rates. Each test gage shall be selected so that the specified test pressure falls within the upper half of the gage's range. Unless otherwise specified, notify the ENGINEER 24 hours prior to each test.
2. Unless otherwise specified, testing, as specified herein, shall include existing piping systems which connect with new piping systems. Existing pipe shall be tested to the nearest existing valve. Any piping which fails the test shall be repaired. Repair of existing piping will be considered and paid for as extra work.
3. Where testing existing chlorine and sulfur dioxide systems to the nearest isolation valve, provide a tee in the line adjacent to the valve. The branch outlet on the tee shall be valved and used for cleaning, pressure testing, draining, and drying the line. Unless otherwise indicated, the existing chlorine or sulfur dioxide system shall not be shut down during testing or connecting the tee and valve. Prior to placing the line in service, the valve on the branch outlet shall be plugged or sealed with a blind flange or threaded plug. Responsibility belongs to CONTRACTOR for all damage to the existing system as a result of this work.

B. Gas, Air, and Vapor Systems:
1. Test steam lines hydrostatically in accordance with the ASME procedure for testing pressure piping.
2. Testing medium and procedures for chlorine systems are specified in Paragraph 3.5.D., below.
3. Unless otherwise specified, the testing medium for other gas, air and vapor systems shall be as follows:

Pipeline size	Specified Test Pressure	Testing medium
2-inch and smaller	75 psi or less	Air or water
2-inch and smaller	Greater than 75 psi	Water
Greater than 2-inch	3 psi or less	Air or water
Greater than 2-inch	Greater than 3 psi	Water

4. Potable Water Systems Additional Requirements:

   a. The CONTRACTOR shall provide all vents, piping, plugs, bulkheads, valves, bracing, blocking, pump, including measuring device and all other equipment necessary for making the tests, except pressure gages.
   b. The pipe shall be tested between each valve or between a valve and the closed end of the pipe.
   c. Pipe test section shall be limited to 1/2 linear mile, or less, unless otherwise approved in writing by the Engineer. Testing cannot be done against an existing valve. The new pipeline must be separated from any potable system in such a way to prevent any potential for cross-contamination between the existing potable water system and the new pipeline.
   d. The test shall be made after the backfilling is completed or compacted, regardless of the compaction method.
   e. All connections, blow-offs, hydrants and valves shall be tested with the main, where practical.
   f. The test section shall be slowly filled with potable water and all air shall be vented from the line. The rate of filling shall be as approved by the Superintendent of Water Distribution, with at least 24-hour notice required before filling is scheduled.

C. Liquid Systems:
   1. Leakage shall be zero at the specified test pressure throughout the specified duration for the following systems: Exposed piping, buried piping, and buried or exposed piping carrying liquid chemicals. Unless otherwise specified, leakage from other buried liquid piping systems shall be less than 0.02 gallon per hour per inch diameter per 100 feet of buried piping.

E. Hydraulic and Lube Oil Systems:
   1. Upon completion of cleaning, all field connections shall be completed and the system tested at the specified pressure. Pressure loss shall be zero for the specified test period. For fluid power systems, the manufacturer shall supervise the installation and testing of all system components including all field piping.

F. Drains:
   1. Drain systems, other than pumped drain systems, shall be tested in accordance with Phoenix Plumbing Code.

3.6 CLEANING AND FLUSHING

A. General:
   1. Piping systems shall be cleaned following completion of testing and prior to connection to operating, control, and regulating or instrumentation equipment. At CONTRACTOR'S option, may clean and test sections of the buried or exposed piping systems. Use of this procedure; however, will not waive the

requirement for a full pressure test of the completed system. Unless specified otherwise, piping 24-inches in diameter and smaller shall first be cleaned by pulling a tightly fitting cleaning ball or swab through the system. Piping larger than 24-inches in diameter may be cleaned manually or with a cleaning ball or swab.

B. Temporary Screens:
1. Upon completion of the cleaning, connect the piping systems to related process equipment. Temporary screens, provided with locator tabs which remain visible from the outside when the screens are in place, shall be inserted in pipelines at the suction of pumps and compressors in accordance with the following table:

Equipment Suction Or Piping Size, (Inches)	Maximum Screen Opening, (Inches)
0 to 1	1/16
1-1/4 to 3	1/4
3-1/2 to 6	1/2
Over 6	1

2. Maintain the screens during testing, initial start-up, and initial operating phases of the commissioning process. In special cases, screens may be removed as required for performance tests. Remove the temporary screens and make the final piping connections after the screens have remained clean for at least 24 consecutive hours of operation. Systems handling solids are exempted.

C. Gas and Air Systems:
1. Unless otherwise specified, gas and air system piping 6-inches in diameter and smaller shall be blown out, using air or the testing medium specified. Piping larger than 6-inches shall be cleaned by having a swab or "pig" drawn through the separate reaches of pipe. After connection to the equipment, it shall then be blown out using the equipment. Upon completion of cleaning, the piping shall be drained and dried with an airstream. Propane systems shall be purged with nitrogen and a nitrogen pad maintained at 10 psi until put in service. Sludge gas systems shall be purged with nitrogen and a nitrogen pad maintained at 3 psi until put in service.

D. Liquid Systems:
1. After completion of cleaning, liquid systems, unless otherwise specified, shall be flushed with clean water. With temporary screens in place, the liquid shall be circulated through the piping system using connected equipment for a minimum period of 15 minutes and until no debris is collected on the screens.

E. Hydraulic and Fluid Power Oil Systems:
1. Upon completion of all field piping, but before connection to any control components, hydraulic and fluid power oil systems shall be flushed and cleaned

Flushing oil and procedures shall comply with ASTM D 4174. System shall be cleaned such that internal contamination of system, when tested using procedures specified in SAE J1227, Section 2.3, shall not exceed the Allowable Cleanliness Level (ACL). Unless otherwise specified, the ACL value shall be established by the manufacturer of the major hydraulic system components in accordance with SAE J1227, Section 9.1. System supplier shall provide Certificate of Compliance as required in Paragraph 1.3.B., above, that the ACL has been met.

F. Potable Water Systems:
   1. Potable water piping systems shall be flushed and disinfected in accordance with AWWA C651.

3.7 PIPING SPECIFICATION SHEET

A. General:
   1. Piping and valves for groupings of similar plant processes or types of service lines are specified on individual Piping Specification Sheets. Piping systems are grouped according to the chemical and physical properties of the fluid conveyed and/or by the temperature or pressure requirements. Each grouping of systems is identified by a piping system number. Piping systems specified on the Drawings are numerically arranged by system as shown in Table A. Table A also indicates the system number and fluid category for each service.
      a. Manual air vents shall be provided at the high points of each reach of pipeline where specified. Air vents shall consist of bronze cock and copper tubing return. Air vents shall be taken to the nearest floor with cock mounted four feet above the floor. Vents in piping systems for fluids containing solids shall be 1-inch nonlubricated eccentric plug valves fitted with quick couplers.
      b. Drains shall be piped to a sump, gutter, floor drain or other collection point with a valve mounted four feet above the floor. Drain valves shall be threaded end gate valves of the size specified or as shown on the Drawings. When drains cannot be run to collection points, they shall be routed to a point of easy access and shall have hose gate valves of the size specified.

(The remainder of this page was left blank intentionally.)

Table A - Piping Systems

Article No.	System No.	Symbol	Service Descriptions	Fluid Category
3.18	7	PW	Potable Water	Water
3.48	22 22	FA FAD	Foul Air Foul Air Duct	Foul Air Foul Air
3.50	24	SW	Sanitary Waste	Drain/Vent
3.60	32	OCD	Odor Control Drain	Drain/Vent

(The remainder of this page was left blank intentionally.)

3.18 SYSTEM - 7

Piping Symbol/Service: PW Potable Water

Test Requirements:	Medium:	Water: Refer to Paragraph 3.5.C., above.	
	Pressure:	Refer to Section 15144, Testing of Plumbing Piping Systems: 200 psig for exposed ductile iron pipe, otherwise 125 psig.	
	Duration:	60 minutes.	
Gasket Requirements:	Flange:	Refer to Section 15101, Ductile Iron Pipe. Refer to Section 15106, Thermoplastic Pipe.	
	Push-on/Mech Cpl:	Refer to Section 15101, Ductile Iron Pipe.	
Exposed Pipe/Valves:			
3-inches and smaller	Pipe:	Copper Tube:	Type K (rigid). Refer to Section 15105, Copper Pipe and Section 15141, Potable Water Piping System.
		Conn:	Solder type with threaded or flanged adapters for valves.
		Ftgs:	Refer to Section 15105, Copper Pipe.
2-inches and smaller	Valves:	Refer to Section 15141, Potable Water Piping System.	
4-inches and larger	Pipe:	Ductile Iron:	Class 53 with cement mortar lining. Refer to Section 15101, Ductile Iron Pipe.
		Conn:	Grooved mechanical pipe coupling or flanged.
		Ftgs:	Refer to Section 15101, Ductile Iron Pipe, ends and lining to match pipe.
2-1/2-inches and larger	Valves:	Butterfly:	Refer to Section 15111, Butterfly Valves, Operators and Appurtenances.
		Swing Check:	Refer to Section 15114, Check Valves and Appurtenances.

3.18 SYSTEM – 7 (Continued)
Piping Symbol/Service: PW Potable Water

Buried and Encased Pipe/Valves:

3-inches and smaller	Pipe:	Copper Tube:	Type K with polythelene tape coating. Field application of coating to all couplings. Refer to Section 15105, Copper Pipe.
		Conn:	Solder type, with threaded or flanged adapters for valves.
		Ftgs:	Refer to Section 15105, Copper Pipe.
3-inches and smaller	Valves:	Gate:	Refer to Section 15110, Gate Valves, Operators and Appurtenances, with extension stem and valve box. Coating in accordance with Section 09900, Painting.
4-inches and larger	Pipe:	Ductile Iron:	Class 53 with exterior bituminous coating. Refer to Section 15101, Ductile Iron Pipe.
		Conn:	Mechanical joint. Flanged adapters for valves.
		Ftgs:	Refer to Section 15101, Ductile Iron Pipe: Coating, lining, and ends to match pipe.
4-inches and larger	Valves:	Butterfly:	Same as exposed with extension stem and valve box. Coating in accordance with Section 09900, Painting.

Exposed Pipe/Valves:

3-inches and smaller	Pipe:	Copper Tube:	Type K (rigid). Refer to Section 15105, Copper Pipe and Section 15141, Potable Water Piping System. Insulation in accordance with Section 15082, Insulation of Piping and Equipment - HVAC and Process Air.

3.18 SYSTEM – 7 (Continued)
Piping Symbol/Service: PW Potable Water

		Conn:	Solder type with threaded or flanged adapters for valves. Insulation in accordance with Section 15082, Insulation of Piping and Equipment - HVAC and Process Air.
		Ftgs:	Refer to Section 15105, Copper Pipe. Insulation in accordance with Section 15082, Insulation of Piping and Equipment - HVAC and Process Air.
2-inches and smaller	Valves:	Refer to Section 15141, Potable Water Piping System. Insulation in accordance with Section 15082, Insulation of Piping and Equipment - HVAC and Process Air.	
4-inches and larger	Pipe:	Ductile Iron:	Class 53 with cement mortar lining. Refer to Section 15101, Ductile Iron Pipe. Insulation in accordance with Section 15082, Insulation of Piping and Equipment - HVAC and Process Air.
		Conn:	Grooved mechanical pipe coupling or flanged. Insulation in accordance with Section 15082, Insulation of Piping and Equipment - HVAC and Process Air.
		Ftgs:	Refer to Section 15101, Ductile Iron Pipe, ends and lining to match pipe. Insulation in accordance with Section 15082, Insulation of Piping and Equipment - HVAC and Process Air.
2-1/2-inches and larger	Valves:	Butterfly:	Refer to Section 15111, Butterfly Valves, Operators and Appurtenances. Insulation in accordance with Section 15082, Insulation of Piping and Equipment - HVAC and Process Air.

3.18 SYSTEM – 7 (Continued)
Piping Symbol/Service: PW Potable Water

2-1/2-inches and larger (Continued)	Valves:	Swing Check:	Refer to Section 15114, Check Valves and Appurtenances. Insulation in accordance with Section 15082, Insulation of Piping and Equipment - HVAC and Process Air.

(The remainder of this page was left blank intentionally.)

3.48 SYSTEM - 22

Piping Symbol/Service: FA Foul Air
FAD Foul Air Duct

Test Requirements:	Medium:	Air: Refer to Paragraph 3.5.B., above.	
	Pressure:	15 psig.	
	Duration:	60 minutes.	
Gasket Requirements:	Flange:	Gylon gasketing, Garlock style 3504.	
	Push-on/Mech Cpl:	N/A.	
Exposed Pipe/Valves:			
All sizes	Pipe:	FRP:	Refer to Section 13125, Odor Control System Wet Scrubber, and Section 15812, Corrosion Resistant Ductwork and Accessories.
		Conn:	Butt weld or flanged. Refer to Section 15812, Corrosion Resistant Ductwork and Accessories.
		Ftgs:	FRP to match pipe, glass filament wound reinforcing only. Refer to Section 15812, Corrosion Resistant Ductwork and Accessories.
All sizes	Valves:	FRP Dampers:	Refer to Section 15812, Corrosion Resistant Ductwork and Accessories.
Buried and Encased Pipe/Valves:			
All sizes	Pipe:	HDPE:	Refer to Section 13125, Odor Control System Wet Scrubber.
		Conn:	Flanged or plain end butt weld.
		Ftgs:	HDPE to match pipe. Refer to Section 15812, Corrosion Resistant Ductwork and Accessories.
All sizes	Valves:	Butterfly:	Same as exposed with extension stem and valve box. Coating in accordance with Section 09900, Painting.

Remarks:
1. Refer to Drawings for pipe size and valve type. Omit coating on encased pipe.

3.50 SYSTEM - 24

Piping Symbol/Service:	SW	Sanitary Waste
	STDR	Storm Drain
	V	Vent
	RD	Roof Drain
	NSD	Non-Sanitary Drain

Test Requirements:	Medium:	In accordance with Phoenix Plumbing Code.	
	Pressure:	In accordance with Phoenix Plumbing Code.	
	Duration:	In accordance with Phoenix Plumbing Code.	
Gasket Requirements:	Flange:	Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder.	
	Push-on/Mech Cpl:	Nitrile or neoprene.	
Exposed Pipe/Valves:			
1 1/2-inches and smaller	Pipe:	Steel:	Schedule 80. Refer to Section 15106, Thermoplastic Pipe.
		Conn:	Plain end, solvent weld.
		Ftgs:	Refer to Section 15106, Thermoplastic Pipe.
2-inches thru 12-inches	Pipe:	CISP:	ASTM A 74.
		Conn:	Service hub and spigot compression type or hubless cast iron sanitary system in accordance with CISPI 301.
		Ftgs:	CISP, ASTM A 74, joint options to match pipe.
14-inches and larger	Pipe:	Ductile Iron:	AWWA C151. Refer to Section 15101, Ductile Iron Pipe.
		Conn:	Flanged or mechanical.

3.50 SYSTEM – 24 (Continued)

Piping Symbol/Service:	SW	Sanitary Waste
	STDR	Storm Drain
	V	Vent
	RD	Roof Drain
	NSD	Non-Sanitary Drain

14-inches and larger (Cont'd)	Pipe:	Ftgs:	Refer to Section 15101, Ductile Iron Pipe. Ends to match pipe.

Buried and Encased Pipe/Valves:

12-inches and smaller	Pipe:	CISP:	Same as exposed.
12-inches and smaller	Valves:	N/A.	
14-inches and larger	Pipe:	Ductile Iron:	Same as exposed.
14-inches and larger	Valves:	N/A.	

Buried and Encased Pipe and Valves Beyond 5 Feet Outside Building:

8-inches and smaller	Pipe:	CPVC:	ASTM D 1784, Class 23447-B, ASTM F 441, Sch. 80. Refer to Section 15106, Thermoplastic Pipe.
		Conn:	Plain end, solvent weld.
		Ftgs:	CPVC, socket type, DWV, ASTM F 493.
8-inches and smaller	Valves:	N/A.	
10-inches and 12-inches	Pipe:	CPVC:	ASTM D 3034, SDR 35.
		Conn:	Push-on with nitrile gasket.
		Ftgs:	CPVC or IPS cast iron: Ends to match pipe.
10-inches and 12-inches	Valves:	N/A.	

3.50 SYSTEM – 24 (Continued)

Piping Symbol/Service:		
	SW	Sanitary Waste
	STDR	Storm Drain
	V	Vent
	RD	Roof Drain
	NSD	Non-Sanitary Drain

14-inches and larger	Pipe:	RCP:	Refer to Section 15104, Concrete Pipe.
		Conn:	ASTM C 443, rubber gasket type.
		Ftgs:	Concrete manhole as shown on the Drawings.
14-inches and larger	Valves:	N/A.	

Remarks:
1. Refer to Drawings for pipe size and valve type. Omit coating on encased pipe.

(The remainder of this page was left blank intentionally.)

3.60 SYSTEM - 32

Piping Symbol/Service: OCD Odor Control Drain
SBD Scrubber Blow Down

Test Requirements:	Medium:	Water: Refer to Paragraph 3.5.C., above.	
	Pressure:	OCD test at 25 psig, SBD test at 100 psig.	
	Duration:	120 minutes.	
Gasket Requirements:	Flange:	N/A.	
	Push-on/Mech Cpl:	N/A.	
Exposed Pipe/Valves:			
All sizes	Pipe:	CPVC:	Sch. 80. Refer to Section 15106, Thermoplastic Pipe.
		Conn:	Plain end, solvent weld.
		Ftgs:	Refer to Section 15106, Thermoplastic Pipe.
All sizes	Valves:	Refer to Section 15113, Thermoplastic Valves, Operators and Appurtenances.	
Buried and Encased Pipe/Valves:			
All sizes	Pipe:	CPVC:	Sch. 80. Refer to Section 15106, Thermoplastic Pipe.
		Conn:	Plain end, solvent weld same as exposed.
		Ftgs:	Refer to Section 15106, Thermoplastic Pipe.
All sizes	Valves:	N/A.	

Remarks:
1. Refer to Drawings for pipe size and valve type. Omit coating on encased pipe.

+ + END OF SECTION + +

SECTION 15051

BURIED PIPING INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown on the Drawings, specified and required to perform all excavating, backfilling, filling, grading and disposing of earth materials and to furnish, install and test all buried piping, fittings, and specials. The Work includes, but is not limited to, the following:
      a. Excavation and backfill.
      b. All temporary means required to prevent discharge of sediment to water courses from dewatering systems or erosion.
      c. All types and sizes of buried piping, except those specified under other Sections.
      d. Piping beneath structures.
      e. Restraints and thrust blocks.
      f. Pipe encasements.
      g. Work on or affecting existing piping.
      h. Testing.
      i. Cleaning and disinfecting.
      j. Installation of all jointing and gasketing materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, and all other Work required to complete the buried piping installation.
      k. Incorporation of valves, meters and special items shown on the Drawings or specified into the piping systems as required and as specified in the appropriate Division 15, Mechanical, Sections.
      l. Unless otherwise specifically shown on the Drawings, specified, or included under other Sections, all buried piping Work required, beginning at the outside face of structures or structure foundations, and extending away from structure.
   2. No classification of excavated materials will be made. Excavation includes all materials regardless of type, character, composition, moisture, or condition thereof.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work that is related to this Section.

2. Section 15051, Buried Piping Installation, specifies the installation of all buried piping materials specified in Sections of Division 15, Mechanical. Coordinate with all applicable Sections.

1.2 QUALITY ASSURANCE

A. Conform to all requirements of Section 601 of the Uniform Standard Specifications for Public Work Construction by the Maricopa Association of Governments (MAG), as supplemented by the City of Phoenix. If there is a conflict between MAG Standard Specifications and these Specifications, the Provisions of these Specifications shall govern.

B. Testing Services:
   1. General: Testing of materials, testing for moisture content during placement and compaction of fill materials, and of compaction requirements for compliance with technical requirements of the Specifications shall be performed by a testing laboratory as designated in Section 01451, Testing Laboratory Services Furnished by OWNER, and Section 01452, Testing Laboratory Services Furnished by CONTRACTOR.
   2. OWNER'S Testing Agency Scope:
      a. Test CONTRACTOR'S proposed materials in the laboratory and/or field for compliance with the Specifications.
      b. Perform field moisture content and density tests to assure that the specified compaction of backfill materials has been obtained.
      c. Report all test results to the ENGINEER and CONTRACTOR.
   3. Authority and Duties of OWNER'S Testing Agency: Technicians representing the testing laboratory shall inspect the materials in the field and perform tests and shall report their findings to the ENGINEER and CONTRACTOR. When the materials furnished or Work performed fails to fulfill Specification requirements, the technician will direct the attention of the ENGINEER and CONTRACTOR to such failure.
      a. The technician shall not act as foreman or perform other duties for CONTRACTOR. Work will be checked as it progresses, but failure to detect any defective Work or materials shall not in any way prevent later rejection when such defect is not discovered, nor shall it obligate the ENGINEER for final acceptance. Technicians are not authorized to revoke, alter, relax, enlarge, or release any requirements of the Contract Documents, nor to approve or accept any portion of the Work.
   4. Responsibilities and Duties of CONTRACTOR:
      a. The use of testing services shall in no way relieve CONTRACTOR of the responsibility to furnish materials and construction in full compliance with the Contract Documents.
      b. To facilitate testing services:

1) Secure and deliver to the ENGINEER or to the testing agency, without cost, preliminary representative samples of the materials he proposes to use, and which are required to be tested.
2) Furnish such casual labor as is necessary to obtain and handle samples at the Work site or at other sources of material.
3) Advise the OWNER'S testing agency sufficiently in advance of operations to allow for completion of quality tests and for the assignment of personnel.

c. CONTRACTOR'S Testing Service shall inspect and approve subgrades and fill layers before further construction Work is performed thereon.
d. Responsibility belongs to CONTRACTOR to accomplish the specified compaction for backfill and to control the operations by confirmation tests to verify and confirm compliance, and is complying at all times, with the requirements of these Specifications concerning compaction, control, and testing.
e. The frequency of CONTRACTOR'S confirmation tests shall be not less than as follows; each test location for trenches shall include tests for each layer, type, or class of backfill from bedding to finish grade.
   1) Trenches for buried pipe:
      a) In open fields: 10 locations every 1,000 linear feet.
      b) Along dirt or gravel roads or off traveled right-of-way: 5 locations every 500 linear feet.

f. Copies of the test reports shall be submitted promptly to the ENGINEER. CONTRACTOR'S tests shall be performed by a soils testing laboratory acceptable to the ENGINEER.
g. Demonstrate the adequacy of compaction equipment and procedures before exceeding any of the following amounts of earthwork quantities:
   1) 200 linear feet of trench backfill.
h. Until the specified degree of compaction on the previously specified amounts of earthwork is achieved, no additional earthwork of the same kind shall be performed.
i. Periodic compliance tests will be made by the ENGINEER to verify that compaction is conforming to the requirements previously specified, at no cost to CONTRACTOR. Remove the overburden above the level at which the ENGINEER wishes to test and shall backfill and recompact the excavation after the test is complete.
j. If compaction fails to conform to the specified requirements, remove and replace the backfill at proper density or shall bring the density up to specified level by other means acceptable to the ENGINEER. Subsequent tests required to confirm and verify that the reconstructed backfill has been brought up to specified density shall be paid by CONTRACTOR. CONTRACTOR'S confirmation tests shall be performed in a manner acceptable to the ENGINEER. Frequency of confirmation tests for

remedial Work shall be double that amount specified for initial confirmation tests.

C. Requirements of Regulatory Agencies:
   1. Comply with requirements of NFPA Standard No. 24 for "Outside Protection" where applicable to water pipe systems used for fire protection.
   2. Comply with requirements of UL, FM, and other jurisdictional authorities, where applicable.
   3. Refer to the General and Supplementary Conditions regarding permit requirements for this Project.
   4. Comply with requirements of Phoenix Building Code.
   5. Obtain all necessary permits for Work in roads, rights-of-way, railroads, etc. Also, obtain permits as required by local, state and federal agencies for discharging water from excavations.
   6. Perform excavation Work in compliance with applicable requirements of governing authorities having jurisdiction.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. Excavation and Backfill:
      a. ASTM D 422, Standard Test Method for Particle-Size Analysis of Soils.
      b. ASTM D 427, Test Method for Shrinkage Factors of Soils by the Mercury Method.
      c. ASTM D 698, Standard Test Method for Laboratory Compaction Characteristics of Soil.
      d. ASTM D 1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
      e. ASTM D 2166, Standard Test Method for Unconfined Compression Strength of Cohesive Soil.
      f. ASTM D 2922, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
      g. ASTM D 3017, Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
      h. ASTM D 4318, Method of Test for Liquid Limit of Soils.
      i. AISC Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings.
      j. OSHA Standard, Title 29, Code of Federal Regulations, Part 1926, Section .650 (Subpart P - Excavations).
      k. AASHTO T-99, The Moisture-Density Relations of Soils Using a (2.5 kg) 5.5 lb Rammer and a (305 mm) 12 in. Drop {Proctor}
      l. ASSHTO-T-191, Density of Soil in Place by the Sand Cone Method.
      m. Uniform Standard Specifications for Public Work Construction by the Maricopa Association of Governments (MAG), as supplemented by the City of Phoenix, Section 601.
   2. Piping Materials and Installation:

a. ASTM D 2321, Practice for Underground Installation of Flexible Thermoplastic Pipe.
b. ASTM D 2774, Practice for Underground Installation of Thermoplastic Pressure Piping.
c. AWWA C105, Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids.
d. AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
e. AWWA C206, Field Welding of Steel Water Pipe.
f. AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances.
g. AWWA C606, Grooved and Shouldered Joints.
h. AWWA C651, Disinfecting Water Mains.
i. AWWA M9, Concrete Pressure Pipe.
j. AWWA M11, Steel Pipe - A Guide for Design and Installation.
k. AWWA M23, PVC - Design and Installation.
l. ASCE MOP No. 37, Design and Construction of Sanitary and Storm Sewers.
m. Concrete Pipe Handbook, American Concrete Pipe Association.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Excavation and Backfill Submittals:
      a. Excavation Plan: Prior to start of excavation operations, a written plan shall be submitted to demonstrate compliance with OSHA Standard 29 CFR Part 1926.650. As a minimum, excavation plan shall include:
         1) Name of competent person.
         2) Excavation method(s) or protective system(s) to be used.
         3) Copies of "manufacturer's data" or other tabulated data if protective system(s) are designed on the basis of such data.
      b. Excavation and backfill requirements detailing sheeting and bracing, or other protective system(s), dewatering systems, cofferdams, and under-pinning.
      c. Shop Drawings shall be prepared by a Registered Professional Engineer, licensed in the State of Arizona, recognized as an expert in the specialty involved. Drawings shall be submitted to ENGINEER for record purposes only. Calculations shall not be submitted. Drawing submittals will not be checked and will not imply approval by ENGINEER of the Work involved. Responsibility belongs to CONTRACTOR for designing, installing, operating and maintaining whatever system is necessary to satisfactorily accomplish all necessary sheeting, bracing, protection, underpinning and dewatering.
      d. Samples of all materials, including select backfill, general backfill, granular embedment, crushed stone and sand shall be submitted to the

ENGINEER and the testing service. Samples of the proposed material shall be submitted at least 14 days in advance of its anticipated use.

2. Piping Materials and Installation Submittals:
   a. Laying schedules for all piping
   b. Full details of piping, specials, manholes, joints, harnessing and thrust blocks, and connections to existing piping, structures, equipment and appurtenances.
   c. Certificates of compliance with referenced Standards for proposed pipe material.
   d. Descriptions of proposed pipe testing methods, procedures and apparatus. Prepare and submit a report for each test conducted.
3. Field Test Reports:
   a. Testing laboratory shall submit copies of test reports for Field Density of Backfill directly to ENGINEER, with copy to CONTRACTOR
4. Record Drawings:
   a. During progress of the Work, keep an up-to-date set of Record Drawings showing field and Shop Drawing modifications.
   b. Submit Record Drawings prior to the time of Substantial Completion.

1.4 JOB CONDITIONS

A. Subsurface Information: Refer to Section 00700, General Conditions, and Section 00800, Supplementary Conditions, for available data on subsurface conditions. The data is not intended as a representation or warranty of continuity of conditions between soil borings nor of groundwater levels at dates and times other than date and time when measured. OWNER will not be responsible for interpretations or conclusions drawn there from by CONTRACTOR. Data is solely made available for the convenience of CONTRACTOR.
   1. Additional test borings and other exploratory operations may be made by CONTRACTOR, at no additional cost to OWNER.

B. Existing Structures: The Drawings show certain surface and underground structures adjacent to the Work. This information has been obtained from existing records. It is not guaranteed to be correct or complete and is shown on the Drawings for the convenience of CONTRACTOR. Explore ahead of the required excavation to determine the exact location of all existing structures. Structures shall be supported and protected from damage by CONTRACTOR. If they are broken or damaged, restore them immediately at no additional cost to the OWNER.

C. Existing Utilities: Locate existing underground utilities in the areas of the Work. If utilities are to remain in place, provide adequate means of protection during all operations.
   1. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult piping or utility owner and ENGINEER

immediately for directions as to procedure. Cooperate with OWNER and utility owner in keeping services and facilities in operation. Repair damaged utilities to satisfaction of utility owner. Comply with requirements of Section 01143, Coordination with OWNER'S Operations.

2. In general, service lines to individual houses and businesses are not shown on the Drawings, however, assume that a service exists for each utility to each house or business.
3. Do not interrupt existing utilities serving facilities occupied and used by OWNER or others, except when permitted in writing by ENGINEER and then only after acceptable temporary utility services have been provided.
4. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.

D. Use of Explosives:
   1. The use of explosives will not be permitted. Comply with requirements of Section 02220, Demolitions.
   2. Do not bring explosives onto site or use in the Work without prior written permission from authorities having jurisdiction. Provide copy of authorization to ENGINEER. Sole responsibility for handling, storage and use of explosive materials, when their use is permitted, belongs to CONTRACTOR.

E. Protection of Persons and Property: Barricade open excavations occurring as part of the Work and post with warning lights. Operate warning lights during hours from dusk to dawn each day and as otherwise required.
   1. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

F. Dust Control: Conduct all operations meeting the requirements specified in Section 01414, Earthmoving and Dust Control.

G. Roadways and Walks: Unless otherwise approved by ENGINEER, excavated material and materials of construction shall be so deposited, and the Work shall be so conducted, as to leave open and free for pedestrian traffic all crosswalks, and for vehicular traffic a roadway not less than ten feet in width. All hydrants, valves, fire alarm boxes, letter boxes, and other facilities which may require access during construction shall be kept accessible for use. During the progress of the Work, maintain such crosswalks, sidewalks, and roadways in satisfactory condition and the Work shall at all times be so conducted as to cause a minimum of inconvenience to public travel, and to permit safe and convenient access to private and public property along the line of the Work.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work.

B. Handle all pipe, fittings, specials and accessories carefully with approved handling devices. Do not drop or roll material off trucks. Do not otherwise drop, roll or skid piping.

C. Store pipes and fittings on heavy wood blocking or platforms so they are not in contact with the ground.

D. Unload pipe, fittings and specials opposite to or as close to the place where they are to be installed as is practical to avoid unnecessary handling. Keep pipe interiors completely free from dirt and foreign matter.

E. Inspect delivered pipe for cracked, gouged, chipped, dented or otherwise damaged material and immediately remove from site.

PART 2 - PRODUCTS

2.1 EMBEDMENT AND BACKFILL MATERIALS

A. Pipe Bedding/Granular Embedment:
1. Bedding is the material placed in the area from the bottom of the trench to one foot above the top of the pipe. Pipe bedding shall be Select Material Type B or Aggregate Base Course having the following gradation. Open graded rock will not be used without the written approval of the ENGINEER.

Sieve Sizes (Square Opening)	Percentage by Weight Passing Sieve	
	Select Material Type B	Aggregate Base Course
1-1/2-inch	100	
1-1/4-inch		100
No. 4	30 – 70	38 - 65
No. 8	20 – 60	25 – 60
No. 30	10 – 40	10 – 40
No. 200	0 - 12	3 - 12

2. Unless otherwise noted, the Plasticity Index as tested in accordance with AASHTO T-146, T-89 and T-90 shall not be more than five.

B. Sand:
1. Sand for use as embedment material around plastic pipes (CPVC, FRP Duct, and HDPE Duct) shall consist of natural or manufactured granular material.

2. No sand will be allowed for embedment material around centrifugally cast, fiberglass reinforced polymer mortar pipe.
3. Sand material shall contain no organic material. Sand shall be nonplastic, when tested in accordance with ASTM D 698, 100 percent shall pass a 1/2-inch screen and no more than 20 percent shall pass a No. 200 screen.
4. All material for sand must be tested and approved by the ENGINEER.
5. No sand shall be placed without the approval of the ENGINEER.

C. Backfill Material:
   1. Materials acceptable for use as backfill above the pipe embedment shall be:
      a. Stockpiled native sandy clay or granular soils obtained from on-site excavations and which are uniformly mixed, contain no organic matter, nor contain rocks or fragments greater than 3-inches in size, nor have greater than 40 percent passing the 200 sieve. The maximum expansion of on-site materials shall be 1.5 percent as performed on a sample remolded to approximately 95 percent of the maximum dry density as determined in accordance with ASTM D 698 at two percent below optimum moisture content under a 100 pound per square foot (psf) surcharge pressure.
      b. Materials from off-site sources shall consist of silty or clayey sand soils which are uniformly mixed, contain no organic matter and which have a Plasticity Index less than ten. The maximum particle size of imported soils shall be 3-inches or less, if required to satisfy trenching, landscaping, or other requirements. The maximum expansion of off-site materials shall be 1.5 percent as performed on a sample remolded to approximately 95 percent of the maximum dry density as determined in accordance with ASTM D 698 at two percent below optimum moisture content under a 100 psf surcharge pressure.
      c. All materials for use as backfill material shall be tested by the laboratory and approved by the ENGINEER.
      d. If on-site material is unsuitable as determined by the ENGINEER, select backfill or approved off-site fill shall be used.

2.2 PIPING MATERIALS

A. Unless otherwise specified, piping materials, including pipe, gaskets, fittings, connection and joint assemblies, linings and coatings, shall be selected from those listed in Section 15050, Piping Systems. Piping materials shall conform to detailed Specifications for each type of pipe and piping appurtenances specified in the applicable Sections of Division 15, Mechanical.

2.3 PIPING IDENTIFICATION

A. Plastic Tracer Tape and Magnetic Tracer Tape Marking shall conform to the requirements specified in Section 15050, Piping Systems.

PART 3 – EXECUTION

3.1 EXCAVATION

A. Provide ENGINEER with sufficient notice and with means to examine the areas and conditions under which excavation is to be performed. ENGINEER will notify CONTRACTOR if conditions are found that may be detrimental to the proper and

timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

B. Perform all excavation required to complete the Work as shown on the Drawings, specified and required. Excavations shall include earth, sand, clay, gravel, hardpan, boulders not requiring drilling and blasting for removal, decomposed rock, pavements, rubbish and all other materials within the excavation limits.

C. Excavations for pipelines shall be open excavations. Provide excavation protection system(s) required by ordinances, codes, law and regulations to prevent injury to workmen and to prevent damage to new and existing structures or pipelines. Unless shown on the Drawings or specified otherwise, protection system(s) shall be utilized under the following conditions.
   1. Excavation Less Than Five Feet Deep: Excavations in stable rock or in soil conditions where there is no potential for a cave-in may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded, or shored and braced.
   2. Excavations More Than Five Feet Deep: Excavations in stable rock where there is no potential for a cave-in may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded or shored and braced.
   3. Excavation protection system(s) shall be installed and maintained in accordance with drawings submitted under Article 1.3, above.

D. Where the pipeline is to be placed below the ground water table, well points, cofferdams or other acceptable methods shall be used to permit construction of said pipeline under dry conditions. Dry conditions shall prevail until the pipelines are properly jointed, tested and backfilled. Water level shall be maintained below top of backfill at all times.

E. Pumping of water from excavations shall be done in such a manner to prevent the carrying away of unsolidified concrete materials, and to prevent damage to the existing subgrade.

F. Except where otherwise noted on the Drawings, or approved, in writing, by the ENGINEER, no more than 40 feet of trench may be opened in advance of pipe laying.

G. Material Storage: Stockpile satisfactory excavated materials in approved areas, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.
   1. Locate and retain soil materials away from edge of excavations.
   2. Dispose of excess soil material and waste materials as specified hereinafter.

3. Stockpiled excavated soils for use as subsequent fill shall be classified by laboratory as on-site granular or sandy clay soils. Use and placement of fill shall be performed as specified for each class.
4. Excess soil from excavations shall be disposed of off-site. Disposal shall be in accordance with state and local regulatory requirements

H. Trench width shall be minimized to greatest extent practical but shall conform to the following:
1. Sufficient to provide room for installing, jointing and inspecting piping. Trenches for other than cast-in-place concrete pipe shall conform to the dimensions listed below, unless otherwise shown on the Drawings, and/or approved by the ENGINEER.

Size of Pipe (I.D.) (Inches)	Maximum Width at Top of Pipe Greater than O.D. of Barrel	Minimum Width at Springline Each Side of Pipe
Less than 18	16-inches	6-inches
18 to 24 inclusive	19-inches	8-inches
27 to 39 inclusive	22-inches	9-inches
42 to 60 inclusive	1/2 of Pipe O.D.	12-inches
Over 60	36-inches	12-inches

2. The width of the trench shall not be greater than the maximum indicated above, at and below the level of the top of the pipe. If the maximum width as specified above is exceeded at the top of the pipe, provide, at no additional cost to the OWNER, the necessary loading bearing capacity by means of bedding, having a higher bedding factor that that specified, higher strength pipe a concrete cradle, cap or encasement, or by other means approved in writing by the ENGINEER.
3. The width of the trench above that level may be made as wide as necessary for shoring or other wall support measures necessary for a safe and proper installation. Trench walls may be sloped in-lieu of shoring, sheeting or other wall support measures. In all cases, responsibility belongs to CONTRACTOR for all costs incurred as a result of increased trench width.
4. Enlargements at pipe joints may be made if required and approved by ENGINEER.
5. Sufficient for shoring and bracing or shielding and dewatering.
6. Sufficient to allow thorough compaction of embedment material adjacent to bottom half of pipe.

I. Depth of trench shall be as required to install the piping at the elevations shown on the Drawings. For all pipe 12-inches or greater in diameter, excavate for and provide an initial granular bedding at least 4-inches thick or 1/2 the outside diameter of the pipe whichever is greater. The bedding material shall be placed at a uniform density with a minimum compaction density of 95 percent as determined

by AASHTOT -99 and T-191 or ASTM D-2922 and D-3017. If required and approved by ENGINEER, depths may be revised. Remove all loose and unsuitable material from the trench bottom.

J. Subgrades for trench bottoms shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud, muck, and other soft or unsuitable materials; and shall remain firm and intact under all construction operations. Where ENGINEER considers the existing subgrades unsuitable, remove same and replace it with granular embedment material. Subgrades which are otherwise solid, but which become soft or mucky on top due to construction operations, shall be reinforced with granular embedment material. The finished elevation of stabilized subgrades shall not be above subgrade elevations required for the piping installation as herein specified. Proof roll all subgrades prior to placing of select fill and general fill material.

K. Except at locations where excavation of rock from the bottom of the trench is required, care shall be taken not to excavate below the required depth. Unauthorized excavation below the specified grade line shall be refilled at CONTRACTOR'S expense with aggregate base material compacted to a uniform density of not less than 95 percent of the maximum density as determined by AASHTO T-99 and T-191 or ASTM D-2922 and D-3017. When AASHTOT-99, Method A or B, and T-191 are used for density determination, MAG, Detail 190, will be used for rock correction.

L. Whenever rock is encountered in the trench bottom, it shall be over excavated to a minimum depth of 6-inches below the O.D. of the pipe. This over excavation shall be filled with granular embedment material and compacted to a uniform density of not less than 95 percent of the maximum density as determined by AASHTOT-99 and T-191 or ASTM D-2922 and D-3017.

M. Where pipe is laid in rock excavation, crushed stone as specified in Section 02318, Crushed Stone and Gravel, shall be carefully placed and tamped over the rock before the pipe is laid. Depth of crushed stone shall be at least 6-inches for pipe 16-inches and smaller and 9-inches for pipe 18-inches and larger. After laying pipe, the balance of the embedment and backfill shall be placed as described herein.

3.2 EXCAVATION DRAINAGE AND DEWATERING

A. General:
   1. Prevent surface and subsurface water from flowing into excavations and from flooding adjacent areas.
   2. Remove water from excavations as fast as it collects.
   3. Maintain the ground water level at approximately three feet below the bottom of the excavation to provide a stable surface for construction operations, a

stable subgrade for permanent work and to prevent damage to Work during all stages of construction.

4. Provide and maintain pumps, sumps, suction and discharge lines and other dewatering system components necessary to convey water away from excavations. Adequate operational standby equipment shall be maintained on the site.
5. Provide approved sediment traps when water is conveyed into water courses.
6. Obtain ENGINEER'S approval before shutting down dewatering system for any reason.

B. Standby Requirements for Dewatering:
1. Provide standby equipment to ensure continuity of dewatering operations.

C. Disposal of Water Removed by Dewatering System:
1. Dispose of all water removed from the excavation in such a manner as not to endanger public health, property, or any portion of the Work under construction or completed.
2. Dispose of water in such a manner as to cause no inconvenience to OWNER, ENGINEER or others involved in work about the site.
3. Convey water from the excavation in a closed conduit. Do not use trench excavations as temporary drainage ditches.

3.3 PIPE BEDDING/GRANULAR EMBEDMENT

A. Bedding/Granular Embedment shall be placed in the trench from the bottom of the trench to one foot above the top of the pipe.

B. Sand shall be placed as an envelope around CPVC pipes, FRP ducts and all pipe 2-inches and smaller. Place and compact minimum 6-inches of sand all around pipes, in 6-inch lifts, to level 12-inches above the top of pipe. The backfill shall be compacted to not less than 95 percent of laboratory maximum density as determined by AASHTOT-99 and T-191.

C. Carefully place and thoroughly compact all pipe bedding with handheld pneumatic compactors as construction progresses.

D. Granular embedment shall be spread, and the surface graded to provide a uniform and continuous support beneath the pipe at all points between bell holes or pipe joints. It will be permissible to slightly disturb the finished subgrade surface by withdrawal of pipe slings or other lifting tackle. After each pipe has been graded, aligned, placed in final position on the bedding material and shoved home, sufficient pipe embedment material shall be deposited and compacted under and around each side of the pipe and back of the bell or end thereof to hold the pipe in proper position and to maintain alignment during subsequent pipe jointing and embedment operations. Embedment material shall be deposited and compacted

uniformly and simultaneously on each side of the pipe to prevent lateral displacement.

3.4 PIPE INSTALLATION

A. General:
1. All bedding shall be inspected by ENGINEER prior to laying pipe. Notify ENGINEER in advance of excavating, bedding and pipe laying operations.
2. The ENGINEER prior to installation shall inspect all piping. ENGINEER'S inspection will not relieve CONTRACTOR or manufacturer from responsibility for damaged products.
3. All piping shall be carefully examined for cracks, damage or other defects before installation. Any piping that is defective, including but not limited to, cracked, damaged, in poor condition, or with damaged linings or improper markings shall be rejected, unless the product can be repaired in a manner acceptable to the manufacturer and ENGINEER. Any piping found to be broken or defective after it has been installed shall be removed, replaced, or repaired at CONTRACTOR'S expense.
4. Take field measurements, where required, prior to installation to ensure proper fitting of the Work. Uncover existing pipelines sufficiently in advance of the proposed Work in order that the type and location of the existing pipes and joints and other information required to fabricate the proposed piping can be determined. Responsibility to obtain whatever information is required to complete the connections of the proposed pipelines to the existing pipelines belongs to CONTRACTOR.
5. Present all conflicts between piping systems and equipment, structures or facilities to ENGINEER for determination of corrective measures before proceeding.
6. Request instructions from ENGINEER before proceeding if there is a conflict between the manufacturer's recommendations and the Contract Documents.
7. Installation of all pipe, fittings, valves, specials and appurtenances shall be subject to the review and approval of the ENGINEER.
8. Install piping as shown on the Drawings, specified and as recommended by the manufacturer and in conformance with referenced standards and approved Shop Drawings.
9. No pipe shall be brought into position until the preceding length has been bedded and secured in its final position.
10. Minimum earth cover over the piping shall be as shown on the Drawings, specified or directed by the ENGINEER, but in no case shall the earth cover be less than 2’-6” for all piping, except drains.
11. Interior of all piping and mating surfaces shall be inspected and all dirt, gravel, sand, debris or other foreign material shall be completely removed from the interior and mating surfaces before installation. Measures shall be taken to maintain the interior of all piping clean until acceptance of the completed Work. Care shall be taken to prevent foreign matter from entering joint space.

Bell and spigot mating surfaces shall be wiped clean immediately before piping is laid. For ductile-iron pipe, the bell and spigot mating surfaces shall be thoroughly cleaned with a wire brush.

12. Install piping accurately to line and grade shown on the Drawings, specified or directed, unless otherwise approved by the ENGINEER. Accurate means of determining and checking the alignment and grade shall be used, which shall be subject to the approval of the ENGINEER. Any modifications to the Contract Documents to suit the pipe manufacturer's standard shall be approved by the

ENGINEER. Remove and relay piping that is incorrectly installed, at CONTRACTOR'S expense.

13. Do not lay piping in water, unless otherwise specified in these Specifications or approved by the ENGINEER. Ensure that the water level in the trench is at least 6-inches below the bottom of piping. Maintain a dry trench until jointing and backfilling are complete, unless otherwise specified in these Specifications or approved by the ENGINEER.
14. Where unforeseen conditions will not permit the installation of piping as shown on the Drawings or specified, no piping shall be installed without approval of the ENGINEER. Do not modify structures or facilities without approval of the ENGINEER.
15. Start laying piping at lowest point and proceed toward the higher elevations, unless otherwise approved by the ENGINEER. Slope piping uniformly between elevations shown on the Drawings or as otherwise directed by the ENGINEER.
16. Place bell and spigot piping so that the bells face the direction of laying, unless otherwise approved by the ENGINEER.
17. Piping shall be installed so that the barrel of the piping, and not the joints, receives the bearing pressure from the trench bottom or other bedding condition.
18. No piping shall be brought into position until the preceding length, valve, fitting, or special has been bedded and secured in place.
19. Whenever pipe laying is not actively in progress, the open ends of the piping shall be closed by a temporary plug or cap to prevent soil, water and other foreign matter from entering the piping.
20. Field cutting of metallic piping, where required for inserting valves, fitting, specials, and closures, shall be made with a machine specially designed for cutting piping and in accordance with the manufacturer's instructions. Cuts shall be carefully done, without damage to piping, so as to leave a smooth end at right angles to the axis of the piping. Cut end shall be tapered and sharp edges filed off smooth. Flame cutting shall not be permitted. Any piping damaged by CONTRACTOR due to improper or careless methods of cutting shall be replaced or repaired at his expense.
21. Blocking under piping shall not be permitted, unless specifically approved by ENGINEER for special conditions.
22. Protective linings and coatings shall be touched up prior to installation, where required.
23. Except where bends, wyes or similar fittings are used, changes in alignment and grade of the piping shall be made by deflecting joints or with beveled pipe. Permissible joint deflection shall not exceed 75 percent of the amount allowed by the manufacturer.
24. All joints shall be made in the presence of the ENGINEER or his duly authorized representative, except as otherwise approved.

25. Special care shall be taken to ensure that each section of piping abuts against the next in such a manner that there will be not shoulder or unevenness of any kind along the piping invert.
26. Piping shall be rotated as required to place outlets in proper position.
27. Blind flanges and cleanouts shall be provided at locations shown on the Drawings, specified, or required. Cleanouts on buried piping shall include all pipe, fittings and appurtenances required to bring cleanout to finished grade and terminate in a flange and blind flange or suitably capped piping as shown on the Drawings. Cleanout piping shall be same as that specified for the main run.
28. All gravity lines shall pitch uniformly at the grade shown on the Drawings or as specified or approved by the ENGINEER.
29. Short pipe stubs, maximum 4-feet-0-inch in length, shall be used at all manholes and other wall faces, except as otherwise specified.
30. Field painting shall be accomplished after joints are made.
31. All piping shall be plugged watertight with a suitable cap or plug securely fastened to the end of the piping at all contact interfaces.
32. On steep slopes, take measures acceptable to ENGINEER to prevent movement of the pipe during installation.
33. Thrust Restraint: During the installation of the pipe, thrust blocks, tied joints, or proprietary restrained joint systems shall be provided wherever required for thrust restraint. Thrust restraint shall conform to the applicable requirements of Article 3.4, below.
34. Exercise care to avoid flotation when installing pipe in cast-in-place concrete.
35. For copper tubing and thermoplastic piping, snake piping in trench to compensate for thermal expansion.

B. Manufacturer's Installation Specialist:
   1. Provide the services of a competent installation specialist of the pipe manufacturer when pipe laying commences if CONTRACTOR is not experienced in laying and jointing a particular type of pipe for the following:
      a. Ductile Iron pipe
      b. VCP pipe
      c. HDPE pipe
      d. PVC pipe

   2. Retain installation specialist at the site for a minimum of 2 days or until competency of the pipe laying crew has been satisfactorily demonstrated.

C. Separation of Sewers and Potable Water Pipelines:
   1. Conform to requirements of MAG Specification Section 610.5

D. Plugs:
   1. Temporarily plug installed pipe at the end of each day's Work or other interruption to the installation of any pipeline. Plugging shall prevent the

entry of animals, liquids or persons into the pipe or the entrance or insertion of deleterious materials.

2. Install standard plugs into all bells at dead ends, tees, or crosses. Cap all spigot ends.
3. Fully secure and block all plugs and caps installed for pressure testing to withstand the specified test pressure.
4. Where plugging is required for phasing of the Work or for subsequent connection of piping, install watertight, permanent type plugs.

E. Laying Pipe:
   1. Conform to manufacturer's instructions and requirements of the standards listed below, where applicable:
      a. Ductile Iron Pipe: AWWA C600, AWWA C105.
      b. Concrete Pipe: AWWA M9, Concrete Pipe Handbook.
      c. Steel Pipe: AWWA M11, AWWA C206.
      d. ASCE Manual of Practice No. 37.
      g. VCP pipe: installation shall be per ASTM C12 “Installing Vitrified Clay Pipe Sewer” and ASTM C12-17

F. Polyethylene Encasement:
   1. Provide polyethylene encasement for ductile iron piping to prevent contact between the pipe and surrounding bedding material and backfill.
   2. Polyethylene may be supplied in tubes or in sheet material.
   3. Polyethylene encasement materials and installation shall be in accordance with the requirements of MAG Section 610.5.

G. Jointing Pipe:
   1. Ductile Iron Mechanical Joint Pipe:
      a. Comply with requirements of Section 15101, Ductile Iron Pipe.
      b. Wipe clean the socket, plain end and adjacent areas immediately before making joint. Make certain that cut ends are tapered and sharp edges are filed off smooth.
      c. Lubricate the plain ends and gasket with soapy water or an approved pipe lubricant, in accordance with AWWA C111, just prior to slipping the gasket onto the plain end of the joint assembly.
      d. Place the gland on the plain end with the lip extension toward the plain end, followed by the gasket with the narrow edge of the gasket toward the plain end.
      e. Insert the pipe into the socket and press the gasket firmly and evenly into the gasket recess. Keep the joint straight during assembly.
      f. Push gland toward socket and center it around pipe with the gland lip against the gasket.
      g. Insert bolts and hand tighten nuts.
      h. Make deflection after joint assembly, if required, but prior to tightening bolts. Alternately tighten bolts 180 degrees apart to seat the gasket evenly. The bolt torque shall be as follows:

Pipe Size (inches)	Bolt Size (inches)	Range of Torque (ft-lbs)
3	5/8	45 to 60
4 to 24	3/4	75 to 90
30 to 36	1	100 to 120
42 to 48	1-1/4	120 to 150

i. All bolts and nuts shall be heavily coated with two 10-mil minimum coats of coal-tar epoxy coating as manufactured by Tnemec, or equal.
j. Restrained mechanical joints shall be in accordance with Section 15101, Ductile Iron Pipe.

2. Ductile Iron Push-On Joint Pipe:
   a. Comply with requirements of Section 15101, Ductile Iron Pipe.
   b. Prior to assembling the joints, the last 8-inches of the exterior surface of the spigot and the interior surface of the bell shall be thoroughly cleaned with a wire brush, except where joints are lined or coated with a special protective lining or coating.
   c. Rubber gaskets shall be wiped clean and flexed until resilient. Refer to manufacturer's instructions for procedures to ensure gasket resiliency when assembling joints in cold weather.
   d. Insert gasket into joint recess and smooth out the entire circumference of the gasket to remove bulges and to prevent interference with the proper entry of the spigot of the entering pipe.
   e. Immediately prior to joint assembly, apply a thin film of approved lubricant to the surface of the gasket which will come in contact with the entering spigot end of pipe. Option, apply a thin film of lubricant to the outside of the spigot of the entering pipe.
   f. For assembly, center spigot in the pipe bell and push pipe forward until it just makes contact with the rubber gasket. After gasket is compressed and before pipe is pushed or pulled all the way home, carefully check the gasket for proper position around the full circumference of the joint. Final assembly shall be made by forcing the spigot end of the entering pipe past the rubber gasket until it makes contact with the base of the bell. When more than a reasonable amount of force is required to assemble the joint, the spigot end of the pipe shall be removed to verify the proper positioning of the rubber gasket. Gaskets which have been scoured or otherwise damaged shall not be used.
   g. Maintain an adequate supply of gaskets and joint lubricant at the site at all times when pipe jointing operations are in progress.

3. Proprietary Joints:
   a. Pipe which utilizes proprietary joints such as Megalug, by EBBA Iron, Inc.; Lok-Ring, by American Cast Iron Pipe Company; restrained joints described under Article 3.4, or other such joints shall be installed in strict accordance with the manufacturer's instructions.

4. Flanged Joints:
   a. Assemble flanged joints using 1/8-inch ring-type gaskets for raised face flanges. Use full face gaskets for flat face flanges, unless otherwise approved by ENGINEER. Gaskets shall be suitable for the service intended in accordance with the manufacturer's ratings and instructions. Gaskets shall be properly centered.
   b. Bolts shall be tightened in a sequence which will ensure equal distribution of bolt loads.
   c. The length of bolts shall be uniform, and they shall not project beyond the nut more than 1/4-inch or fall short of the nut when fully taken up. The ends of bolts shall be machine cut so as to be neatly rounded. No washers shall be used.
   d. Bolt threads and gasket faces for flanged joints shall be lubricated prior to assembly.
   e. After assembly, coat all bolts and nuts with two 8-mil coats of a high-build epoxy or bituminous coating as manufactured by Tnemec, or equal.
5. Prestressed Concrete Cylinder Pipe Joints:
   a. Immediately before making the joint, completely clean the bell and spigot surfaces to be jointed.
   b. Apply a lubricant supplied by the pipe manufacturer to the sealing surfaces of the bell and spigot and the gasket. After lubrication, install the gasket in the spigot groove and ensure that the stretch in the gasket is equalized.
   c. After the pipe is lowered into place, align the spigot and bell so that the spigot will squarely enter the bell.
   d. Before the joint is fully assembled, check the position of the gasket in the bell using methods recommended by the pipe manufacturer and approved by the ENGINEER.
   e. If the gasket is found to be in the correct position around the entire circumference of the bell, remove temporary joint stoppers, if used, and shove the pipe completely home. If the gasket is not in the proper location, the joint shall be opened and reinstalled using a new gasket.
   f. Where a joint opening is required to make a grade or alignment adjustment, the joint shall be installed completely closed first, then opened as necessary on one side. Joint openings shall not be greater than 75 percent of the maximum opening recommended by the pipe manufacturer.
   g. Strap a diaper to the outside of the completed joint straddling the external joint recess. Pour a grout mix consisting of Portland cement and sand in proportions recommended by the pipe manufacturer to completely fill the external joint recess. In lieu of the joint diaper, with written approval of the pipe manufacturer, use a polyurethane foam joint protector with unhydrated Portland cement dispersed throughout the protector. The protector shall have the cross-sectional shape required for

the type of joint being installed and shall be formed in a loop to fit the size of pipe on which it is to be used.

h. Point interior joint recess of all pipe 24-inches in diameter and larger with Portland cement/sand mortar mixed in proportions recommended by the pipe manufacturer. Strike off grout smooth with the interior face of the pipe. For pipes 20-inches in diameter and smaller which convey sewage or nonpotable water, the interior surfaces of the steel joint ring shall be protected by a flexible mastic joint filler applied to the bell socket just prior to joining the pipe such that the mastic squeezes out to fill the internal joint recess.

i. Coat all exterior exposed steel portions of the pipe, flanges, couplings, bolts and nuts with two 8-mil coats of high-build epoxy or bituminous coating as manufactured by Tnemec, or equal.

j. Maintain a sufficient quantity of joint lubricant, gaskets, joint diapers and joint fillers at the site of the Work at all times.

k. Do not use gaskets which have been scored or otherwise damaged.

l. Where welded joints are required to handle thrust, the steel spigot shall be cut at the trailing edge of the gasket groove to provide a surface suitable for welding in the field. All field welded joints shall be full circumferential welds designed to take the thrust at the joint location. A minimum 3/16-inch weld is required. The exposed steel surface of the pipe joints shall have a temporary protection system of a rust and corrosion inhibitor applied which need not be removed prior to welding. After welding is complete, the joint protection shall be completed with interior and exterior cement mortar grouting.

6. Thermoplastic Pipe Joints:

a. Solvent Cement Joints:

1) Bevel pipe ends and remove all burrs before making joints. Clean both pipe and fittings thoroughly. Do not attempt to make solvent cement joints if temperature is below 40°F or above 90°F when exposed to direct sunlight or in wet conditions.

2) Use solvent cement supplied or recommended by the pipe manufacturer.

3) Apply joint primer and solvent cement and assemble joints in strict accordance with the recommendations and instructions of the manufacturer of the joint materials and the pipe manufacturer.

4) Observe safety precautions with the use of joint primers and solvent cements. Allow air to circulate freely through pipelines to permit solvent vapors to escape. Slowly admit water when flushing or filling pipelines to prevent compression of gases within pipes.

b. Push-On Joints:

1) Bevel all field-cut pipes, remove all burrs and provide a reference mark the correct distance from the pipe end.

2) Clean the pipe end and the bell thoroughly before making the joint. Insert the O-ring gasket, making certain it is properly oriented.

Lubricate the spigot well with an approved lubricant; do not lubricate the bell or O-ring. Insert the spigot end of the pipe carefully into the bell until the reference mark on the spigot is flush with the bell.

7. Mechanical Coupling Joints:
   a. Prior to the installation and assembly of mechanical couplings, the joint ends shall be cleaned thoroughly with a wire brush to remove foreign matter. Following this cleaning, lubricant shall be applied to the rubber gasket or inside of the coupling housing and to the joint ends. After lubrication, the gasket shall be installed around the joint end of the previously installed piece and the joint end of the subsequent piece shall be mated to the installed piece. The gasket shall be positioned and the coupling housing placed around the gasket and over the grooved or shouldered joint ends. The bolts shall be inserted and the nuts screwed up tightly by hand. The bolts shall then be tightened uniformly in order to

produce an equal pressure on all parts of the housing. When the housing clamps meet metal to metal, the joint is complete and further tightening is not required.

8. HDPE Double Containment Pipe (Containment and Carrier Pipe):
   a. Joints of double containment piping system shall be installed in strict accordance with the manufacturer's instructions and shall be of the butt fusion process.

H. Connections to Valves and Hydrants:
   1. Install valves and hydrants as shown on the Drawings. Valves shall be located in such a way that they are accessible for repair and removal in the future.
   2. Provide suitable adapters when valves or hydrants and piping have different joint types.
   3. Provide thrust restraint at all hydrants and at valves at pipeline terminations.

I. Transitions from One Type of Pipe to Another:
   1. Provide all necessary adapters, specials and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.

J. Closures:
   1. Provide all closure pieces shown on the Drawings or required to complete the Work.

3.5 THRUST RESTRAINT

A. Provide thrust restraint on all pressure piping systems and where otherwise shown on the Drawings and specified. Refer to Section 03200, Concrete Reinforcement.

B. Thrust restraint shall be accomplished by means of restrained pipe joints. Concrete thrust blocks shall be used only when specifically shown on the Drawings or as directed by the ENGINEER. Thrust restraints shall be designed for the axial thrust exerted by the test pressure for each piping system as specified in Section 15050, Piping Systems.

C. Restrained Pipe Joints:
   1. Pipe joints shall be restrained by means suitable to the type of pipe being installed.
      a. Prestressed concrete cylinder pipe shall be restrained utilizing welded joints. Concrete pipe requiring restraint shall have sufficient longitudinal steel reinforcement provided to handle the thrust forces at a maximum design stress of 12,500 psi. The thrust forces in the longitudinales must be transmitted directly to the steel joint bands using welded connections sufficient to carry the stresses involved. No allowance for the concrete to handle any tensile forces is permitted.

b. Ductile-iron push on joints and mechanical joints shall be restrained utilizing a proprietary restrained joint system such as American Lok-Ring, Ebba Iron, Inc., Series 1100 Megalug, U.S. Pipe TR Flex System, lugs, and tie rods, or other system approved by ENGINEER.
c. Steel pipe shall have butt-welded joints, flanged joints, or flexible or mechanical coupling connectors as specified in Section 15050, Piping Systems. Tie rods connected to ears welded to the steel pipe shall be provided for restraint at all flexible coupling connectors.
d. Thermoplastic and copper piping shall generally be installed with soldered, solvent weld, threaded, flanged, or similar type joints. Where push-on type or other non-restrained joints are used, provide tie rods or other suitable joint restraint system for these joints, subject to the approval of ENGINEER.
e. Harnessed lengths for buried pipe shall be determined by the pipe manufacturer in accordance with the formula for determination of buried pipe harnessed lengths located at the end of this Section.
f. Concrete cylinder pipe thrust restraint shall be in accordance with AWWA Manual M-9, Chapter 7.

D. Concrete Thrust Blocks:
1. Thrust blocks shall be constructed of Type 2 concrete.
2. Blocks shall be placed against undisturbed soil as shown on Drawings or as directed by the ENGINEER. Concrete shall be placed so that pipe joints and fitting joints will be accessible for repair.
3. Size of concrete thrust blocks shall be as shown on the Drawings, or as directed and approved by ENGINEER.
4. Provide concrete thrust blocks on pressure piping at all changes in alignment of 15 degrees or more, at all tees, plugs and caps and where shown on the Drawings.

3.6 BACKFILL

A. General
1. Backfill begins after the placement of the pipe bedding/granular embedment. Pipeline trenches may be backfilled prior to pressure testing, but no structure shall be constructed over any pipeline until it has been tested.
2. Place and compact backfill as construction progresses.
3. Compacted backfill shall be required for the full depth of the trench above the granular pipe embedment material. Where the trench for one pipe passes beneath the trench for another pipe or electrical duct bank, the lower trench shall be compacted to the level of the bottom of the upper trench.
4. Each layer of backfill material shall be compacted by at least two complete coverages of all portions of the surface of each lift using approved compaction equipment. One coverage is defined as the conditions reached

when all portions of the fill lift have been subjected to the direct contact of the compacting surface of the compactor.

5. The method of compaction and the equipment used shall be appropriate for the material to be compacted and shall not transmit damaging shocks to the pipe.
6. The degree of compaction required for all types of fills shall be as listed below. Material shall be moistened or aerated as necessary to provide the moisture content that will facilitate obtaining the specified compaction.
7. The trench backfill shall be thoroughly compacted to no less than the following densities when tested and determined by ASSHTO T-99 and T-191 or ASTM D 2922 and D 3017. When ASSHTO T-99, Method A or B, and T-191 are used for density determination, MAG Detail 190 will be used for rock correction. The minimum density required is identified below:

Material	Required Minimum Density-Percent Compaction (ASTM D 698)	Maximum Uncompacted Lift (inches) Thick. (in)
Aggregate Base Course:		
Below asphalt paving	100	8
Trench Backfill above pipe:	95	12
Granular Pipe Embedment Material:	100	6
Sand Embedment Material:	95	6

All fill must be wetted and thoroughly mixed to achieve optimum moisture content, ± three percent, with the following exceptions: On site clayey soils optimum to plus three percent.

Natural undisturbed soils or compacted soil subsequently disturbed or removed by construction operations shall be replaced with materials compacted as specified above.

3.7 GRADING

A. General: Uniformly grade areas within limits of grading shown on the Drawings or specified, including adjacent transition areas. Smooth subgrade surface within specified tolerances, compact with uniform levels or slopes between points where elevations are shown on the Drawings, or between such points and existing grades.

B. Turfed Areas: Finish areas to receive topsoil to within not more than 1-inch above or below the required subgrade elevations.

C. Walks: Shape surface of areas under walks to line, grade and cross-section, with finish surface not more than 1-inch above or below the required subgrade elevation.

D. Pavements: Shape surface of areas under pavements to line, grade and cross-section, with finish surface not more than 1/2-inch above or below the required subgrade elevation.

E. Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/2-inch when tested with a 10-foot straightedge.

F. Compaction: After grading, compact subgrade surfaces to the depth and percentage of maximum density required.

3.8 PAVEMENT SUBBASE COURSE

A. General: Place subbase material, in layers of specified thickness, over ground surface to support pavement base course.
   1. Refer to Section 02742, Bituminous Paving.

B. Grade Control: During construction, maintain lines and grades including crown and cross-slope of subbase course.

C. Shoulders: Place shoulders along edges of subbase course to prevent lateral movement. Construct shoulders of acceptable soil materials, placed in such quantity to compact to thickness of each subbase course layer. Compact and roll at least a 12-inch width of shoulder simultaneously with compacting and rolling of each layer of subbase course.

D. Placing: Place subbase course material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting subbase material during placement operations.
   1. When a compacted subbase course is shown on the Drawings to be 6-inches thick or less, place material in a single layer. When shown on the Drawings to be more than 6-inches thick, place material in equal layers, except no single layer more than 6-inches or less than 3-inches in thickness when compacted.

3.9 DISPOSAL OF EXCAVATED MATERIALS

A. Material removed from the excavations which does not conform to the requirements for fill or is in excess of that required for backfill shall be hauled away by CONTRACTOR and disposed of in compliance with municipal, county, state, federal or other applicable regulations at no additional cost to OWNER.

3.10 RESTORING AND RESURFACING EXISTING ROADWAYS AND FACILITIES

A. Place 1-1/2 inches of temporary bituminous pavement immediately after backfilling trenches in paved roadways. Maintain the surface of the paved area over the trench in good and safe condition during progress of the entire Work, and promptly fill all depressions over and adjacent to the trench caused by settlement of backfill. Immediately prior to constructing the permanent paving and base, remove and

dispose of temporary pavement. Permanent replacement pavement shall be equal to that of the existing roadways unless otherwise shown on the Drawings or specified.

B. Pavement, gutters, curbs, walks, driveways and roadways disturbed or damaged by CONTRACTOR'S operations, except areas designated "New Pavement" or "Proposed Pavement", shall be restored or replaced at CONTRACTOR'S expense to as good condition as they were previous to the commencement of the Work and in accordance with applicable local and state highway specifications.

3.11 WORK AFFECTING EXISTING PIPING

A. Location of Existing Piping:
   1. Locations of existing piping shown on the Drawings should be considered approximate.
   2. Determine the true location of existing piping to which connections are to be made, and location of other facilities which could be disturbed during earthwork operations, or which may be affected by CONTRACTOR'S Work already installed.
   3. Conform to applicable requirements of Division 1, General Requirements, pertaining to cutting and patching, and connections to existing facilities.

B. Taking Existing Pipelines Out of Service:
   1. Do not take pipelines out of service unless specifically listed below, or approved by ENGINEER.
      a. Refer to Section 01143, Coordination with OWNER'S Operations.
   2. Notify ENGINEER at least 48 hours prior to taking any pipeline out of service.

C. Work on Existing Pipelines:
   1. Cut or tap pipes as shown on the Drawings or required with machines specifically designed for this Work. All taps shall be made at the spring line except for air release taps. Taps to buried piping 16-inches in diameter and larger shall be protected by an access vault to the surface or shall be 4-inches larger, with a shut off ball valve and a riser to the surface. Taps made to pipe smaller than 16-inches may be 2-inch taps. Taps shall not be located under slabs.
   2. Install temporary plugs to prevent entry of mud, dirt, water and debris.
   3. Provide all necessary adapters, fittings, pipe and appurtenances required to complete the Work.
   4. Existing pipelines which are cut and abandoned shall be adequately capped or filled with grout.

3.12 TESTING OF PIPING

A. General:
   1. Test all piping, except as otherwise authorized by ENGINEER.
   2. Notify ENGINEER and local authorities having jurisdiction at least 48 hours in advance of testing if their presence is required.
   3. Conduct all tests in the presence of the ENGINEER.
   4. Remove or protect any pipeline-mounted devices which may be damaged by the test pressure.
   5. Provide all apparatus and services required for testing, including but not limited to, the following:
      a. Test pumps, bypass pumps, hoses, calibrated gauges, meters, test containers, valves and fittings.
      b. Temporary bulkheads, bracing, blocking and thrust restraints.
   6. Provide air if an air test is required and power if pumping is required.
   7. Unless otherwise specified, OWNER will provide fluid required for testing.
   8. Repair and retest pipelines that fail to hold specified test pressure or which exceed the allowable leakage rate.
   9. Unless otherwise noted, pipelines shall hold specified test pressure for two hours.
   10. Unless otherwise specified, test pressures required are at the lowest elevation of the pipeline section being tested.

B. Schedule of Pipeline Tests:
   1. Refer to Section 15050, Piping Systems, for the type of test required and the required hydrostatic test pressure.
   2. Unless otherwise specified, the required hydrostatic test pressures are at the lowest elevation of the pipeline.
   3. For piping not listed in Section 15050, Piping Systems:
      a. Hydrostatically test pipe that will be operating at a pressure greater than five psig.
      b. Use exfiltration testing or low-pressure air testing for all other piping.
   4. Hydrostatic Test Pressure:
      a. Use test pressures listed in Section 15050, Piping Systems.
      b. If a test pressure is not listed in Section 15050, Piping Systems, or if a hydrostatic test is required for piping not listed in Section 15050, Piping Systems, the test pressure will be determined by the ENGINEER based on the maximum anticipated sustained operating pressure and the methods described in the AWWA Manual or Standard which applies to the piping system.

C. Hydrostatic Testing:
   1. Preparation for Testing:
      a. For plastic pipe, including fiberglass pipe, follow procedures described in Section 7 of AWWA Standard C605.

b. For all other piping follow procedures described in AWWA Manual M9 except that the minimum wetting period required immediately prior to testing for cement-lined steel pipe and asbestos cement pipe shall be 24 hours rather than the 48 hours prescribed for concrete pipe. A wetting

period is not required for metal pipe that is not cement-lined or for plastic pipe.

c. Ensure that adequate thrust protection is in place and that all joints are properly installed.

2. Test Procedure:
   a. Complete backfill and compaction at least to the pipe centerline before testing, unless otherwise required or approved by ENGINEER.
   b. Allow concrete for thrust blocks to reach design strength before testing.
   c. Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate should not exceed one foot per second in the pipe being tested. Install corporation cocks, if necessary, to remove all air.
   d. Examine exposed joints and valves, and correct visible leakage.
   e. After the wetting period prescribed above, add fluid to pressurize line to the required test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
   f. After the stabilization period, maintain test pressure for the duration specified in Section 15050, Piping Systems. Add fluid to restore test pressure if pressure drops five psi below test pressure at any time during the test period.
   g. Pump from a test container to maintain test pressure. Measure the volume of fluid pumped from the container and record on the test report. Record pressure at the test pump at 15 minute intervals for the duration of the test.
3. Allowable Leakage Rates:
   a. Conduct leakage test for all liquid piping after satisfactory completion of pressure test.
   b. Allow concrete pipe to stand full of water at least 12 hours prior to starting leakage test.
   c. Maintain test pressure constantly for the minimum test period and accurately measure the amount of water which must be added to maintain the test pressure.
   d. Allowable Leakage Rates (in gallons per hour per 1,000 feet per inch diameter):
      1) DIP Push On or Mechanical Joints: 0.075.
      2) Centrifugally Cast, Fiberglass -Reinforced Polymer Mortar Pipe: 0.0.

D. Required Tests for Gravity Sewer and Storm Drains:
   1. Elect to test piping, using either air or water test procedures. Notify ENGINEER, in writing, in advance of all testing, which method he plans to utilize and must follow through with the same method on all pipeline testing.
      a. Gravity sewers shall be tested with either air or water testing; however, storm drains may only be water tested.
      b. Tests shall be performed after backfilling is completed, but shall be performed before final cleanup and acceptance of Work.

c. Tests shall be performed prior to final acceptance.
   1) Test all piping and manholes for leakage by means of the tests described below.
   2) Test to be performed between adjacent manholes or as approved by the ENGINEER.

d. Prior to making tests, submit details of his testing procedures, with a description of methods and equipment CONTRACTOR proposes to use, to the ENGINEER for approval. Furnish all necessary labor, equipment, water, watertight bulkheads, rodding machine, generator, pumps and all else necessary to carry out the required tests.

2. Air Test:
   a. Wet and thoroughly clean the inside of the pipe before test is performed.
   b. Insert test plugs in ends of pipe to be tested.
   c. Securely brace test plugs.
   d. Measure and record groundwater height above the pipe invert. All gage pressures in the test shall be increased by the amount of the back pressure due to groundwater submergence.
   e. Slowly fill the pipe with air to a pressure of four psig. Maintain pressure between 4 and 3.5 psig for at least two minutes for temperature stabilization.
   f. Check all plugs for tightness.
   g. With a pressure of approximately four psig in pipe, disconnect air supply.
   h. Allow pressure to decrease to 3.5 psig.
   i. When the pressure reaches 3.5 psig, record the time required to decrease to 2.5 psig using a stopwatch.
   j. The line is considered acceptable if the time for the pressure to decrease from 3.5 psig to 2.5 psig is not less than the amount shown on the following table for the respective pipe diameters.

Minimum Acceptance Times	
Pipe Diameter (Inches)	Time
6	2 min. 50 sec.
8	3 min. 50 sec.
10	4 min. 45 sec.
12	5 min. 40 sec.
14	6 min. 40 sec.
16	7 min. 5 sec.
18	7 min. 35 sec.
20	9 min. 30 sec.

Minimum Acceptance Times	
Pipe Diameter (Inches)	Time
21	9 min. 55 sec.
24	11 min. 20 sec.
27	12 min. 45 sec.

k. If the leakage in the section tested exceeds the specified amount, make the necessary repairs or replacements required to reduce the leakage to within the specified limits and the test shall be repeated until the leakage requirement is met.
l. No one shall be allowed in the manhole during air testing.

3. Water Test:
   a. When water test is performed for reinforced concrete pipe, the test section shall be filled with water and allowed to stand for 24 hours. The water shall then be replenished, and the test performed.
   b. Insert test plugs and securely brace.
   c. Fill the pipe and manhole with water to provide a positive differential head on the top of the pipe at the highest point of the pipeline under test of at least the test pressure specified in Section 15050, Piping Systems.
   d. The amount of water added to maintain this head shall be the leakage.
   e. Test for a period of at least four hours.
   f. Total leakage of any section tested shall not exceed the following rates:
      1) Gravity Sewer: 0.5 gallons per hour per 100 feet of pipe per inch diameter of pipe.
      2) Storm Drains: 2.0 gallons per hour per 100 feet of pipe per inch diameter of pipe.
   g. If the leakage in the section tested exceeds the specified amount, make the necessary repairs or replacements required to reduce the leakage to within the specified limits and the test shall be repeated until the leakage requirements is met.
   h. On steep grades it may be necessary to place plugs in the pipe between manholes to avoid excessive pressures in the pipe.
4. Visual Inspection:
   a. Prior to final acceptance, a visual inspection by ENGINEER of all appurtenant structures, (e.g., manholes, chambers, etc.), shall be required. Any visual leaks, regardless of their magnitude shall be repaired by CONTRACTOR.
5. Watertight Sewers:
   a. It is imperative that all sewers and appurtenant structures be constructed as watertight as practicable. Adhere rigidly to all requirements of the Contract Documents and follow all directions of the ENGINEER to secure a watertight sewer. If, during the Work or after its completion,

any leaks are discovered, they shall be repaired in a satisfactory manner at the expense of CONTRACTOR even though the pipe and appurtenant structures may have already successfully passed the leakage tests.

E. Vertical Deflection Test for Thermoplastic Pipe:
   1. The vertical deflection test shall be conducted after the final backfill has been in place at least 30 days.
   2. Manually pull a pin-type vertical gauge mounted on a sled through the pipe. Gauge shall be set so that if vertical deflection of pipe exceeds five percent, it will stop. Excavate and reinstall all such piping. Gauge shall be as manufactured by Quality Test Products, or equal.

3.13 DISPOSAL OF WATER

A. Provide suitable means for disposal of test and flushing water so that no damage results to facilities or waterways.

B. Means of disposal of test and flushing water shall be subject to the approval of ENGINEER, local governing authorities and regulatory agencies.

C. Responsibility belongs to CONTRACTOR for any damage caused by water disposal operations.

3.14 CLEANING AND DISINFECTION

A. Cleaning:
   1. Thoroughly clean all piping and flush in a manner approved by ENGINEER, prior to placing in service.
   2. Piping 24-inches in diameter and larger shall be inspected from inside and all debris, dirt and foreign matter removed.
   3. If piping which requires disinfection has not been kept clean during storage or installation, swab each section individually before installation with a five percent hypochlorite solution, to ensure clean piping.

3.15 INSTALLATION OF DETECTABLE PIPE LOCATING TAPE

A. Underground Pipe Locating Tape:
   1. Refer to paragraph 2.3.A of this Section, and Section 15050, Piping Systems.
   2. Detectable pipe locating tape shall be placed above all underground pipelines. Tape shall be buried 12-inches below finished grade directly above entire pipeline length.
   3. Detectable pipe locating tape for reuse water shall be buried on top and in contact with the pipe in addition to 12-inches below finished grade.

FORMULA FOR DETERMINATION OF BURIED PIPE HARNESSED LENGTHS

Lengths shall be based on the following:

Harnessed Length (L) on each side of bend $= \frac{T}{f \sum W}$

$T = 1.25 PA \sin \Delta/2$

T = Thrust (lbs)

P = Test Pressure (psi), refer to Section 15050, Piping Systems.

A = Pipe Area (sq.in.)

Δ = Angle of Bend

f = friction factor between soil and pipe = 0.3*

$\sum W = W_p + W_s + W_w$

W_p = weight pipe (pounds per linear foot-PLF)

W_s = weight soil (PLF)**

W_w = weight fluid (PLF)

* For ductile iron and steel pipe: friction factor = 0.1.

** Based on depth of cover on pipe, and outside diameter of pipe. Soil weight = 100 pcf.

+ + END OF SECTION + +

SECTION 15052

EXPOSED PIPING INSTALLATION

PART 1 - GENERAL

1.1DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install and test all exposed piping, fittings, and specials. The Work includes, but is not limited to, the following:
      a. All types and sizes of exposed piping, except those specified under other Sections.
      b. Piping embedded in concrete within a structure or foundation will be considered as exposed and included herein.
      c. Supports, restraints, thrust blocks and other anchors.
      d. Work on or affecting existing piping.
      e. Testing.
      f. Cleaning and disinfecting.
      g. Installation of all jointing and gasketing materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, and all other Work required to complete the exposed piping installation.
      h. Incorporation of valves, meters and special items shown on the Drawings or specified into the piping systems as required and as specified in the appropriate Division 15, Mechanical, Sections.
      i. Unless otherwise specifically shown on the Drawings, specified, or included under other Sections, all exposed piping Work required, beginning at the outside face of structures or structure foundation and extending into the structure.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work that is related to this Section.
   2. Section 15052, Exposed Piping Installation, specifies the installation of all exposed piping materials specified in Division 15, Mechanical. Coordinate with these Sections.

1.2QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:

1. Comply with applicable requirements of NFPA Standard No. 13 for "Installation of Sprinkler Systems" and NFPA Standard No. 14 for "Standpipe and Hose Systems" used for fire protection.
2. Comply with requirements of UL, FM and other jurisdictional authorities, where applicable.
3. Refer to the General and Supplementary Conditions regarding requirements for this Project.
4. Phoenix Building Code.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. ANSI B 16.3, Malleable-Iron Threaded Fittings, Classes 150 and 300.
2. ANSI B 16.4, Cast Iron Threaded Fittings, Classes 125 and 250.
3. ANSI B 16.5, Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.
4. ANSI B 16.9, Factory-Made Wrought Steal Butt Welding Fittings.
5. ANSI B 16.11, Forged Steel Fittings, Socket-Welding and Threaded.
6. ANSI B 31.1, Power Piping.
7. ANSI B 31.3, Chemical Plant and Petroleum Refinery Piping.
8. ANSI B 31.8, Gas Transmission and Distribution Piping Systems.
9. AWWA C 111, Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
10. AWWA C 206, Field Welding of Steel Water Pipe Joints.
11. AWWA C 600, Installation of Ductile Iron Water Mains and Their Appurtenances.
12. AWWA C 606, Grooved and Shouldered Type Joints.
13. AWWA C 651, Disinfecting Water Mains.
14. AWWA M9, Concrete Pressure Pipe.
15. AWWA M11, Steel Water Pipe Design and Installation.
16. AWWA M23, PVC Piping.
17. AWS D 1.1, Structural Welding Code.
18. AWS D 10.7, Recommended Practices For Gas Shielded-Arc Welding of Aluminum and Aluminum Alloy Pipe.
19. AWS D 10.9, Standard for Qualification of Welding Procedures and Welders for Piping and Tubing.
20. ASME Boiler and Pressure Vessel Code.
21. NFPA 13, Installation of Sprinkler Systems.
22. NFPA 14, Standpipe and Hose Systems.
23. NFPA 54, National Fuel Gas Code.
24. Phoenix Building Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Detailed drawings in plan and section and laying schedules.

2. Details of piping, valves, supports, accessories, specials, joints, harnessing, and connections to existing pipes and structures.

B. Tests: Submit description of proposed testing methods, procedures and apparatus. Submit copies of test report for each test.

C. Certificates: Submit certificates of compliance with referenced standards.
1. Welder's Certificate to comply with the requirements of Paragraph 3.1.D.5.b.1) of this Section, below.

D. Record Drawings:
1. Submit Record Drawings prior to the time of Substantial Completion.

1.4PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work.

B. Handle all pipe, fittings and accessories carefully with approved handling devices. Do not drop or roll pipe off trucks. Do not otherwise drop, roll or skid piping.

C. Store pipes and fittings on heavy wood blocking or platforms so they are not in contact with the ground.

D. Unload pipe, fittings and specials opposite to or as close to the location where they are to be installed as is practical to avoid unnecessary handling. Keep pipe interiors completely free from dirt and foreign matter.

E. Inspect delivered pipe for cracked, gouged, chipped, dented or other damaged material and immediately remove from site.

PART 2 - PRODUCTS

2.1MATERIALS

A. Required pipe materials are listed in Section 15050, Piping Systems. Refer to applicable Sections for material specifications.

B. General:
1. Marking Piping:
a. Clearly mark each piece of pipe or fitting with a designation conforming to that shown on the approved Shop Drawings.
b. Cast or paint material, type and pressure designation on each piece of pipe or fitting 4-inches in diameter and larger.
c. Pipe and fittings smaller than 4-inches in diameter shall be clearly marked by manufacturer as to material, type and rating.

PART 3 - EXECUTION

3.1INSTALLATION

A. General:
   1. Install piping as shown on the Drawings, specified and as recommended by the manufacturer.
   2. If there is a conflict between manufacturer's recommendations and the Contract Documents, request instructions from ENGINEER before proceeding.

B. Manufacturer's Installation Specialist:
   1. Provide the services of a competent installation specialist of the pipe manufacturer when pipe installation commences, if CONTRACTOR is not experienced installing a particular type of pipe, for the following:
      a. Ductile Iron pipe

   2. Retain installation specialist at the site for a minimum of 2 days or until competency of the pipe installation crew has been satisfactorily demonstrated.

C. Piping Installation:
   1. Install straight runs true to line and elevation.
   2. Install vertical pipe truly plumb in all directions.
   3. Install piping parallel or perpendicular to building walls. Piping at angles and 45 degree runs across corners will not be accepted, unless specifically shown on the Drawings or approved by the ENGINEER.
   4. Install small diameter piping generally as shown on the Drawings when specific locations and elevations are not indicated. Locate such piping as required to avoid ducts, equipment, beams, and other obstructions.
   5. Install piping so as to leave all corridors, walkways, work areas, and like spaces unobstructed. Unless otherwise approved by the ENGINEER, provide a minimum headroom clearance under all piping of 7 feet-6 inches.
   6. Protect and keep clean water pipe interiors, fittings and valves.
   7. Provide temporary caps or plugs over all pipe openings at the end of each day's work, and when otherwise required or directed by ENGINEER.
   8. Cutting: Cut pipe from measurements taken at site, not from Drawings.
   9. Install dielectric unions or dielectric flange kits with sleeves and washers wherever dissimilar metals are connected, except for bronze or brass valves in ferrous piping.
   10. Provide a union downstream of each valve with screwed connections.
   11. Provide screwed or flanged unions at each piece of equipment, where shown on the Drawings, and where necessary to install or dismantle piping.
   12. Additional Requirements for Thermoplastic Piping:
      a. Support all valves independently of the piping system.
      b. Utilize wide band supports as recommended by manufacturer and approved by ENGINEER to minimize localized stresses.

c. Provide piping passing through walls with a sleeve of wearing material to prevent abrasion damage to piping.
d. When anchors are required at locations other than equipment or tanks they shall be placed at elbows, valve locations and at bends in pipe line.
e. Spacing of supports shall be in accordance with the manufacturer's published recommendations at the maximum design operating temperature of the pipe and requirements of Section 15061, Pipe Hangers and Supports.
f. Use "U" clamps with wide band circumferential contact.
g. Use guides on long runs of piping to maintain alignment and reduce chance of elastic failure of pipe. Space guides as recommended by manufacturer.
h. Expansion compensation shall comply with the requirements of Section 15061, Pipe Hangers and Supports.
j. Do not install pipe when temperature is less than 60°F.

D. Joints:
1. General:
a. Make joints in accordance with the pipe manufacturer's instructions and recommendations and the requirements below.
b. Cut piping accurately and squarely and install without forcing or springing.
c. Ream out all pipes and tubing to full inside diameter after cutting. Remove all sharp edges on end cuts.
d. Remove all cuttings and foreign matter from the inside of pipe and tubing before installation. Thoroughly clean all pipe, fittings, valves, specials, and accessories before installing.
2. Mechanical Joint Pipe:
a. Wipe clean the socket, plain end and adjacent areas immediately before making joint. Make certain that cut ends are tapered and sharp edges are filed off smooth.
b. Lubricate the plain end and gasket with soapy water or manufacturer's recommended pipe lubricant, in accordance with AWWA C 111, just prior to slipping the gasket onto the plain end of the joint assembly.
c. Place the gland on the plain end with the lip extension toward the plain end, followed by the gasket with the narrow edge of the gasket toward the plain end.
d. Insert the pipe into the socket and press the gasket firmly and evenly into the gasket recess. Keep the joint straight during assembly.
e. Push gland toward socket and center it around pipe with the gland lip against the gasket.
f. Insert bolts and hand tighten nuts.
g. Make deflection after joint assembly, if required, but prior to tightening bolts. Alternately tighten bolts 180 degrees apart to seat the gasket evenly. The bolt torque shall be as follows:

Pipe Size (inches)	Bolt Size (inches)	Range of Torque (ft-lbs)

3	5/8	45 to 60
4 to 24	3/4	75 to 90
30 to 36	1	100 to 120
42 to 48	1-1/4	120 to 150

3. Flanged Joints:
   a. Assemble flanged joints using 1/8-inch ring-type gaskets for raised face flanges. Use full face gaskets for flat face flanges, unless otherwise approved by ENGINEER. Gaskets shall be suitable for the service intended in accordance with the manufacturer's ratings and instructions. Gaskets shall be properly centered.
   b. Bolts shall be tightened in a sequence which will ensure equal distribution of bolt loads.
   c. The length of bolts shall be uniform, and they shall not project beyond the nut more than 1/4-inch or fall short of the nut when fully taken up. The ends of bolts shall be machine cut so as to be neatly rounded. No washers shall be used.
   d. Bolt threads and gasket faces for flanged joints shall be lubricated prior to assembly as recommended by manufacturer.
   e. Alternately tighten bolts 180 degrees apart to compress the gasket evenly.

E. Installing Valves and Accessories:
1. Provide supports for large valves, flow meters and other heavy items as shown on the Drawings or required.
2. Install floor stands as shown on the Drawings and as recommended by the manufacturer.
3. Provide lateral restraints for extension bonnets and extension stems as shown on the Drawings and as recommended by the manufacturer.
4. Provide steel sleeves where operating stems pass through floor. Extend sleeves 2-inches above floor.
5. Position valve operators as shown on the Drawings. When the position is not shown on the Drawings, install the valve so that it can be conveniently operated and as approved by ENGINEER. Avoid placing operators at angles to the floors or walls.
6. Position flow measuring devices in pipelines so that they have the amount of straight upstream and down stream runs recommended by the manufacturer, unless specific location dimensions are shown on the Drawings. Position swing check valves so that they do not conflict with the discs of butterfly valves.

F. Unions:
1. Install dielectric unions wherever dissimilar metals are connected, except for bronze or brass valves in ferrous piping.
2. Provide a union downstream of each valve with screwed connections.

3. Provide screwed or flanged unions at each piece of equipment, where shown on the Drawings, and where necessary to install or dismantle piping.

G. Eccentric Reducers: Use eccentric reducers where shown on the Drawings and where air or water pockets would otherwise occur in mains because of a reduction in pipe size.

H. Transitions from One Type of Pipe to Another:
1. Provide all necessary adapters, specials and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.

I. Taking Existing Pipelines Out of Service:
1. Do not take pipelines out of service, unless specifically named below or approved by ENGINEER.
a. Refer to Section 01143, Coordination with OWNER'S Operations.
2. Notify ENGINEER at least 48 hours prior to taking pipeline out of service.

J. Work on Existing Pipelines:
1. Cut or tap pipes as shown on the Drawings or required with machines specifically designed for this Work.
2. Install temporary plugs to keep out all dirt, water and debris.
3. Provide all necessary adapters, fittings, pipe and appurtenances required.

3.2THRUST RESTRAINT

A. Provide thrust restraint on all pressure piping systems and where otherwise shown on the Drawings or specified.

B. Thrust restraint shall be accomplished by means of restrained pipe joints. Thrust restraints shall be designed for the axial thrust exerted by the test pressure specified in Section 15050, Piping Systems.

C. Restrained Pipe Joints:
1. Pipe joints shall be restrained by means suitable for the type of pipe being installed.
a. Restrain concrete pipe joints utilizing welded joints.
b. Restrain ductile iron mechanical joint pipe utilizing tie rods and clamps or proprietary restrained joint system conforming to the requirements of Section 15101, Ductile Iron Pipe.
c. Restrain ductile iron pipe connected by flexible couplings or flanged coupling adapters by harnessing across the coupling or adapter using tie rods or extended bolts connecting between flanges.
d. Steel pipe shall have butt-welded joints, flanged joints, or flexible or mechanical coupling connectors. Provide tie rods connected to ears welded to the steel pipe for restraint at all flexible coupling connectors.

3.3PAINTING

A. Field painting shall conform to the requirements of Section 09900, Painting.

3.4TESTING OF PIPING

A. General:
   1. Test all piping as specified below, unless otherwise authorized by ENGINEER.
   2. Notify ENGINEER 48 hours in advance of testing.
   3. Provide all testing apparatus including pumps, hoses, gages, and fittings.
   4. Pipelines shall hold the specified test pressure for two hours.
   5. Repair and retest pipelines which fail to hold specified test pressures or which exceed the allowable leakage rate.
   6. Test pressures required are at the lowest elevation of the pipeline section being tested, unless otherwise specified.
   7. Follow special test procedures below for gaseous chemical and liquid chlorine lines.
   8. Conduct all tests in the presence of the ENGINEER. Repeat tests in the presence of local authorities having jurisdiction, if required.

B. Schedule of Pipeline Tests:
   1. Test piping at the test pressure specified in Section 15050, Piping Systems.
   2. For piping not included in Section 15050, Piping Systems, the ENGINEER will notify CONTRACTOR, in writing, of the test pressure to be utilized.

C. Pressure Test Procedure:
   1. Ensure that all supports and restraint protection are securely in place.
   2. Fill section to be tested slowly with water and expel all air. Install cocks, if necessary, to ensure removal of air.
   3. Test only one section of pipe at a time.
   4. Apply specified test pressure required for two hours and observe pressure gage. Check carefully for leaks while test pressure is being maintained.

D. Leakage Testing:
   1. Conduct leakage test after satisfactory completion of pressure test.
   2. Allow concrete pipe to stand full of water at least 12 hours prior to starting leakage test.
   3. Allowable Leakage Rates (gallons per hour per 1000 feet per inch diameter):
      a. Concrete Pressure Pipe: 0.0.
      b. Copper, Steel, Ductile Iron, Thermoplastic, and all Other Piping: 0.0.
      c. Ductile Iron Pipe with Mechanical Joints: 0.0.
   4. Leakage Test Procedure:
      a. Examine exposed pipe, joints, fittings and valves. Repair visible leakage or replace the defective pipe, fitting or valve.
      b. Refill the line under test to reach the required test pressure.

c. Provide a test container filled with a known quantity of water at the start of the test. Attach the test pump suction to the test container.
d. Pump water from the test container into the line with the test pump to hold the specified test pressure for the test period. Water remaining in the container shall be measured and the amount used during the test shall be recorded on the test report.
e. Perform all repair, replacement, and retesting required because of failure to meet testing requirements.
f. Leakage shall be less than rate specified above.

3.5TESTING OF DRAINAGE PIPING

A. General:
1. Test all drainage piping installed under this Section.
2. Provide all testing apparatus required.
3. Notify ENGINEER 48 hours in advance of test.
4. Conduct all tests in presence of ENGINEER.

B. Procedures:
1. Perform test on entire system or on individual sections as approved by ENGINEER.
2. Completely seal all openings except highest opening in system or section to be tested.
3. Fill with water completely and test with at least ten feet of water above highest point.
4. Allow water to stand in system for at least 15 minutes. Inspect for leaks and repair all leaks found. Retest repaired sections.

3.6CLEANING AND DISINFECTION

A. Cleaning:
1. Thoroughly clean all piping and flush prior to placing in service in a manner approved by ENGINEER.
2. Piping 24-inches in diameter and larger shall be inspected from inside and all debris, dirt and foreign matter removed.
3. If piping which requires disinfection has not been kept clean during storage or installation, swab each section individually with a five percent hypochlorite solution, to ensure clean piping.

B. Disinfection:
1. Disinfect all potable and finished water piping.
2. A suggested procedure for accomplishing disinfection is specified below. Other procedures will be considered for approval by the ENGINEER.
a. Thoroughly flush piping prior to disinfection with water. For pipelines 24-inches in diameter and larger, pipelines shall be manually cleaned, carefully removing all sweeping, dirt and debris prior to disinfection.

b. Conform to procedures described in AWWA C 651. Continuous feed method of disinfecting shall be used, unless alternative methods are acceptable to ENGINEER.

3. Water for initial flushing, testing and chlorination will be furnished by OWNER. Provide all temporary piping, hose, valves, appurtenances and services required. Cost of water required for redisinfection will be paid by CONTRACTOR to OWNER at OWNER'S standard rates.
4. Chlorine will be supplied by CONTRACTOR.
5. Bacteriologic tests will be performed by OWNER. A certified laboratory report will be available to CONTRACTOR, if requested.
6. Chlorine concentration in the water entering the piping shall be between 50 and 100 parts per million, such that a minimum residual concentration of 25 mg/l will be left after a 24-hour retention period. Care shall be taken to ensure disinfection of the piping in all its parts. The operation shall be repeated as required to provide complete disinfection.
7. After the required retention period, the heavily chlorinated water shall be flushed to approved drain location, unless otherwise directed by the ENGINEER.

3.7DISPOSAL OF WATER

A. Provide suitable means for disposal of test and flushing water so that no damage results to facilities or waterways.

B. Means of disposal of test and flushing water shall be subject to the approval of ENGINEER, local governing authorities and regulatory agencies.

C. Responsibility for any damages caused by the water disposal operations belongs to CONTRACTOR.

3.8IDENTIFICATION OF PIPING

A. Pipe Identification Markers and Arrows:
   1. Product and Manufacturer: Provide one of the following:
      a. Brady B-500 vinyl cloth self sticking arrows and markers except on insulated pipe. Brady B-350 perma-code film self sticking arrows and markers on pipe insulation.
      b. Equivalent products as made by Seton Name Plate Corporation.
      c. Or equal.
   2. Install markers and arrows at following locations:
      a. At intervals not exceeding 50 feet along continuous runs of pipe.
      b. Wherever pipes pass through walls, floors or panels.
      c. At each valve or equipment connection.
      d. At each branch where it connects to a main line.

+ + END OF SECTION + +

SECTION 15061

PIPE HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown on the Drawings, specified, and required to design, furnish, and install all hangers, supports and appurtenances required to complete the Work.

1.2 QUALITY ASSURANCE

A. Each type of pipe hanger, pipe guide, anchor or support shall be the product of one manufacturer.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. The Manufacturers Standardization Society of the Valve and Fittings Industry:
      a. MSS SP-58, Pipe Hangers and Supports - Materials and Design.
      b. MSS SP-69, Pipe Hangers and Supports - Selection and Application.
   2. Federal Specification, FS A-A-1192, Hangers and Support, Pipe.
   3. ASTM A 575, Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
   4. Underwriters' Laboratories, Inc., Standard UL-203-Pipe Hanger Equipment.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Detailed drawings showing all hangers, supports and expansion compensation for each piping system specified. Shop Drawings shall show location, installation, material, loads and forces, and deflection of all hangers and supports, including expansion and contraction. Each pipe system shall be analyzed for all loads and forces on the hangers and supports, and their reaction forces to the structure to which they are fastened.
   2. Submit and coordinate these with Shop Drawings required for all piping systems, valves and appurtenances.
   3. Refer to and comply with the requirements of Section 01332, Shop Drawing Procedures.

B. Product Information: Submit manufacturers' catalogs, literature, and engineering data on all hangers and supports. Load ratings, materials and installation shall be consistent with the recommendations of the MSS SP-58, MSS SP-69 and Federal Specification A-A-1192.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work. Deliver pipe hanger inserts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of the Work. Refer to and comply with the requirements of Section 01651, Transportation and Handling of Materials and Equipment.

B. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the site. Notify ENGINEER of any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

C. Store materials to permit easy access for inspection and identification. Keep all materials off ground, using pallets, platforms or other supports. Protect steel members and packaged materials from corrosion and deterioration. Refer to and comply with the requirements of Section 01661, Storage of Materials and Equipment.

PART 2 - PRODUCTS

2.1 GENERAL

A. Hangers and supports shall meet with the following requirements:
   1. Standard and fabricated hangers and supports shall be furnished complete with necessary inserts, bolts, nuts, rods, washers, and other accessories.
   2. Generally, run piping in groups where practicable and parallel to building wall. Provide minimum clearance of 1-inch between pipe and other work.
   3. Install hangers or supports at all locations where pipe changes direction.
   4. All hangers and supports shall be capable of adjustment after placement of piping.
   5. Different types of hangers or supports shall be kept to a minimum.
   6. All suspended or supported ductile iron pipe shall have a hanger or support adjacent to each hub.
   7. Support vertical piping at each floor and between floors by stays or braces to prevent rattling and vibration.
   8. Hanger rods shall be straight and vertical. Chain, wire, strap or perforated bar hangers shall not be used. Hangers shall not be suspended from piping.
   9. Maximum support spacing, unless otherwise shown on the Drawings or approved shall be as follows:

Pipe Size (inches)	Maximum Pipe Span [1] (feet)
	Cast/Ductile Iron [2]
14	12

[1] Pipe shall not have pockets formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

[2] Pipe hanger and support selection shall be as shown on the Drawings and this Section.

10. Maximum support spacing, unless otherwise shown on the Drawings, for plastic pipe at ambient temperature shall be one-half of the values specified for steel pipe.
11. Plastic pipe at temperature greater than 130°F shall be continuously supported in a metal cradle or tray.
12. Where proper hanger or support spacing does not correspond with joist or rib spacing, structural steel channels may be attached to joists or ribs and pipes suspended therefrom.
13. Prevent contact between dissimilar metals when supporting copper tubing, by use of copper plated, rubber or vinyl coated, or stainless-steel hangers or supports.
14. Isolate thin-walled stainless steel piping from carbon steel by use of plastic coated hangers or supports or by taping at points of contact with PVC or vinyl.
15. Supports and hangers shall be of a material that is compatible with the fluid being conveyed in such pipe being supported.
16. Anchors for pipe support systems shall be compatible or protected by a coating system which is compatible with the fluid being conveyed in such pipe being supported.
17. Pipe stands shall be a minimum of 3-inches in diameter and the discharge header shall have hold-down straps. Supports shall have a minimum of 2-inch dry packed grout under 100 percent of the support plate and no voids are allowed. The grout shall be struck off tapered on all sides.
18. Wherever there is a removable, serviceable piece of equipment within the piping system, there must be a support on either side in such a way to allow the equipment to be removed without disturbing the pipe alignment.

B. Expansion compensation shall be designed for individual exposed piping systems with the following Design Criteria:
   1. $\Delta L = L \times \Delta T \times \alpha$
      a. Where ΔL = pipe length change (in.)
      b. L = pipe length between anchors (in.)
      c. ΔT = 100 (F)
      d. α = coefficient of thermal expansion (in./in./F)
   2. Expansion compensation shall be designed as an integral part of the piping hanger, support and anchorage system.

3. Expansion compensation shall be achieved via expansion joints specified in Section 15120, Piping Specialties and Accessories.

2.2 HANGERS AND SUPPORTS

A. Hangers, supports, pipe guides and anchors where shown shall be in accordance with the Drawings. Hangers and supports not shown shall be in accordance with MSS SP-58.

B. Product and Manufacturers: Provide one of the following:
   a. ITT Grinnel Company
   b. Elean
   c. B Line
   d. Unistrut Corporation
   e. Or equal

2.3 ACCESSORIES

A. Hanger rods shall be made from ASTM A 575, with square head nut on top and running thread on bottom end.

B. Concrete Inserts:
   1. Concrete inserts shall be MSS SP-58 malleable Type 18.
   1. Concrete inserts shall be of the continuous type capable of supporting 1,500 pounds per foot of insert as shown on the Drawings.
   2. Product and Manufacturer: Provide one of the following:
      a. Unistrut Corporation.
      b. Elcan Metal Products.
      c. ITT Grinnell.
      d. B-Line.

C. Steel Beam Clamps:
   1. Steel beam clamps shall be of malleable iron and conform to MSS SP-58 Type 24.

D. Inserts for Pipe Insulation:
   1. Insulated pipe, larger than 1-1/2-inches in diameter, shall be supported by a rigid insert to protect the insulation. A steel metal saddle of sufficient gage to carry the weight of the pipe and its fluid without deforming shall extend 2-inches minimum on each side of the rigid insert. The joints between insert and insulation shall be sealed before saddle is installed. Sizes up to 6-inches IPS shall be MSS SP-58 Type 40 and for sizes over 10-inches shall be MSS SP-58 Type 39.

E. Brackets:
   1. Brackets for wall mounting shall be MSS SP-58 Type 32.

F. Fabricated Pipe Rack:
   1. Pipes shall be supported and anchored to the fabricated pipe rack as shown on the Drawings. Clamps, rollers, and supports for piping shall conform to the general requirements of MSS SP-69.

2.4 PAINTING

A. Clean and shop prime ferrous metal surfaces in the shop in accordance with the requirements of Section 09900, Painting.

B. Field painting shall conform to the requirements of Section 09900, Painting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate hangers, supports, and accessories to support piping, valves, and at all concentrated loads.

B. Locate hangers, supports, and accessories within maximum span lengths specified to support continuous pipeline runs unaffected by concentrated loadings.

C. Locate hanger, supports to prevent vibration or swaying and to provide for expansion and contraction.
   1. Temperature differential as specified in this Section.
   2. Support piping independently so that equipment is not stressed by piping weight or expansion/contraction.
   3. For Uninsulated Copper Pipe or Tubing: Clamps and supports, electroplated copper finish. All tubing layout and connections shall be as approved by the manufacturer of the equipment.
   4. Uncoated Hangers, Rods and Supports: Dip in zinc chromate primer before installation.
   5. Maximum spacing for horizontal piping:
      a. Refer to table in Paragraph 2.1.A.9, above.
      b. Additional supports at:
         1) Change in direction.
         2) Branch piping and runouts over five feet.
         3) Concentrated loads due to valves, strainers, and other similar items.
      c. Maximum support spacing for plastic pipe at ambient temperature shall conform to the requirements of the table located in Paragraph 2.1.A.9., above, unless otherwise shown on the Drawings.
   6. Hanger types for horizontal piping, except as noted and shown on the Drawings:
      a. Forged steel adjustable clevis type, rod support for all service.

b. Slide Bases:
   1) Pipe stand, brackets, trapeze or other equivalent structural support.
   2) For piping 2-inches or larger.
c. For pipe and covering provide:
   1) Saddles for rollers or slide bases.
   2) Protective shields or saddles for all other types of supports.
d. Threaded Steel Rods:
   1) Two-inch vertical adjustment with two nuts at each end for positioning and locking.
   2) Size hanger rods according to the schedule below, unless otherwise noted on the Drawings:

Nominal Pipe (Inches)	Rod Diameter (Inches)
2 and less	3/8
2-1/2 to 3-1/2	1/2
4	5/8
6	3/4
8 through 12	7/8
14 through 18	1
20 through 30	1-1/4

   3) For Double Rod Hangers: One size smaller than above.
   4) Connection to Structure for Piping to 2-Inches: Concrete inserts in shear into sides of beams.
   5) Connection to Structure for Piping 2-1/2 Inches or Larger: Concrete inserts, beam clamps or suitable bridging.

7. Vertical Piping:
   a. Base Support: Base elbow or welded equivalent.
      1) Bearing plate on structural support.
   b. Guides not to exceed:
      1) Twenty-five feet for piping to 2-inches.
      2) Thirty-six feet for piping 2-1/2-inches or larger.
      3) Ten feet for chlorination piping.
   c. Top Support:
      1) Special hanger or saddle in horizontal connection.
      2) Provisions for expansion/contraction.
   d. Intermediate Supports: Steel pipe clamp at floor.
      1) Bolted and welded to pipe.
      2) Extension ends bearing on structural steel or bearing plates.
   e. For Multiple Pipes: Coordinate guides, bearing plates and accessory steel.
8. Insulated Piping:
   a. Horizontal Pipe Shields at Supports:
      1) Minimum 120-degree arc.
      2) Length equal to diameter of insulation, 12-inch minimum.
      3) To 6-Inch Pipe Size: No. 18 USSG stainless steel.

b. Vertical Pipe Shields at Guides:
   1) Full 360-degree arc, securely banded.
   2) Length equal to diameter of insulation, 12-inch minimum.
   3) To 6-Inch Pipe Size: No. 18 USSG stainless steel.

D. Install items to be embedded before concrete placement.

E. Fasten embedded items securely to prevent movement during concrete placement.

F. Install hangers and support units on piping systems in accordance with manufacturer's recommendations and instructions.

G. Adjust hangers, supports, pipe guides and anchors and place grout for concrete supports to bring pipelines to specified elevations.

H. Bring all pipe systems up to operating pressures and temperatures. Cycle systems to duplicate operating conditions. Correct all support malfunctions.

++ END OF SECTION ++

SECTION 15101

DUCTILE IRON PIPE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish ductile iron pipe and fittings.
   2. The extent of the piping is shown on the Drawings and in Section 15050, Piping Systems.

1.2 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer shall have a minimum of five years of experience producing ductile iron pipe and fittings, and shall be able to show evidence of at least five installations in satisfactory operation of similar diameters, lengths, and pipe class required for the Work.
   2. All ductile iron pressure water pipe shall be furnished by a single manufacturer and fully manufactured in the USA, including casting, testing, and all applicable linings and coatings. The supplier shall be responsible for the provisions of all test requirements specified in AWWA C151 as applicable. In addition, all ductile iron pressure water pipe to be installed under this Contract may be inspected at the plant for compliance with these specifications by an independent testing laboratory provided by the OWNER. The CONTRACTOR shall require the manufacturer's cooperation in these inspections. The cost of plant inspection of all pipe approved for this Contract, will be borne by the OWNER.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. AWWA C104, Cement-Mortar Lining for Ductile Iron Pipe and Fittings.
   2. AWWA C110, Ductile Iron and Gray-Iron Fittings.
   3. AWWA C111, Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
   4. AWWA C115, Flanged Ductile Iron Pipe with Ductile-Iron or Grey-Iron Threaded Flanges.
   5. AWWA C150, Thickness Design of Ductile Iron Pipe.
   6. AWWA C151, Ductile Iron Pipe, Centrifugally Cast.
   7. AWWA C153, Ductile-Iron Compact Fittings for Water Service.
   8. AWWA C600, Installation of Ductile Iron Water Mains and Their Appurtenances.
   9. AWWA C606, Grooved and Shouldered Joints.
   10. ANSI/ASME B16.1, Grey Iron Pipe Flanges and Flanged Fittings.

11. ANSI/ASME B18.2.1, Square, Hex, Heavy Hex and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head and Lax Screws (Inch Series).
12. ANSI/ASME B18.2.2, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
13. ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
14. ASTM A354, Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Submit detailed drawings and data on pipe, fittings, gaskets and appurtenances as required. Refer to and comply with the requirements of Section 15051, Buried Piping Installation, Section 15052, Exposed Piping Installation, Section 15121, Wall Pipes, Floor Pipes and Pipe Sleeves, and Section 15061, Pipe Hangers and Supports.
   2. Within 14 days of the Date of Agreement, submit the name of the pipe manufacturer and a list of materials to be furnished by said manufacturer. Also, include information on local representative for manufacturer, if product is sold through a distributor.
   3. Shop Drawings shall include piping layouts and schedules. Drawings shall include dimensioning, joint details (including standard and restrained joint details) indicating all pertinent dimensions and manufacturing tolerances, methods and location of supports, anchorage, gasket material, grade of material, and all other pertinent technical information for all items to be furnished.
   4. Submit manufacturer's catalog data and descriptive literature for all material items listed below. Show dimensions and materials of construction by specification reference and grade where applicable.
      a. Polyethylene film for encasement of ductile iron.
      b. Wire.
      c. Exothermic weld kit.
      d. Weld caps.
      e. Weld coating.
   5. Qualifications of the contractor’s Corrosion Engineer and Corrosion Technician.

B. Certificates: Submit certificates of compliance with referenced standards.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work.

B. Handle all pipe, fittings, specials and accessories carefully with approved handling devices. Do not drop or roll material off trucks. Do not otherwise drop, roll or skid piping.

C. Store pipes and fittings on heavy wood blocking or platforms so they are not in contact with the ground.

D. Unload pipe, fittings and specials opposite to or as close to the place where they are to be installed as is practical to avoid unnecessary handling. Keep pipe interiors completely free from dirt and foreign matter.

E. Inspect delivered pipe for cracked, gouged, chipped, dented or otherwise damaged material and immediately remove from site.

F. Any pipe or fitting showing a crack or which has received a blow that may have caused an incident fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
1. Joints shall be as specified in Section 15050, Piping Systems. If not specified, provide flanged joints for exposed piping and push-on or mechanical joints for buried piping. Couplings shall be provided on pipe with plain or grooved ends where shown on the Drawings or where approved by ENGINEER. Joints for piping located in vaults and structures shall be flanged unless mechanical clamp-type couplings or flange adapters are shown on the Drawings.
2. Ductile iron pipe shall be designed, manufactured, tested, inspected, and marked in accordance with the provisions of this Specification and AWWA C151 except as modified herein.
3. All ductile iron pipe 16-inches and larger shall have cathodic protection. Pipelines less than 16-inches shall have cathodic protection where called for in the plans and specifications.

B. Ductile Iron Pipe and Fittings:
1. Flanged Pipe: Fabricate in accordance with requirements of AWWA C115.
   a. Thickness: Wall thickness shall be minimum Class 53 except where the specified pressure requires heavier pipe.
2. Non-Flanged Pipe: Conform to AWWA C151 for material, pressure, dimensions, tolerances, tests, markings and other requirements.
   a. Pressure: Pipe shall be designed to meet the testing requirements of Paragraph 3.1.C. If not shown on the Drawings, use Pressure Class 350.
   b. Minimum Thickness: Class 53.
3. Joints:
   a. Flanged Joints: Conform to AWWA C110, C115 and C153 capable of meeting, working and test pressure specified in Paragraph 3.1.C.
      1) Gaskets: High temperature resistant sealing compounds (Loctite PST 592) or equivalent with Dimethacrylate ester base and Teflon can be used.
         a) Gaskets: Unless otherwise specified, gasket stock shall be a synthetic rubber, 1/8-inch thick, full face, compound in which the elastomer is

nitrile or neoprene. The compound shall contain not less than 50 percent by volume nitrile or neoprene and shall be free from factice, reclaimed rubber and other deleterious substances. Gaskets shall comply with AWWA C111 for push-on and mechanical joints with AWWA C606 for grooved end joints.

2) Bolts and Nuts: Conform to ANSI B18.2.1 and ANSI B18.2.2, respectively. Exposed and buried bolts and nuts shall be ASTM A307, Grade B. Buried bolts and nuts not encased in polyethylene shall be mortar coated to a minimum thickness of 1-inch or alternately coated with a petroleum based mastic and wrapping tape system Denso Paste primer and Densyl Tape finish as manufactured by Denso, or approved equal. Submerged bolts and nuts shall be Type 316 stainless steel.

b. Mechanical Joints: Conform to AWWA C110, AWWA C111 and C-153.
   1) Glands: Ductile iron.
   2) Gaskets: Plain Tip.
   3) Bolts and Nuts: Conform to ANSI B18.2.1 and ANSI B18.2.2, respectively. Bolts and nuts shall be ASTM A307, Grade B. Buried bolts and nuts not encased in polyethylene shall be mortar coated to a minimum thickness of 1-inch or alternately coated with a petroleum-based mastic and wrapping tape system Denso Paste primer and Densyl Tape finish as manufactured by Denso, or approved equal.

c. Push-On Joints: Conform to AWWA C111.
   1) Gaskets: Molded rubber.
   2) Strips: Each plain end shall be painted with a circular stripe to provide a guide for visual check that joint is properly assembled.

d. Grooved End Joints: Conform to AWWA C606.
   1) Gaskets: Flush seal type designed for ductile iron.
   2) Bolts and nuts: As specified for flanged joints.
   3) Unless otherwise specified, grooved end couplings shall be rigid joint for exposed service and flexible joint for buried service.
   4) Grooved end joints shall be as manufactured by one of the following:
      a) Victaulic, Style 31
      b) Or equal.
   5) For grooved-end pipe, wall thickness shall be minimum Class 53 except where the specified pressure requires heavier pipe.

e. Restrained Joints: Restrained push-on joints shall be capable of being deflected after full assembly. Joint assembly shall be in strict conformance with AWWA C600 and manufacturer's recommendations. No field cuts of restrained pipe are permitted without prior approval of the ENGINEER.

f. Restrained Joints:
   1) All pipeline valves and fittings shall have thrust blocks as shown or referenced on the drawings designed for the working pressure in addition to the restraining systems per Paragraph 2.1.B.3.f 2 and 3).
   2) Restrained joints for mechanical joint piping shall be one of the following:
      a) Romagrip, as manufactured by Romac Industries.
      b) Megalug, Series 1100, as manufactured by EBBA Iron Sales, Inc.

c) Stargrip, Series 3000, as manufactured by Star Pipe Products
d) Uni-Flange Series 1400, as manufactured by Ford Meter Box.

3) Restrained joints for push-on joint piping shall be one of the following:
a) Clow Super-lock Joint Pipe, as manufactured by Clow Cast Iron Pipe and Foundry Division of Clow Corporation.
b) Lok-Ring Joint, or Flex-Ring Joint, as manufactured by American Cast Iron Pipe Company.
c) TR Flex Joint, as manufactured by U.S. Pipe.
d) Thrust-lock, as manufactured by Pacific States Pipe.
e) Snap-Lok or Bolt-Lok, as manufactured by Griffin Pipe.

4) Split restrained joint glands for mechanical joints, or wedge action restrained joint glands for push (non-mechanical) joints, are only allowed for connection or repair to existing installed pipe. The split restrained joint or wedge glands shall be one of the following:
a) Stargrip Series 3000S, 3100P, 3100S, as manufactured by Star Pipe Products
b) Megalug Series 1100SD, 1100H D, as manufactured by EBAA Iron Sales, Inc.
c) Megalug Series 1700, as manufactured by EBAA Iron Sales, Inc.
d) Uni-Flange Series 1450, as manufactured by Ford Meter Box

4. Flanged fittings: Conform to AWWA C110 and AWWA C115. AWWA C153 compact ductile iron fittings are acceptable for use unless otherwise specified. Long-radius elbows shall be provided where specified.
a. Pressure Rating: Class 350.
b. Material: Ductile iron.
c. Gaskets: As specified above for joints.
d. Bolts and Nuts: As specified above for joints.

5. Mechanical Joint Fittings: Conform to AWWA C110. AWWA C153 compact ductile iron fittings are acceptable for use unless otherwise specified. Long-radius elbows shall be provided where specified.
a. Pressure Rating: Class 350.
b. Material: Ductile iron.
c. Glands: Use ductile iron glands only. Cast iron glands are not allowed.
d. Gaskets: As specified above for joints.
e. Bolts and Nuts: As specified above for joints.

6. Coatings and Linings:
a. Unless otherwise specified, pipe and fittings shall be lined with a cement-mortar lining in accordance with AWWA C104.
b. Where specified in Section 15050, Piping Systems, glass-lined pipe shall be provided in accordance with Section 15107, Glass Lined Ductile Iron Pipe.
c. Buried pipe and fittings shall be coated on the outside with a bituminous coating, approximately 1-mil thick material as specified in AWWA C151. Buried flanged joints shall be coated with a petroleum based mastic and wrapping tape system Denso Paste primer and Densyl Tape finish as manufactured by Denso, or approved equal. Exposed pipe shall be prime coated in accordance with Section 09900, Painting.

d. Polyethylene Encasement:
   1) All polyethylene film shall be manufactured in accordance with ANSI/AWWA C105/A21.5.
   2) All open cut installed buried pipe shall be provided with polyethylene encasement to prevent contact between the pipe and surrounding bedding material and backfill.
   3) Polyethylene may be supplied in tubes or in sheet material.

7. Epoxy Lining Material: Where specified in Section 15050, Piping Systems, epoxy lining shall be provided. The material shall be an amine cured novalac epoxy containing at least 20 percent by volume of ceramic quartz pigment. Epoxy lining material manufacturer shall demonstrate a successful history of lining pipe and fittings for sewer service and submit a test report verifying the following properties, and a certification of the test results.
   a. A permeability rating of 0.00 when tested according to Method A of ASTM E-96-66, Procedure A with a test duration of 30 days.
   b. The following test shall be run on coupons from factory lined ductile iron pipe:
      1) ASTM B-117 Salt Spray (scribed panel): Results to equal 0.0 undercutting after two years.
      2) ASTM G-95 Cathodic Disbondment 1.5 volts at 77°F: Results to equal no more than 0.5 mm undercutting after 30 days.
      3) Immersion Testing rated using ASTM D-714-87.
         a) 20 percent Sulfuric Acid: No effect after two years.
         b) 25 percent Sodium Hydroxide: No effect after two years.
         c) 160°F Distilled Water: No effect after two years.
         d) 120°F Tap Water (Scribed panel): 0.0 undercutting after two years with no effect.
   c. An abrasion resistance of no more than four mils loss after one million cycles - European Standard EN 598: 1994 Section 7.8 Abrasion Resistance.
   d. Interior of the pipe shall receive 40 mils dry film thickness.
   e. Applicator: The lining shall be applied by a competent firm with a successful history of applying linings to the interior of ductile iron pipe and fittings.
   f. Surface Preparation: Pipe surfaces shall be cleaned and sand blasted prior to lining application in accordance with manufacturer's recommended procedures.
   g. Inspection and Certification:
      1) All ductile iron pipe and fitting linings shall be checked for thickness using a magnetic film thickness gauge. The thickness testing shall be done using the method outlined in SSPC-PA-2 Film Thickness Rating.
      2) The interior lining of all pipe barrels and fittings shall be tested for pinholes with a non-destructive 2,500-volt test. Any defects found shall be repaired prior to shipment.
      3) The pipe or fitting manufacturer shall supply a certificate attesting to the fact that the applicator met the requirements of this specification.
   h. Product and Manufacturer: Provide one of the following:
      1) Protecto 401.
      2) Or equal.

8. Bonded Joints:

a. All pipes 16 inches and larger shall have bonded joints.

b. Joint Bond Wires: Bond wires shall be provided across all non-conductive ductile iron pipe joints to ensure electrical continuity. Joint bonds shall be installed as shown on the drawings.

Joint bonds shall be made utilizing #4 AWG type HMWPE stranded conductors. Bond wires shall not exceed 18 inches in length. Connections shall be made utilizing the exothermic weld process as described below.

c. Exothermic Welds: Exothermic welds shall be provided for wire to structure connections in strict accordance with the manufacturers recommendations. Connections shall be made at locations shown on drawings. Exothermic welds shall be "Cadweld", as manufactured by Erico Products, Inc., "Thermoweld" as manufactured by Continental Industries, Inc., "Pin Brazing" by BAC, or approved equal. Duxseal packing as manufactured by Johns-Manville or approved equal shall be used where necessary to prevent leakage of molten weld metal.

The shape and charge of the exothermic weld shall be chosen based on the following parameters:

1) Pipe Material
2) Pipe Size
3) Wire Material
4) Number of Strands to be Welded
5) Orientation of Weld (Vertical or Horizontal)

Type of exothermic weld to be used shall be submitted to the Construction Manager for approval.

Copper sleeves specifically designed for the purpose shall be crimped on all bare wire ends of all stranded wires prior to exothermic welding to improve mechanical strength and thermal capacity.

d. Weld Caps: Welds to be buried or submerged shall be primed with an elastomer resin based primer then be covered with a 100% solids mastic filled plastic cap. Use the plastic cap on dielectric coated pipe following the manufacturer's instructions. Primer shall be Roybond Primer 747 as manufactured by Royston Laboratories, or equivalent. Weld caps shall be Royston Handy Cap, as manufactured by Royston Laboratories, Inc. Thermit Weld Cap, as manufactured by Phillips Petroleum Co. or an approved equal.

C. Couplings:
1. Refer to Section 15120, Piping Specialties and Accessories.

D. Specials:
1. Transition Pieces:
   a. Furnish suitable transition pieces (adapters) for connections to existing piping.
   b. Unless shown on Drawings, expose existing piping to determine material, dimensions and other data required for transition pieces.
2. Taps:
   a. Provide taps where shown on the Drawings or required for small diameter pipe connections.

b. Provide a tapping saddle conforming to the requirements of the City of Phoenix Water Services Department. Tapping saddles shall have a maximum outlet diameter of 3".

3. Welded Outlets:
   a. Provide welded outlet fittings as shown on the Drawings.
   b. Welded-on outlets shall be limited to branch or radial outlets.
   c. Welded-on outlets may be provided as a radial (tee) outlet, or lateral outlet fabricated at a specific angle to the main line pipe, as indicated on the drawings.
   d. Outlets greater than fifty percent (50%) of the nominal diameter of the main line pipe or 12-inch, which ever is smaller, shall be an integral tee fitting.
   e. Welded outlets for ductile iron pipe are not acceptable for a tangential configuration unless shown on the plans or approved by the ENGINEER.
   f. No welding shall be permitted within 24-inches from the end of the pipe. Spacing of welded outlets shall not be closer than two times the diameter of the largest outlet.
   g. The pipe manufacturer or fabricator performing the welds shall have a minimum of 5 years experience in the fabrication and testing of outlets of similar size and configuration.
   h. The joints on welded-on branch outlets shall meet, where applicable, the requirements of ANSI/AWWA C111/A21.11 and/or ANSI/AWWA C115/A21.15.
   i. Design
      1) Weldment for welded-on outlets shall be based on the method described in Section VIII of the ASME Unfired Pressure Vessel Code. Reinforcing welds shall be placed using Ni-Rod FC 55o cored wire or Ni-Rod 55o electrodes manufactured by INCO Alloys (or an electrode with equivalent performance properties). Carbon Steel electrodes are not acceptable. 2) Parent pipe and branch outlet pipe shall be centrifugally cast ductile iron pipe designed in accordance with ANSI/AWWA C150/A21.50 and manufactured in accordance with NSI/AWWA C151/A21.51. Minimum classes shall be: for sizes 4-inch through 54-inch, Special Thickness Class 53; for sizes 60-inch through 64-inch, Pressure Class 350.
      2) Welded outlets require submittal and approval of design calculations, welding procedures, and actual structural testing results for both hydrostatic pressure as well as transverse and axial loading imposed on the outlet itself.
   j. Testing
      1) All welded-on outlets shall be rated for a working pressure of 250 psi and must have a minimum safety factor of 2.0 based on proof of design hydrostatic test results. The manufacturer shall, at the request of the owner or owner's Engineer, provide representative proof test data confirming hydrostatic test results and safety factors.
      2) Prior to the application of any coating or lining in the outlet area all weldments for branch outlets to be supplied on this project shall be subjected to an air pressure test of at least 15 psi. Air leakage is not acceptable. Any leakage shall be detected by applying an appropriate soapy water solution to the entire exterior surface of the weldment and adjoining pipe edges or by immersing the entire area in a vessel of water and visually inspecting the weld surface for the presence of air bubbles. Any weldment that shows signs

of visible leakage shall be repaired and retested in accordance with the manufacturer's written procedures.

k. Quality Assurance:
   1) The manufacturer shall have a fully documented welding quality assurance system and maintain resident quality assurance records based on ANSI/AWS D11.2, the Guide for Welding Iron Castings. The manufacturer shall maintain appropriate welding procedure specification (WPS), procedure qualification (PQR), and welder performance qualification test (WPQR) records as well as appropriate air test logs documenting air leakage tests. The manufacturer shall have ISO 9001 or 9002 registration.
   2) Prior to the start of manufacturing any proposed manufacturer not meeting ISO 9001 or 9002 registration requirements shall submit to the owner or owner's Engineer the name of an Independent Inspection Agency and the agency's qualifications. Submitted qualifications shall include but are not limited to the following:
      a) List of project references for projects of similar type and size
      b) Resumes for inspection and testing personnel
      c) Capacities for chemical and mechanical testing of material specimens
      d) Frequencies for all instrument and testing equipment certifications
   3) The independent inspection agency shall be responsible for all of the following:
      a) Verify compliance to written welding procedures specification (WPS) and procedure qualification (PQR)
      b) Verify qualification of all welders (WPQR) per ANSI/AWS D11.2 criteria
      c) Document use of Ni-Rod FC 55o cored wire or Ni-Rod 55o electrodes manufactured by INCO Alloys (or an electrode with equivalent performance properties)
      d) Witness and document all air testing of outlet welds

l. Field Welding: No field welding or field repairs shall be allowed. Should a leak be detected at a welded-on outlet after installation, the piece shall be removed and returned to the pipe manufacturer's facility, where originally produced, for repair or replacement.

2.2 MARKING FOR IDENTIFICATION

A. All pipeline materials shall be stamped, marked or identified with the following:
   1. Name or trademark of the manufacturer.
   2. Pipe class.
   3. Size and length dimensions.
   4. Date and place of manufacture.

B. Plastic Tracer Tape: Tracer tape shall be 6-inches wide, colored the same as the background colors as specified in Section 09900, Painting, and made of inert plastic material suitable for direct burial. Tape shall be capable of stretching to twice its original length and shall be as

manufactured by Allen Systems, W. H. Brady Co., Seton Name Plate Corporation, Marking Services Inc., or equal.

Two messages shall be printed on the tape. The first message shall read "CAUTION CAUTION CAUTION _____ PIPE BURIED BELOW" with bold letters approximately 2-inches high. The blank shall be filled with the particular system fluid such as potable water. The second message shall read, "CALL _____" with letters approximately 3/4-inch high. The blank shall be filled in with the City telephone number (--1--). Both messages shall be printed at maximum intervals of two feet.

2.3 SURFACE PREPARATION AND SHOP PAINTING

A. Exposed pipe and fittings:
   1. Clean and prime coat ferrous metal surfaces of piping in the shop in accordance with the requirements of Section 09900, Painting.
   2. Field painting shall conform to the requirements of Section 09900, Painting.

B. Buried pipe and fittings:
   1. Refer to Paragraph 2.1.B.6.c., above

PART 3 - EXECUTION

3.1 INSTALLATION

A. For buried piping installation and testing, refer to Section 15050, Piping Systems, and Section 15051, Buried Piping Installation.

B. For exposed piping installation and testing, refer to Section 15050, Piping Systems, and Section 15052, Exposed Piping Installation.

C. Testing
   1. General:
      a. The Contractor shall test waterlines for water tightness, including all fittings and connections to the waterlines. Each pipe shall be tested for leakage and pressure in accordance with applicable provisions of AWWA standards and/or Manuals, except as modified below.
      b. The Contractor shall provide all vents, piping, plugs, bulkheads, valves, bracing, blocking, pump, including measuring device and all other equipment necessary for making the tests, except pressure gages. Contractor shall furnish all labor and material, and all water required for pressure testing and obtain all permits for test water discharge at no additional cost to the Owner. All water must be dechlorinated to negligible levels prior to discharge to any location. All test water shall be potable. No other water shall be allowed in the pipe.
      c. The pipe shall be tested between the closed ends of the pipe. There shall be no testing against a valve unless otherwise approved. Pipe test section shall be

limited to 2,500 linear feet, or less, unless otherwise approved in writing by the Engineer. No section of the pipeline shall be tested until all field-placed concrete or mortar has attained a strength of 3000 psi. The Contractor shall be responsible for ascertaining that all test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to, or movement of, the adjacent pipe. Any unharnessed sleeve-type couplings, expansion joints, or other sliding joints shall be restrained or suitably anchored prior to the test, to avoid movement and damage to piping and equipment.

d. The test shall be made after the backfilling is completed and compacted, regardless of the compaction method.
e. All connections, blowoffs, hydrants and valves shall be tested with the main, where practical.
f. The test section shall be slowly filled with potable water and all air shall be vented from the line. The rate of filling shall be as approved by the Superintendent of Water Distribution, with at least 24-hour notice required before filling is scheduled.
g. Connections to existing pipelines or existing valves shall be made after new construction has satisfactorily passed the pressure and leakage tests and potable water piping has been flushed and disinfected in accordance with AWWA C651.

2. Pressure Test
   a. Waterlines, including all fitting and connections shall be tested for water tightness by subjecting each test section to pressure test. The test pressure shall be measured at the lowest end of the test section. The test pressure shall be 188 psi unless otherwise specified. The duration of each pressure test shall be at least 2 hours. The pressure test shall begin after the pipe has been filled with water for a minimum of 48 hours to allow the concrete or mortar lining, as applicable, to absorb what water it will and to allow the escape of air from any air pockets. During this period, bulkheads, valves, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to the Engineer shall be taken.
   b. Makeup water can be added to the pipeline to maintain test pressure. The amount of make-up water does not indicate a pass or fail of the pressure test. Satisfactory test results shall be per Paragraph 3.1.C.2.c.
   c. Satisfactory test results are achieved if the test pressure is maintained within 5 psi of the required test pressure for the duration of the 2-hour test.

3. Leakage Test
   a. Leakage tests shall be made after pressure test has been completed and pressure test results are satisfactory.
   b. The duration of each leakage test shall be at least 2 hours. Leakage test pressure shall be a minimum of 150 psi unless otherwise indicated and the test pressure shall be maintained within 5 psi of the specified leakage test pressure during the test. Water may be continually fed or added when the pressure drops 5 psi.
   c. The maximum allowable leakage from the pipe line shall be determined by the applicable formula:

$$L = \frac{ND\sqrt{P}}{7400}$$

in which:

L = allowable leakage in gallons per hour

N = number of joints in the main run pipe being tested, with no allowance for joints at branches, blowoff, fittings, and similar appurtenances. "N" is calculated using the standard length of pipe installed divided into the length being tested.

D = nominal inside diameter of pipe in inches.

P = average test pressure, in psi gage, as measured at the lowest point in the test section.

d. Should the test on any section of the pipeline show leakage greater than specified above, the Contractor shall locate and correct until the leakage is within the specified allowance for a 2-hour duration. All repairs and retests shall be at the Contractor's expense.

e. Leakage is defined as the quantity of make-up water necessary for the test section to maintain the specified leakage test pressure after the pipeline has been filled with water and all air expelled.

4. Cleaning and Flushing: Cleaning and flushing shall be per Section 15050-3.6.

D. Polyethylene Encasement:
1. Encase all ductile iron pipe with polyethylene in accordance with ANSI/AWWA C105/A21.5.
2. Repair any rips, punctures or other damage to the tube with the adhesive tape or pieces of tube material secured with tape.

3.2 PIPING IDENTIFICATION

A. Pipe Coding: After application of the specified coating and insulation systems, exposed piping, interior and exterior, and piping in ceiling spaces, pipe trenches, pipe chases and valve boxes shall be identified with painted bonding and lettering as specified in Paragraph 2.2, above. Legend markers and directional arrows shall be located at each side of walls, floors and ceilings, at one side of each piece of equipment, at piping intersections, and at approximately 25-foot centers.

B. Plastic Tracer Tape: A single line of tape as specified in Paragraph 2.2.B., above, shall be provided 2.5 feet above the centerline of buried ferrous pipe. For pipelines buried eight feet or greater below finished grade, provide a second line of tape 12-inches below finished grade,

above and parallel to each buried pipe. Tape shall be spread flat with message side up before backfilling.

3.3 BONDED JOINTS

A. Description: Upon completion of installation of all components as shown on the drawings and in accordance with these specifications, testing shall be performed to demonstrate that the installation has been completed and is in working order in conformance with the drawings and specifications. In no case shall the testing be less than those tests outlined herein unless requested in writing by the Contractor and approved by the Construction Manager. The testing described herein shall be in addition to and not a substitution for any required testing of individual items at the manufacturers' plant. The Contractor shall provide testing of the system. The test data shall be submitted to the Construction Manager for acceptance to demonstrate that the system is in proper working order. The cost of the testing shall be borne by the Contractor, including any additional expenses which result from retesting due to equipment or installation which is not in conformance with these specifications and drawings.

B. Joint Bond Wires: Joint bond wires shall be installed as shown on the drawings. Make connections by the exothermic weld process per 3.3.C. After installation, all joint bonds shall be tested for effectiveness. The testing shall be performed prior to backfill of the pipe and shall be verified upon completion of backfilling operations. Prior to backfilling, current shall be circulated through the pipe and the measured resistance shall be compared to the theoretical resistance of the pipe and bond wires. The resistance measured shall not exceed 120 percent of the theoretical resistance. Once backfilling operations have been completed, the testing shall be repeated to ensure continued effective continuity. All data shall be tabulated and submitted upon completion of testing and prior to final acceptance of the contract.

C. Exothermic Welds: Exothermic weld connections shall be installed in the manner and at the locations shown on the plans. Coating materials shall be removed from the surface over an area of sufficient size to make the connection. The steel surface shall be cleaned to shiny metal by grinding or filing prior to welding the conductor. The use of resin impregnated grinding wheels will not be allowed. The conductor shall be welded to the pipe by the exothermic welding process with a copper sleeve fitted over the conductor. Only enough insulation shall be removed such that the copper conductor can be placed in the welding mold. After the weld has cooled, all slag shall be removed, and the metallurgical bond shall be tested for adherence to the pipe or casing. All defective welds shall be removed and replaced. All exposed surfaces of the copper and steel shall be covered with insulating materials as shown in the detail drawings. No connections to the piping shall be buried prior to inspection and approval of the Engineer. Connections made in violation of this requirement shall be rejected.

Welds shall be primed with an elastomer resin-based primer, covered with a weld cap, and then over-coated with bitumastic.

Exothermic welds shall be tested by the Contractor for adherence to the pipe or casing and for electrical continuity between the pipe or casing and wires. Test completed weld by striking weld with a hammer and pulling on wire. A 22-ounce hammer shall be used for adherence testing by striking a blow to the weld. Care shall be taken to avoid hitting the wires.

3.4 INSPECTION

A. Inspect all piping to assure that piping is free from defects in material and workmanship. The compatibility of all pipe, fittings, gaskets and coatings shall be verified.

+ + END OF SECTION + +

SECTION 15108

FIBERGLASS REINFORCED PLASTIC PIPE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install fiberglass reinforced plastic (FRP) piping.
   2. The extent of fiberglass reinforced plastic pipe is shown on the Drawings and as specified in Section 15050, Piping Systems.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturers of fiberglass reinforced plastic pipe and fittings shall have a minimum of five years of experience producing fiberglass reinforced plastic pipe and fittings and shall be able to show evidence of at least five installations in satisfactory operation.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM D 1330, Specification for Rubber-Sheet Gaskets.
   2. ASTM D 1599, Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing and Fittings.
   3. ASTM D 2105, Test Method for Longitudinal Tensile Properties of Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Tube.
   4. ASTM D 2122, Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.
   5. ASTM D 2310, Classification for Machine-Made Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Tube.
   6. ASTM D 2412, Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
   7. ASTM D 2992, Practice for Obtaining Hydrostatic or Pressure Design Basis for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings.
   8. ASTM D 2996, Specification for Filament-Wound Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
   9. ASTM D 2997, Specification for Centrifugally Cast Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
   10. ASTM D 3754, Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe.

11. ASTM D 3839, Practice for Underground Installation of Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
12. ASTM D 4024, Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Flanges.
13. ASTM D 4161, Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals.
14. AWWA C950, Glass-Fiber-Reinforced Thermosetting-Resin Pressure Pipe.
15. Standards of Society of the Plastic Industry.

C. Shop Tests:
1. Manufacturer shall maintain a continuous quality control program and shall provide the ENGINEER with certified test reports.
2. Tests shall be witnessed by a Registered Professional Engineer or a member of ASTM, who may be an employee of the manufacturer. The Registered Professional Engineer shall seal and sign all test reports.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Details of construction, fabrication, and specifications for pipe laminate construction.
2. Details of piping system including location of supports, fittings, anchors, and all accessories necessary for piping system.
3. Pipe laying schedules.
4. Submit these with Shop Drawings required under Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.

B. A sample piece of pipe approximately 1-foot long of each diameter, if requested by ENGINEER.

C. Test Reports: Submit reports for any tests required above with test specimens.

D. Certificates: Submit certificates of compliance with referenced standards.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Refer to Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.

B. Follow “Recommended Practices for Shipping and Installation of Reinforced Plastic Pipe, Duct and Tanks” of the Society of the Plastics Industry, Inc.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. Fiberglass reinforced thermosetting plastic piping system shall be specifically designed, constructed, and installed for the service intended and shall comply with the following service conditions.

B. Service Conditions:

1.	Nominal Pipe Size:	10 inch
3.	Fluid Temperature: °F max.	120
4.	Fluid Pressure: psi max.	150
5.	Fluid Pressure: psi min.	0
6.	Fluid Flow: cfm	400
7.	Fluid Chemical Composition:	H2S, RSCs, VOCs, Wastewater odors
8.	Fluid Specific Gravity:	0.0013

2.2 DETAILS OF CONSTRUCTION

A. Pipe shall be manufactured to meet the applicable requirements of ASTM D 2996.

B. Product and Manufacturer: Provide one of the following:
1. Fibercast Company, Division of Youngstown Sheet and Tube Company.
2. Ameron Bondstrand.
3. Or equal.

C. Products shall be of standard manufacture, conforming to applicable requirements of ASTM and as herein specified.

D. Fittings: Fittings such as elbows, laterals, tees, and reducers shall be of the same resin as and equal or superior in strength to the adjacent pipe section and shall have the same internal diameter as the adjacent pipe. Face to face flange dimensions shall conform to the standards of 150-psi ANSI fittings.

E. Fasteners: Furnish all bolts, nuts, washers and other fasteners required. Material of metallic fasteners shall be 316 SST.

F. Gaskets: Gaskets shall be furnished by the piping manufacturer with suitable chemical resistance to the service environment. Gaskets shall be 1/8-inch minimum in thickness with a Shore Durometer hardness of 60 to 70.

G. Flanged Connections: Connections to expansion joints, valves, tanks or other equipment shall be flanged. Flanges shall be hand laid up to PS15-69 thickness, except that minimum thickness shall be 3/4-inch. Each flange face shall be machined flat, and a new corrosion barrier applied. Face shall be textured for use with full-face chlorobutyl gaskets, 1/8-inch minimum thickness. Flange drilling shall be ANSI B16.1 125 pounds. Boltholes shall be back spot-faced for a washer seat. Flange bolts shall be torqued to manufacturer's recommended values.

H. Guides, Anchors and Supports: Guides, anchors and supports shall be as shown on the Drawings and in accordance with manufacturer's recommendations. Provide

saddle bands and FRP buildup. Support spacing shall not exceed six feet, unless otherwise shown on the Drawings.

I. Expansion Compensation: Have the pipe manufacturer review the piping layout shown on the Drawings including the number and position of expansion joints and supports. If recommended by the pipe manufacturer, and approved by ENGINEER, supply additional expansion joints, pipe supports, and pipe anchors as required for the particular piping system proposed by the manufacturer.

2.4 MAINTENANCE TOOLS AND SPARE MATERIALS

A. Furnish and deliver the following tools and maintenance materials carefully boxed or packaged and plainly marked for recording:
   1. One set of special tools required to maintain and repair the piping.
   2. All materials in kit form to make or repair joints. Kits shall be in a number sufficient to repair 10 percent of the joints.
   3. Pipe and fittings equal to ten percent of the installed system.
   4. Names and addresses of all manufacturers of fiberglass reinforcements, resins, hardeners and components used to repair and maintain fiberglass reinforced plastic piping system.

B. Store and safeguard tools and materials until completion of the Work, at which time they shall be inventoried, delivered and placed in an area designated by OWNER.

2.5 MARKING FOR IDENTIFICATION

A. All pipeline materials shall be permanently marked with the following:
   1. Name or trademark of manufacturer.
   2. Pipe class and specification designation.
   3. Pipe size, grade and type.
   4. Date and place of manufacture.
   5. Pipe schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

A. For buried piping installation, refer to Section 15051, Buried Piping Installation.

B. For exposed piping installation, refer to Section 15052, Exposed Piping Installation.

+ + END OF SECTION + +

SECTION 15112

ECCENTRIC PLUG VALVES, OPERATORS AND APPURTENANCES

PART I - GENERAL

1.1DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals required to furnish and install all eccentric plug valves, operators and appurtenances complete and operational as shown on the Drawings and as specified.
   2. The Work includes, but is not necessarily limited to, all valves required for buried, exposed, submerged and other types of piping, except where otherwise specifically included in other Sections.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work which is related to this Section including buried piping installation, exposed piping installation and site utilities.

1.2QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience of producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
   2. Each eccentric plug valve shall be the product of one manufacturer.

B. Unit Responsibility:
   1. Unit Responsibility shall assigned by CONTRACTOR as specified in Section 01600, General Equipment Provisions, to the individual gate suppliers for the entire gate assembly, including both the equipment provided under this Section and the associated electric actuators provided under Section 11200, 480 Volt Motor-Operated Valve and Gate Actuators. A Certificate of Unit Responsibility shall be provided.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
   2. ANSI B16.4, Cast Iron Fittings.
   3. ASTM A 48/A 48M, Specification for Gray Iron Castings.
   4. ASTM B 62, Specification for Composition Bronze or Ounce Metal Castings.
   5. ASTM A 126, Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.

6. ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
7. ASTM A 354, Specification for Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners.
8. ASTM A 436, Specification for Austenitic Gray Iron Castings.
9. ASTM A 536, Specification for Ductile Iron Castings.
10. ASTM A 743/A 743M, Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
11. ASTM A 2472, Specification for Nickel-Copper Alloy Plate, Sheet and Strip.
12. ASTM B 98/B 98M, Specification for Copper-Silicon Alloy Rod, Bar and Shapes.
13. ASTM B 127, Specification for Nickel-Copper Alloy Plate, Sheet and Strip.
14. AWWA C540, Power Actuating Devices for Valves and Sluice Gates.
15. AGMA Standards.
16. NEMA, National Electrical Manufacturer's Association.
17. National Electrical Code (NEC) current adoption.
18. City of Phoenix – Amendments to the National Electrical Code.

1.3SUBMITTALS

A Certificate of Unit Responsibility attesting that CONTRACTOR has assigned, and the supplier accepts unit responsibility in accordance with the requirements of this Section and Section 01600, General Equipment Provisions. No other Submittal material will be reviewed until the certificate has been received and conforms to the specified requirements.

B. Shop Drawings: Submit for approval the following:
1. Comply with the requirements of Section 01332, Shop Drawing Procedures.
2. Manufacturer's literature, illustrations, paint certifications, specifications, detailed drawings, data and descriptive literature on all eccentric plug valves and appurtenances.
3. Deviations from Contract Documents
4. Engineering data including dimensions, materials, size and weight.
5. Fabrication, assembly and installation drawings.
6. Certificates of compliance with AWWA Standards, where applicable.
7. Corrosion resistance information to confirm suitability of the eccentric plug valve materials for the application. Information on chemical resistance of elastomers shall be furnished from the elastomer manufacturers.
8. Complete manufacturer’s nameplate data of eccentric plug valves.
9. Special tools list.
10. C_V values and headloss curves.
11. Calculations:
    a. Sizing of operating mechanism with extension stems.
    b. Sizing of gear actuators.
    c. Sizing of anchor bolts.

C. Operation and Maintenance Manuals:
   1. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation and spare parts information.
   2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01781, Operation and Maintenance Data.

D. Shop Tests:
   1. Test motor operated eccentric plug valves before shipment to ensure that the mechanisms can close the valves in the specified time limit, and for proper seating.
   2. Hydrostatic tests shall be performed, when required by the valve specifications included herein.

E. Certificates: Where specified or otherwise required by ENGINEER, submit test certificates.

1.4PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work.
   1. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to not delay the Work.

B. Handle all eccentric plug valves and appurtenances very carefully. Eccentric plug valves which are cracked, dented, or otherwise damaged or dropped will not be acceptable.

C. Store materials to permit easy access for inspection and identification. Keep steel members off the ground, using pallets, platforms or other supports. Protect steel members and packaged materials from corrosion and deterioration.

D. Store all mechanical equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long term storage.

PART 2- PRODUCTS

2.1MATERIALS

A. General:
   1. Eccentric plug valves shall have manufacturer's name and working pressure cast in raised letters on valve body.
   2. Manual eccentric plug valve operators shall turn clockwise to close, unless otherwise specified. Valves shall indicate the direction of operation.

3. Manually operated eccentric plug valves, with or without extension stems, shall require not more than a 40-pound pull on the manual operator to open or close a valve against the specified criteria. The gear actuator and the eccentric plug valve components shall be able to withstand a minimum pull of 200-pounds on the manual operator and an input torque of 300-foot pounds to an actuator nut. Manual operators include handwheel, chain, crank, lever and a T-handle wrench.
4. Unless otherwise specified, all flanged eccentric plug valves shall have ends conforming to ANSI B16.1. The pressure class of the flanges shall be equal to or greater than the specified pressure rating of the valves.
5. Buried eccentric plug valves shall have flanged ends with mechanical joint adapters and installed with a flanged adapter or have grooved mechanical couplings. All bolts shall be Type 316 stainless steel.
6. Buried eccentric plug valves shall be provided with adjustable two piece valve boxes and provided with extension stems, operating nuts and covers, unless otherwise shown on the Drawings or specified. Extension stems shall terminate 12-inches below finished grade.
7. All bolts, nuts and studs on or required to connect buried or submerged valves shall be Type 316 stainless steel.
8. All bolts and studs embedded in concrete and studs required for wall pipe shall be of Type 316 stainless steel.
9. For stainless steel bolting, except where Nitronic-60 nuts are required, use anti-seize compound, graphite free, to prevent galling. Strength of the joint shall not be affected by the use of anti-seize compound.
10. All other bolts, nuts and studs shall, unless otherwise approved, conform to ASTM A 307, Grade B; or ASTM A 354.
11. Bolts and nuts shall have hexagon heads and nuts.
12. All materials of construction of the eccentric plug valves shall be suitable for the service identified in Section 15050, Piping Systems, and as shown on the Drawings.
13. Protect wetted parts from galvanic corrosion due to contact of two different metals.
14. Gasket material and installation shall conform to manufacturer's recommendations.
15. Identification: Identify each eccentric plug valve 4-inches and larger with a stainless-steel manufacturer’s nameplate stamped with the approved designation. Manufacturer’s nameplate shall be permanently fastened to valve body at the factory. Stenciled designations are acceptable for buried valves.
16. All eccentric plug valves for digester gas service shall be suitable for gas having the following composition by percent volume and other characteristics:
    a. Methane: 60 to 70 percent.
    b. Carbon Dioxide: 30 to 35 percent.
    c. Nitrogen: 0 to 50 percent.
    d. Hydrogen Sulfide: 0 to 0.2 percent.
    e. Gas Temperature: 0° to 140°F.
    f. Relative Humidity: 100 percent.

17. Buried or submerged service eccentric plug valves shall be provided with greased filled actuators with position indicators.

B. Eccentric Plug Valves:
   1. General:
      a. Non-lubricated eccentric type plug valves shall be installed where flow through the valve will be in only one direction.
      b. Eccentric plug valve shall have flanged ends. Flanges shall be faced and drilled to ANSI B16.l, Class 125.
   2. Eccentric Plug Valves:
      a. Valves shall have a valve port area of a minimum 80 percent of the full pipe area. Special application eccentric plug valves shall be provided with a port area of 100 percent of full pipe area as shown on the Drawings.
      b. Valves shall be rated for a minimum working pressure of 150 psig.
      c. Exposed valve flanges shall be faced and drilled in accordance with ANSI B16.1, Class 125. Buried valves shall be provided with flange ends with mechanical joint adapters.
      d. Valve bodies shall be of cast iron conforming to ASTM A 126, Class B. Valve seats shall be of welded-in 90 percent nickel alloy, or Monel, a minimum of 1/8-inch thick conforming to ASTM B 127.
      e. Valves shall be furnished with replaceable stainless steel sleeve-type bearings in the upper and lower journals. These bearings shall comply with the applicable sections of AWWA C507 and AWWA C504. Bearings shall be of sintered, oil impregnated permanently lubricated Type 316 stainless steel for valves 12-inch and smaller. Bearings shall be ASTM A 743/A 743M Grade CF-8M, ANSI Type 316 stainless steel for Teflon coated Type 316 stainless steel for valves 14-inches and larger.
      f. Shaft seals shall be of the multiple V-ring type, externally adjustable, replaceable without removing the bonnet or actuator from the valve, repackable under pressure and shall comply with the applicable sections of AWWA C504 and AWWA C507. Packing shall be adjustable chevron type replaceable without disassembling the valve for aboveground valves. Buried or submerged service valves shall have a self adjusting, multi-V-ring type packing in a suitable sealed enclosure.
      g. Eccentric plug valves for liquid service shall have a balanced plug coated with a vulcanized resilient isobutene-isoprene solidly bonded to a semi-steel core, as required, to assure low torque and drip-tight shutoff, suitable for bi-directional shutoff, with sewage, grit, sludge, potable and non-potable water operating at a temperature of 250°F.
      i. Products and Manufacturers: Provide one of the following:
         1) DeZurik Corporation.
         2) Val-Matic Valve & Mfg. Corp.
   3. All Eccentric Plug Valves:
      a. All valves 6-inches in diameter and larger and all manually operated eccentric plug valves installed more than five feet above the operating floor regardless of size, shall be equipped with a geared operator.

b. Manually operated valves smaller than 6-inches diameter installed five feet or less above the operating floor shall be lever wrench operated.
c. Size gear actuators for valves 8-inch and smaller for 175 psig differential pressure.
d. Size gear actuators for valves larger than 8-inch for the following maximum differential pressures:
    1) Valve Size and Location: 14" on new 14" force main.
    2) Maximum Differential Pressure Across Closed Valve: 200 psi.
e. Design the actuators to hold the valves in any intermediate position without creeping or vibrating.
f. Provide a valve position indicator on each actuator. Provide stop-limiting devices for open and closed position.
g. Provide an adjustable stop to adjust the seating pressure.
h. Make packing accessible for adjustment without requiring the removal of actuator from the valve.
i. The diameter ratio of the handwheel or the chainwheel and the gear sector shall be less than two.
j. For buried or submerged valves, the gear actuator shall be grease-packed and designed to withstand submersion and be driptight in water to 20 feet submergence.
k. Provide each actuator with gearing totally enclosed.
l. The operator shaft and the gear sector shall be supported on permanently lubricated bronze bearings.
m. Provide metal encased spring loaded seals in top and bottom covers of the gear housing.
n. Actuators shall be designed to produce the indicated torque with a maximum pull of 40-pounds on the handwheel or chainwheel and a maximum input of 150-foot pounds on operating nuts, both for seating and unseating heads equal to the maximum differential pressure.
o. All actuator components between the input and the stops shall be designed to withstand, without damage, a pull of 200-pound for handwheel or chainwheel actuators and an input torque of 300-foot pound for operating nuts when operating against the stops.
p. Materials of Construction:
    1) Housing: Cast Iron, ASTM A 126, Class B.
    2) Gear Sector: Ductile Iron, ASTM A 536.
    3) Worm Gear: Steel, AISI 1144, hardened and tempered to an average Rc 40 and within range of Rc 35 to 45.
    4) All Bearings: Bronze oil impregnated.
    5) All Hardware including Bolts, Nuts, Washers, Set Screws and Pins: Type 316 stainless steel.
q. Valves higher than five feet above the operating floor:
    1) Chainwheels, sprockets and Type 304 stainless steel chain shall be provided for gear operated valves mounted more than five feet above the operating floor.
    2) Chain shall extend to three feet above the operating floor.

3) Gearing shall be enclosed in a semi-steel housing and shall be suitable for running in a lubricant, with seals provided on all shafts to prevent entry of dirt and water into the operator.
4) Operator shaft and the gear quadrant shall be supported on permanently lubricated stainless steel bearings.
5) Operator shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque.
6) Exposed nuts, bolts and washers shall be zinc plated.

r. Where lever wrench operated valves are required, each valve shall be furnished with its own lever wrench operator.

s. Extension Bonnets: Where required, extension bonnets shall be provided. Extension bonnet shall be of steel or cast iron, with carbon steel stems, constructed so that when connected to the valve the extension bonnet shall be vertical, and designed to fully support the operator and stem extension. Exposed extension stems shall be of Type 316 stainless steel. Intermediate bearings shall be provided on the extension bonnet, as required.

t. Valve packing adjustment on non-submerged valves shall be accessible without removing the actuator from the valve.

u. Shop Painting:
1) Interior ferrous metal surfaces of the valve except finished or bearing surfaces and the plug, shall be shop painted with two coats of an approved two component coal tar epoxy coating applied in accordance with the manufacturer's recommendations.
2) Exterior surfaces of the valve and operator shall be shop painted as specified hereinafter under Article 2.8, below.

4. Eccentric Plug Valves - Guarantee:

(The remainder of this page was left blank intentionally.)

ECCENTRIC PLUG VALVES - GUARANTEE

WHEREAS

of (Address)

, Telephone:

Herein called the "Valve Manufacturer" has furnished eccentric plug valves on the following Project:

City of Phoenix
38107 North Pioneer Road
Lift Station 76 Phase II Expansion

OWNER: City of Phoenix

Guarantee Period: Five years Date of Final Acceptance:
Date of Expiration:

AND WHEREAS the Valve Manufacturer has contracted (either directly with the OWNER or indirectly as a subcontractor) to Guarantee said Valves against leaks and faulty or defective materials and workmanship for the designated Guarantee Period;

NOW THEREFORE the Valve Manufacturer hereby Guarantees, subject to the terms and conditions herein set forth, that during the Guarantee Period he will at his own cost and expense, make or cause to be made such repairs to or replacements of said Valves as are necessary to correct faulty and defective work, and as are necessary to maintain said Valves to operate as specified.

This Guarantee is made subject to the following terms and conditions:

1. Specifically excluded from this Guarantee are damages to the Valves caused by: a) lightning, and other unusual phenomena of the elements; b) fire. When the Valves have been damaged by any of the foregoing causes, the Guarantee shall be null and void until such damage has been repaired by the Valve Manufacturer, and until the cost and expense thereof has been paid by the OWNER or by another responsible party so designated.
2. During the Guarantee Period if the OWNER allows alteration of the Valves by anyone other than the Valve Manufacturer, including maintenance in connection with other Work, this Guarantee shall become null and void upon the date of said alterations. If the OWNER engages CONTRACTOR to perform said alterations, the Guarantee shall not become null and void, unless the Valve Manufacturer, prior to proceeding with said Work shall have notified the OWNER, in writing, showing

reasonable cause for claim that said alterations would likely damage or deteriorate the Valves, thereby reasonably justifying a termination of this Guarantee.

3. The OWNER shall promptly notify the Valve Manufacturer of observed known or suspected, defects or deterioration, and shall afford reasonable opportunity for the Valve Manufacturer to inspect the valves, and to examine the evidence of such leaks, defects or deterioration.
4. This Guarantee is recognized to be the only Guarantee of the Valve Manufacturer on said Valves and shall not operate to restrict or cut off the OWNER from other remedies and recourses lawfully available to him in cases of valves failures. Specifically, this Guarantee shall not operate to relieve the Valve Manufacturer of his responsibility for performance of the Valves, regardless of whether original contract was a contract directly with the OWNER or a subcontract with the OWNER'S CONTRACTOR.

IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, 20__.

Valve Manufacturer's Signature:

Typed Name:

As Its (position):

And has been countersigned by CONTRACTOR issuing the Valve Manufacturer's subcontract for said Valves:

Name of CONTRACTOR:

Date: Authorized Signature:

Typed Name:

As Its (position):

(The remainder of this page was left blank intentionally.)

2.3 APPURTENANCES FOR EXPOSED VALVES

A. General:
   1. For valves located less than 5 feet-0 inches above the operating floor, provide levers on 4-inch quarter turn valves and handwheels on all other valves, unless otherwise shown on the Drawings or specified.
   2. For valves located at 5 feet-0 inches or more above the operating floor, provide chain operators.
   3. Where shown on the Drawings, provide extension stems and floorstands.

B. Handwheels:
   1. Conform to the applicable AWWA Standards.
   2. Material of Construction: Ductile iron or cast aluminum.
   3. Arrow indicating direction of opening and word "OPEN" shall be cast on the trim of the handwheel.
   4. Maximum Handwheel Diameter: 30-inches.

C. Chain Operators:
   1. For valves more than 5 feet-0 inches above the operating floor provide chain operators.
   2. Chains shall extend to three feet above the operating floor.
   3. A 1/2-inch stainless steel hook bolt shall be provided to keep the chain out of the walking area.
   4. Materials of Construction:
      a. Chain: Type 304 stainless steel.
      b. Chain wheel: Recessed groove type made out of bronze bushed with guides.
   5. Chain Construction:
      a. Chain shall be of welded link type with smooth finish. Chain that is crimped or has links with exposed ends shall not be acceptable.
   6. Provide geared operators where required to position chain wheels in vertical position.

D. Crank Operator:
   1. Crank operator shall be removable and fitted with a rotating handle.
   2. Maximum Radius of Crank: 15-inches.
   3. Materials:
      a. Crank: Cast iron or ductile iron.
      b. Handle: Type 304 stainless steel.
      c. Hardware: Type 304 stainless steel.

E. Extension Stems and Floorstands for Valves:
   1. Conform to the applicable requirements of AWWA C501 for sizing of the complete lifting mechanism.
   2. Bench and Pedestal Floorstands:

a. For valves requiring extension stems, provide bench or pedestal floorstands with handwheel or crank as indicated. Make provisions for use of portable electric actuator for opening and closing of the valves.
b. Type: Heavy-duty with tapered roller bearings enclosed in a weatherproof housing, provided with positive mechanical seals around lift nut and pinion shaft to prevent loss of lubrication and to prevent moisture from entering the housing. A lubrication fitting shall be provided for grease. The base shall be machined.
c. Materials of Construction:
   1) Housing: Cast-iron, ASTM A 126, Class B, or steel.
   2) Lift Nut: Cast bronze, ASTM B 98/B 98M.
   3) Grease Fitting: Stainless steel.
   4) All Bolting: Type 316 stainless steel.

3. Wall brackets for floorstands shall be of Type 316L stainless steel construction.
4. Extension Stems:
   a. Materials of Stems and Stem Couplings: Type 316 stainless steel.
   b. Maximum Slenderness Ratio (L/R): 100.
   c. Minimum Diameter: 1.5-inch.
   d. Threads: ACME.
   e. Stem couplings shall be provided where stems are furnished in more than one piece. The couplings shall be threaded and keyed or threaded and bolted and shall be of greater strength than the stem.
   f. A Type 316 stainless steel cap suitable for the square end of the valve stem shall be welded to the bottom of the extension stem.
5. Bottom Couplings: Ductile iron with Type 316 stainless steel pin and set screw.
6. Stem Guides:
   a. Material: Type 316 cast stainless steel with bronze bushing for stem.
   b. Maximum Stem Length between Guides: Seven feet.
   c. Stem guides shall be adjustable in two directions.

F. Floor Boxes: Provide cast-iron floor boxes for all valves which are to be operated from floor above valve. Boxes shall be equal in depth to floor slab. Boxes shall have cast-iron covers and be fitted with bronze bushing.

2.4 APPURTENANCES FOR BURIED VALVES (NOT USED)

2.5 ANCHOR AND MISCELLANEOUS MOUNTING BOLTS

A. All bolts, nuts and washers for connection of the valve appurtenances to concrete structure or other structural members shall be obtained from the valve manufacturer and shall be of ample size and strength for the purpose intended. Anchor bolts shall be hooked or adhesive type and shall be Type 316 stainless steel. Anchor bolts shall conform to the requirements of Section 05051, Anchor Bolts, Toggle Bolts and Concrete Inserts.

B. Provide anchor bolts for stem guides of required strength to prevent twisting or sagging of the guides under load.

C. Provide bolts and washers of Type 316 stainless steel and nuts of Nitronic 60. The bolts shall have rolled threads and both bolts and nuts shall be electropolished to remove burrs.

D. Minimum Size of Anchor Bolts: 5/8-inch.

2.6PAINTING

A. Clean and shop prime coat and shop finish coat ferrous metal surfaces of equipment in accordance with the requirements of Section 09900, Painting.

B. Coat machined, polished and non-ferrous surfaces including gears, bearing surfaces and similar unpainted surfaces with corrosion prevention compound which shall be maintained during storage and until equipment begins operation.

C. Field painting shall conform to the requirements under Section 09900, Painting.

D. Certify, in writing, that the shop primer and coating system is compatible with the finish coating system in accordance with Section 09900, Painting.

2.7 INSPECTION AND WITNESS SHOP TESTS

A. Allow for inspection and witness testing of the following valves by the ENGINEER at the place of manufacturer:
   1. Valve Type: Eccentric Plug Valve with Manual Operators.
   2. Valve Sizes: 14”.
   3. Number of Valves to be Inspected and Witness Tested: 4.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all valves and appurtenances in accordance with the manufacturer's instructions.

B. Conform to appendices of AWWA Standards, where applicable.

C. Install all valves so that operating handwheels or levers can be conveniently turned from operating floor without interfering with access to other valves and equipment, and as approved by the ENGINEER. Orient chain operators out of the way of the walking areas. Mount valves so that indicator arrows are visible from floor level.

D. Install all valves plumb and level. Install all valves to be free from distortion and strain caused by misaligned piping, equipment or other causes.

E. For buried valve installations, set valve boxes plumb and centered, with soil carefully tamped to a lateral distance of four feet on all sides of the box, or to the undisturbed trench face if less than four feet. Provide a flexible coupling next to a buried valve for ease of valve removal.

3.2 FIELD TESTS AND ADJUSTMENTS

A. Adjust all parts and components as required to provide correct operation of the valves.

B. Conduct a functional field test on each valve in the presence of the ENGINEER to demonstrate that each valve operates correctly.

C. Demonstrate satisfactory opening and closing of valves at the specified criteria requiring not more than 40-pounds effort on the manual actuators.

D. Test ten percent valves of each type by applying 200-pounds effort on the manual operators. There shall be no damage to the gear actuator or the valve.

E. For motor operated valves, perform all field tests and adjustments required under Section 11200, 480 Volt Motor-Operated Valve and Gate Actuators.

3.3 MANUFACTURER'S SERVICES

A. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of 2 visits, minimum 4 hours on-site for each visit, to the site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation and start-up of the system. The third visit shall be as described under Section 01821, Instruction of Operations and Maintenance Personnel. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the eccentric plug valves and appurtenances conform to the requirements. Representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

B. All costs, including travel, lodging, meals, and incidentals, shall be considered as included in CONTRACTOR'S bid price.

+ + END OF SECTION + +

SECTION 15114

CHECK VALVES AND APPURTENANCES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals required to furnish and install all check valves and appurtenances complete and operational as shown on the Drawings and as specified.
   2. The Work includes, but is not necessarily limited to, all types of valves required for buried, exposed, submerged and other types of piping, except where otherwise specifically included in other Sections.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work which is related to this Section including buried piping installation, exposed piping installation and site utilities.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience of producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
   2. Each type of check valve shall be the product of one manufacturer.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. AGMA Standards.
   2. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
   3. ANSI B16.4, Cast Iron Fittings.
   4. ASTM A 48, Specification for Gray Iron Castings.
   5. ASTM A 126, Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
   6. ASTM A 216, Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
   7. ASTM A 240, Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.
   8. ASTM A 285, Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength.

9. ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

10. ASTM A 354, Specification for Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners.
11. ASTM A 436, Specification for Austenitic Gray Iron Castings.
12. ASTM A 536, Specification for Ductile Iron Castings.
13. ASTM B 62, Specification for Composition Bronze or Ounce Metal Castings.
14. ASTM D 1784, Specification for Rigid Poly (Vinyl Chloride) PVC Compounds and Chlorinated Poly (Vinyl Chloride) CPVC compounds.
15. AWWA C111, Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
16. AWWA C506, Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.
17. AWWA C508, Swing Check Valves for Waterworks Service, 2-inch through 24-inch NPS.
18. NEMA, National Electrical Manufacturer's Association.
19. Comply with National Sanitation Foundation (NSF-61) and Arizona Administration Code requirements as stated in Specification Section 01420 – References.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's literature, illustrations, paint certifications, specifications, detailed drawings, data and descriptive literature on all valves and appurtenances.
   2. Deviations from Contract Documents.
   3. Engineering data including dimensions, materials, size and weight.
   4. Fabrication, assembly and installation drawings.
   5. Control characteristics of modulating valves.
   6. Certificates of compliance with AWWA Standards, where applicable.
   7. Corrosion resistance information to confirm suitability of the valve materials for the application. Information on chemical resistance of elastomers shall be furnished from the elastomer manufacturers.
   8. Power and control wiring diagrams, including terminals numbers.
   9. Complete manufacturer’s nameplate data of valves.
   10. Special tools list.
   11. Cv Values and headloss curves.

B. Operation and Maintenance Manuals:
   1. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation, and spare parts information.

2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01781, Operation and Maintenance Data.

C. Certificates: Where specified or otherwise required by ENGINEER, submit test certificates.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to not delay the Work.

B. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the site. Notify ENGINEER if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition, in accordance with manufacturer's instructions.

C. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms or other supports. Protect steel members and packaged materials from corrosion and deterioration.

D. Store all mechanical equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long term storage.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
1. Valves shall have manufacturer's name and working pressure cast in raised letters on valve body.
2. Unless otherwise specified, all flanged valves shall have ends conforming to ANSI B16.1. The pressure class of the flanges shall be equal to or greater than the specified pressure rating of the valves.
3. All bolts, nuts and studs on/or required to connect buried or submerged valves shall be Type 316 stainless steel.
4. All bolts and studs embedded in concrete and studs required for wall pipe shall be of Type 316 stainless steel.
5. For stainless steel bolting, except where Nitronic-60 nuts are required, use anti-seize compound, graphite free, to prevent galling. Strength of the joint shall not be affected by the use of anti-seize compound.
6. All other bolts, nuts and studs shall, unless otherwise approved, conform to ASTM A 307, Grade B; or ASTM A 354.

7. Bolts and nuts shall have hexagon heads and nuts.
8. Gasket material and installation shall conform to manufacturer's recommendations.
9. Identification: Identify each valve 4-inches and larger with a stainless steel manufacturer's nameplate stamped with the approved designation. Manufacturer's nameplate shall be permanently fastened to valve body at the factory. Stenciled designations are acceptable for buried valves.
10. All materials of construction of the valves shall be suitable for the applications as shown on the Drawings.
11. Protect wetted parts from galvanic corrosion due to contact of two different metals.

B. Check Valves - Liquid Service:
   1. General:
      a. Check valves shall absolutely prevent the return of water back through the valve when the upstream pressure decreases below the downstream pressure. The valve shall be tight seating.
   3. 3-Inches Diameter and Larger - Lever and Spring Type:
      a. Valves shall be single disc, iron body, bronze mounted, rubber disc, furnished with lever and spring and conforming to AWWA C508-09, as to materials and pressure ratings.
      b. Unless otherwise shown on the Drawings or specified valves shall have flanged ends conforming to ANSI B16.1, Class 125.
      c. Shop Painting:
         1) Interior metal surfaces of cast iron valves, except finished or bearing surfaces, shall be shop painted with two coats of an NSF 61 approved epoxy coating applied in accordance with the manufacturer's recommendations.
         2) Exterior surfaces of the valves shall be shop painted as specified hereinafter under Article 2.2, below.
      d. Product and Manufacturer: Provide one of the following:
         1) G.A. Industries.
         2) Dresser Manufacturing Division, M&H Division.
         3) Pratt/CCNE
         4) Or equal.

C. 3-Inch Diameter and Larger - Air Cushioned Type:
   1. Provide valves conforming to AWWA C508-09 and as specified herein.
   2. Valve shall be a counterweighted, rubber seated swing check valve with external air cushion chamber. Valve shall permit flow in one direction only and close tightly, without slamming, when its discharge pressure exceeds its inlet pressure.
   3. Valve shall have a hinge shaft located completely above the waterway, and shall be Type 316 stainless steel with the disc-arm and counterweight arm keyed thereon. Hinge shaft packing gland shall be of adjustable packing gland

design employing a compression type packing. Simple O-ring shaft seals will not be accepted.

4. Valve shall be tight seating when closed, and provide a full equivalent pipe area when open fully. Seating shall be by a resilient field replacement ring on the valve disc contacting a Type 316 stainless steel seat ring in the valve body.
5. Provide an external adjustable counterweight to initiate valve closure, and an air cushion chamber mounted externally to dampen valve closure due to counterweight action. The air cushion chamber shall be of all bronze or bronze and stainless steel, and shall be field adjustable.
6. Materials of Construction: All materials of construction shall conform to AWWA C508 and shall be as follows for various valve components:
   a. Body, Disc, Cover and Gland: Cast-iron or ductile iron.
   b. Disc Arm: Ductile iron.
   c. Hinge Shaft: Type 316 stainless steel.
   d. Hinge Shaft Bushings: Bronze.
   e. Shaft End Plate: Type 316 stainless steel.
   f. Body Seat: Type 316 stainless steel.
   g. Follower ring for Rubber Seat on Disc: Type 316 stainless steel.
   h. Disc Center Pin Assembly: Type 316 stainless steel.
   i. Air Cushion Chamber:
      1) Chamber and Plunger: Bronze.
      2) Linkages and Pins: Type 316 stainless steel.
      3) Air Check Valve and Tubing: Brass.
   j. All Rubber Items:
      1) Up to 180°F Fluid Temperature: Buna-N, or other synthetic rubber suitable for the application.
      2) Greater than 180°F Fluid Temperature: Viton, or other synthetic rubber suitable for the application.
   k. All internal and external bolting and other hardware including pins, set screws, studs, bolts, nuts and washers: Type 316 stainless steel.
   l. Gland Packing: Graphite and Kevlar.
7. Testing:
   a. Test all valves in the shop in conformance with AWWA C508.
   b. Permitted Leakage at Rated Pressures: Zero.
8. Shop Painting:
   a. Interior metal surfaces of the valve, except finished or bearing surfaces, shall be shop painted with two coats of an NSF 61 approved epoxy coating applied in accordance with the manufacturer's recommendations.
   b. Exterior surfaces of the valve shall be shop painted as specified hereinafter under Article 2.2, below.
9. Product and Manufacturer: Provide one of the following:
   a. G.A. Industries.
   b. Pratt/CCNE
   c. Or equal.

10. Provide a multiple limit switch on each pump discharge check valve, as shown on the Drawings. Contacts on this switch shall be interlocked to:
    a. Prevent start of motor, unless the valve is closed.
    b. Display an alarm and stop the motor after an adjustable time delay should the check valve fail to open or fail to close.
    c. Display an alarm and stop the motor should the check valve close when the level in the wet well is such that the pump is operating.
    d. Limit switch shall be of the precision plunger type with a differential of 1/10-inch or less. Distance between the center of the valve shaft and the plunger of the limit switch shall not be less than the diameter of the valve disc. Limit switch shall indicate that the disc is not more than one degree

open, and shall not indicate that the valve is closed until the disc is within 1/4 degree of being completely closed.

e. Assembly shall be suitable to be mounted on an outside weight and lever swing check valve without modification of the valve or piping, and shall provide proper signals to permit the control system to function as described above without causing false pump cutout and alarm indications, when properly adjusted.

f. Mount the assembly on the valve in accordance with the manufacturer's recommendations and instructions and shall make all necessary adjustments to actuate the limit switch to provide the specified functional features.

2.2 SURFACE PREPARATION AND PAINTING

A. Valves, appurtenances, etc., shall receive shop primer and shop finish coating conforming to the requirements of Section 09900, Painting. If any damage to the paint system occurs, the equipment shall be repainted as directed by the ENGINEER.

B. Surface preparation and painting shall conform to the requirements of Section 09900, Painting.

C. All gears, bearing surfaces, machined surfaces and other surfaces which are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. This coating shall be maintained during storage and until the equipment is placed into operation.

D. Certify, in writing, that the shop primer and shop finish coating system conforms to the requirements of Section 09900, Painting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all valves and appurtenances in accordance with manufacturer's instructions and recommendations.

B. Unless otherwise approved by the ENGINEER, install all valves plumb and level. Install valves free from distortion and strain caused by misaligned piping, equipment or other causes.

3.2 FIELD TESTS AND ADJUSTMENTS

A. Adjust all parts and components as required to provide correct operation.

B. Conduct functional field test of each valve in presence of ENGINEER to demonstrate that each part and all components together function correctly.

3.3 MANUFACTURER'S SERVICE

A. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of 3 visits, 1 hours per visit, to the site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation and start-up of the system. The third visit shall be as described under Section 01821, Instruction of Operations and Maintenance Personnel. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that valves conform to the requirements. Manufacturer's representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

B. All costs, including travel, lodging, meals and incidentals, shall be considered as included in CONTRACTOR'S bid price.

+ + END OF SECTION + +

SECTION 15119

SPECIALTY VALVES AND APPURTENANCES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. Provide all labor, materials, equipment and incidentals required to furnish and install all specialty valves and appurtenances complete and operational as shown on the Drawings and as specified.
2. The Work includes, but is not necessarily limited to, all types of valves required for buried, exposed, submerged and other types of piping, except where otherwise specifically included in other Sections.

B. Coordination:
1. Review installation procedures under other Sections and coordinate with the Work which is related to this Section including buried piping installation, exposed piping installation, site utilities, insulation, heating, ventilating and air conditioning and plumbing.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
1. Manufacturer shall have a minimum of five years experience of producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
2. Each type of specialty valve shall be the product of one manufacturer.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. ANSI A13.1, Scheme for Identification of Piping Systems.
2. ANSI/ASME A112.1.2, Air Gaps in Plumbing Systems.
3. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
4. ANSI B16.4, Cast Iron Fittings.
5. ANSI B40.1, Gauges-Pressure Indicating Dial Type-Elastic Element.
6 ASTM A 48, Specification for Gray Iron Castings.
7. ASTM A 126, Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
8. ASTM A 240, Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
9. ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
10. ASTM A 354, Specification for Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners.

11. ASTM A 436, Specification for Austenitic Gray Iron Castings.
12. ASTM A 536, Specification for Ductile Iron Castings.
13. ASTM B 62, Specification for Composition Bronze or Ounce Metal Castings.
14. ASTM D 1784, Specification for Rigid Poly (Vinyl Chloride) PVC Compounds and Chlorinated Poly (Vinyl Chloride) CPVC compounds.
15. ASTM D 1785, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedulers 40, 80 and 120.
16. AWWA C111, Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
17. AWWA C500, Gate Valves for Water and Sewerage Systems.
18. AWWA C502, Dry-Barrel Fire Hydrants.
19. AWWA C503, Wet-Barrel Fire Hydrants.
20. AWWA C506, Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.
21. AWWA C507, Ball Valves, 6-Inch Through 48-Inch.
22. AWWA C508, Swing Check Valves for Waterworks Service, 2-inch through 24-inch NPS.
23. AWWA C509, Resilient-Seated Gate Valves, 3 through 12 NPS, for Water and Sewerage Systems.
24. AWWA C512 Air-Release, Air/Vacuum and Combination Air Valves for Water Works Service
25. AGMA Standards.
26. ASSE 1003, Water Pressure Reducing Valves.
27. NEMA, National Electrical Manufacturer's Association.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's literature, illustrations, paint certifications, specifications, detailed drawings, data and descriptive literature on all valves and appurtenances.
   2. Deviations from Contract Documents.
   3. Engineering data including dimensions, materials, size and weight.
   4. Fabrication, assembly, installation and wiring diagrams.

B. Operation and Maintenance Manuals:
   1. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation, and spare parts information.
   2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01781, Operation and Maintenance Data.

C. Shop Tests:
   1. Test motor operated valves before shipment to ensure that the mechanisms can close the valves in the specified time limit, and for proper seating.
   2. Hydrostatic tests shall be performed, when required by the valve specifications included herein.

D. Certificates:
   1. Where specified or otherwise required by ENGINEER, submit test certificates.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to not delay the Work.

B. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the site. Notify ENGINEER if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition, in accordance with manufacturer's instructions.

C. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms or other supports. Protect steel members and packaged materials from corrosion and deterioration.

D. Store all mechanical equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long term storage.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
   1. Valves shall have manufacturer's name and working pressure cast in raised letters on the valve body or on a stainless-steel manufacturer's nameplate stamped with the approved designation and permanently attached to the valve body.
   2. Manual valve operators shall turn clockwise to close, unless otherwise specified. Valves shall indicate the direction of operation.
   3. Unless otherwise specified, all flanged valves shall have ends conforming to ANSI B16.1. The pressure class of the flanges shall be equal to or greater than the specified pressure rating of the valves.
   4. Buried valves shall have flanged ends with mechanical joint adapters and installed with a flanged adapter or have grooved mechanical couplings. All bolts shall be Type 316 stainless steel.
   5. Buried valves shall be provided with adjustable two-piece valve boxes and provided with extension stems, operating nuts and covers, unless otherwise shown or specified. Extension stems shall terminate 12-inches below finished grade.
   6. All bolts, nuts and studs on or required to connect buried or submerged valves shall be Type 316 stainless steel.

7. All bolts and studs embedded in concrete and studs required for wall pipe shall be of Type 316 stainless steel.
8. For stainless steel bolting, except where Nitronic-60 nuts are required, use anti-seize compound, graphite free, to prevent galling. Strength of the joint shall not be affected by the use of anti-seize compound.
9. All other bolts, nuts and studs shall, unless otherwise approved, conform to ASTM A 307, Grade B; or ASTM A 354.
10. Bolts and nuts shall have hexagon heads and nuts.
11. Gasket material and installation shall conform to manufacturer's recommendations.
12. Identification: Identify each valve 4-inches and larger with a stainless steel manufacturer's nameplate stamped with the approved designation. Manufacturer's nameplate shall be permanently fastened to valve body at the factory. Stenciled designations are acceptable for buried valves.
13. All materials of construction of the valves shall be suitable for the applications as shown on the Drawings.
14. Protect wetted parts from galvanic corrosion due to contact of two different metals.

B. Hose Bibbs, Pipe Drains:
   1. Valve:
      a. Type: Boiler drain globe valve, chrome plated.
      b. Material: Bronze body, screwed bonnet, renewable composition disc.
      c. End Connections: Hose thread outlet, male pipe thread or sweat inlet.
      d. Rating: 125 lbs. WOG.
   2. Vacuum Breaker:
      a. Type: Non-removable, atmospheric.
      b. Materials: Brass body, stainless steel trim, silicone rubber diaphragm and disc.
      c. End Connections: Hose thread inlet and outlet.
   3. Product and Manufacturer: Provide one of the following:
      a. Woodford Manufacturing Co., Model 19.
      b. Nibco Incorporated, Fig. No. H-Hosebibb.
      c. Or Approved Equal.

C. Pipe Labels:
   1. Type: Self-adhering, temperature resistant, waterproof, corrosion resistant.
   2. Marker size, marker color, legend size, and legend color shall conform to ANSI A13.1.

D. Flexible Connections:
   1. Type: Flexible connections for piping 2-1/2-inches and smaller:
   2. Construction:
      a. Hose: Bronze.
      b. Braid: Bronze.
   3. Pressure Ratings: 190 psig working pressure at 250°F temperature.
   4. End Connections: Solder end welded to hose and braid ends.

5. Product and Manufacturer: Provide one of the following:
   a. Flexonics Incorporated.
   b. Anaconda Metal Hose Division, Anamet Incorporated.
   c. Or equal.

E. Air/Vacuum
   1. All valves listed below shall meet AWWA C512, latest edition, Standard for Air-Release, Air/Vacuum and Combination Air Valves for Water Works Service.
   3. Air / Vacuum Valves:
      a. Purpose: Valve is used to automatically exhaust large quantities of air during pipeline filling, and to admit large quantities of air when the internal pressure drops below atmospheric.
      b. Operation: Float actuated valve with large orifice exhausts or admits air from the system.
      c. Design Conditions:
         1) Air Discharge (Fill/Vent) Rate: 227 cfm @ 29 psi
         2) Air Inlet Rate (Empty/Vacuum) Rate: 227 cfm @ -12 psi
         3) Orifice Size: 2 inch or inch fraction
      d. Construction:
         1) Body: Type 316 Stainless Steel ASTM A351.
         2) Float: Type 316 Stainless Steel ASTM A240.
         3) O-Ring: EPDM.
         4) Trim: Type 316 Stainless Steel ASTM A240.
         5) Inlet Size/Conn: Size and connection flanged unless otherwise shown on drawings.
         6) Outlet Size/Conn: Size and connection (threaded, flanged, hooded) as shown on Drawings.
      e. Installation: Outdoors
   5. Product and Manufacturer: Provide one of the following:
      a. Crispin – as manufactured by Multiplex Manufacturing Co., AX Series
      b. H-Tec, Model 986
      c. Or Approved Equal

2.2 SURFACE PREPARATION AND PAINTING

A. Valves, appurtenances, etc., shall receive shop primer and shop finish coating conforming to the requirements of Section 09900, Painting. If any damage to the paint system occurs, the equipment shall be repainted as directed by the ENGINEER.

B. Surface preparation and painting shall conform to the requirements of Section 09900, Painting.

C. All bearing surfaces, machined surfaces and other surfaces which are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. This coating shall be maintained during storage and until the equipment is placed into operation.

D. Certify, in writing, that the shop primer and shop finish coating system conforms to the requirements of Section 09900, Painting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all valves and appurtenances in accordance with manufacturer's instructions and recommendations.

B. Install all valves so that operating handwheels or wrenches may be conveniently turned from operating floor but without interfering with access, and as approved by ENGINEER.

C. Unless otherwise approved by the ENGINEER, install all valves plumb and level. Install valves free from distortion and strain caused by misaligned piping, equipment or other causes.

3.2 FIELD TESTS AND ADJUSTMENTS

A. Adjust all parts and components as required to provide correct operation.

B. Conduct functional field test of each valve in presence of ENGINEER to demonstrate that each part and all components together function correctly.

3.3 MANUFACTURER'S SERVICE

A. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of 3 visits, 1 hours per visit, to the site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation and start-up of the system. The third visit shall be as described under Section 01821, Instruction of Operations and Maintenance Personnel. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the valves conform to the requirements. Manufacturer's representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

B. All costs, including travel, lodging, meals, and incidentals, shall be considered as included in CONTRACTOR'S bid price.

+ + END OF SECTION + +

SECTION 15120

PIPING SPECIALTIES AND ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install all piping specialties and accessories. Included, but not limited to, are: flexible couplings, mechanical couplings, flanged and harnessed adapters, and expansion joints.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience of producing substantially similar types of piping specialties specified and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
   2. Each type of piping specialty and accessory shall be the product of one manufacturer.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Detailed drawings and data on each type of coupling, adaptor and expansion joint to be furnished. Submit and coordinate these with Shop Drawings required for piping systems. Comply with requirements of Section 01330, Submittals, and Section 01332, Shop Drawing Procedures.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Refer to Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Couplings: Unless otherwise specified, piping 2-inches in diameter and larger passing from concrete to earth shall be provided with two pipe couplings or flexible joints as specified within 2-feet or one pipe diameter of the structure, whichever is greater.

1. Sleeve Type, Flexible Couplings:
   a. Pressure and Service: Same as connected piping.
   b. Material: Carbon steel for carbon steel and exposed ductile iron piping systems, or stainless steel for stainless steel and buried or submerged ductile iron piping systems.
   c. Gasket: Suitable for wastewater service, or high temperature air service.
   d. Bolts and Nuts: Alloy steel, corrosion-resistant, prime coated. Buried couplings shall have Type 316 stainless steel bolts and nuts.
   e. Harnessing:
      1) Harness couplings to restrain pressure piping. Test pressures for pressure pipelines shall conform to the requirements of Section 15050, Piping Systems.
      2) Adjacent flanges shall be tied with bolts of corrosion resistant alloy steel. Provide flange mounted stretcher bolt plates as shown on the Drawings and to be designed by manufacturer, unless otherwise approved by the ENGINEER.
      3) Conform to dimensions, size, spacing and materials for lugs, bolts, washers and nuts as recommended by manufacturer and approved by ENGINEER for the pipe size, wall thickness and test pressure required. However, the following minimum bolting shall be provided, unless otherwise approved by the ENGINEER.

Pipe Diameter (Inches)	Number of Bolts	Bolt Diameter (Inches)	At (Degrees)
4	2	5/8	180
6-8	2	3/4	180
10-12	2	7/8	180 or 250
14-20	4	1	190
24-48	4	1	90
54	4	1	250
60	4	1-1/4	90

   f. Remove pipe stop, unless otherwise shown on the Drawings or specified.
   g. Product and Manufacturer: Provide one of the following:
      1) Dresser Industries, Style 38
      2) Smith-Blair, Type 411
      3) Or equal.

B. Rubber Type Expansion Joints:
   1. General:
      a. Use rubber type expansion joints at all expansion joint locations, except where stainless steel expansion joints are shown on the Drawings or specified.
   2. Liquid Service:
      a. Expansion joints for liquid service shall be constructed of Neoprene or Buna N suitable for temperatures to 180°F.
      b. Expansion joints shall be of the filled arch type. Furnish backup or retaining rings as recommended by the manufacturer.

c. Expansion joints shall be yoked in a manner to provide for transmission of any tension loading to which the joint may be subjected during system operation. The compressive and/or lateral movement of the joint shall not be impaired by the yoking system. Details of expansion joint yoking shall be submitted to the ENGINEER for approval.

C. Packed Expansion Joints:
1. The expansion joint shall be of the slip type containing injectable packing ports, allowing additional packing to be added under full line pressure.
2. Expansion joints shall be able to handle a 150 psi steam working pressure and to withstand 300°F temperature.
3. Graphite injectable packing and seals are required.
4. Internal and external guides are required and shall conform to ASTM SB 169-C614.
5. An approximate, 360-degree, stainless steel, extension limit stop shall be included on each slip tube. The slip tube shall be made from Schedule 80 carbon steel pipe, conforming to ASTM A 53 GR.B pipe through 16-inches internal pipe size (IPS).
6. The slip tube shall be hard-chrome plated 0.802-inch thick in accordance with ASTM B 650. The one piece body shall conform to ANSI A 53, GR.B.
7. A drain port shall be provided.
8. Flanges shall be ASTM A 105 raised face slip on or flat faced.
9. Internal and external non-chromed surfaces shall be coated with a 0.008-inch dry-film thickness of Tnemec Potapox epoxy coating.
10. Expansion joints minimum travel shall be 4-inches, and shall allow 0.5-inch expansion.
11. Expansion joints full stroke life cycle shall be a minimum of 20,000 full strokes.
12. Expansion joints shall have the same requirements as listed above.
13. Product and Manufacturer: Provide packed expansion joints of one of the following:
    a. Hyspan.
    b. Or equal.

D. Dielectric Connections:
1. Where a copper pipe is connected to steel or cast iron pipe, an insulating section of rubber or plastic pipe shall be provided. The insulating section shall have a minimum length of 12 pipe diameters. Dielectric unions may be used instead of the specified insulating sections.
2. Product and Manufacturer: Provide one of the following:
    a. EPCO.
    b. Capitol Manufacturing.
    c. Or equal.

E. Materials or products which contact drinking water as part of a water treatment process or water supply system including but not limited to pipe, gaskets, fittings, linings, coatings, etc., must Comply with National Sanitation Foundation (NSF-61) and Arizona Administration Code requirements as stated in Specification Section 01420

– References.

2.2 PAINTING

A. Clean and shop prime and shop finish coat ferrous metal surfaces of equipment in accordance with the requirements of Section 09900, Painting.

B. Coat machined, polished and non-ferrous surfaces and similar unpainted surfaces with corrosion prevention compound which shall be maintained during storage and until equipment begins operation.

C. Field painting shall conform to the requirements of Section 09900, Painting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install piping specialties and accessories in accordance with manufacturer's instructions and recommendations.

B. Make adjustments to expansion joints as required to ensure that they will be fully extended when the ambient temperature is at minimum operating temperature and fully compressed at maximum operating temperature for the system in which they are installed.

+ + END OF SECTION + +

SECTION 15812

CORROSION RESISTANT DUCTWORK AND ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified, and required to furnish and install a complete corrosion resistant duct system with all appurtenances required for proper operation.
   2. Field verify locations, sizes and elevations for all connections, supports, dampers, test ports, and flexible connections.
   3. Items to be furnished and installed under this Section include, but are not limited to the following:
      a. Fiberglass Reinforced Plastic (FRP) duct, fittings and accessories.
      b. High Density Polyethylene (HDPE) pipe, fittings and accessories.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Engage a single firm, with undivided responsibility for performance and other requirements and components of the corrosion resistant ductwork and accessories.
   2. Engage a firm which can demonstrate successful experience in the fabrication and erection of corrosion resistant ductwork systems of at least five systems of the scope and type similar to the required Work.

B. Installer's Qualifications:
   1. Engage a single installer regularly engaged in FRP and HDPE ductwork installation and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Submit name and qualifications of installers to ENGINEER.
   2. Engage a single installer for the entire corrosion resistant ductwork system with undivided responsibility for performance and other requirements.

C. Requirements of Regulatory Agencies: Comply with the applicable provisions of regulatory agencies below and others having jurisdiction.
   1. Phoenix Building Code.
   2. Underwriters' Laboratories, Incorporated (UL).
   3. National Fire Protection Association (NFPA).

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
2. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
   a. HVAC Duct Construction Standards.
   b. Thermoset FRP Duct Construction Manual.
   c. Fire Damper Guide for Air Handling Systems.
3. ASTM A 774, Specification for As-Welded Wrought Austenitic Stainless-Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
4. ASTM A 778, Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
5. ASTM C 581-655 Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass Fiber Reinforced Structures.
6. ASTM D 2310, Classification for Machine-Made Reinforced Thermosetting Resin Pipe.
7. ASTM D 2563, Practice for Classifying Visual Defects In Glass Reinforced Plastic Laminate Parts.
8. ASTM D 2583, Test Method for Indentation Hardness of Plastics by Means of a Barcol Impressor.
9. ASTM D 2996, Specification for Filament-Wound Reinforced Thermosetting Resin Pipe.
10. ASTM D 4024, Specification for Machine Made Fiberglass (Glass Fiber Reinforced Thermosetting Resin) Flanges.
11. ASTM D 4097, Specification for Contact Molded Glass Fiber Reinforced Thermoset Chemical Resistant Tank.
12. Standards of Society of the Plastic Industry, PS15-69, Custom Contact Molded Reinforced-Polyester Chemical Resistant Process Equipment.
13. NFPA 91, Blowers and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying.
14. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
15. ANSI B16.5, Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.
16. Phoenix Building Code.

E. Field Measurements: Take field measurements where required prior to installation to ensure proper fitting of Work.

F. Provide certification that all hardware and appurtenances including screws, bolts, nuts and other support and expansion joint hardware shall be Type 316L stainless steel.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. 1/4-inch scale duct layouts, dimensioned to show length of duct runs, duct sizes, support spacing and expansion provisions.

2. Details of construction, including condensate sumps and condensate eductor stations.
3. Details of installation, including duct support loads on tank and channel covers. Duct support loads on tank covers and channel cover shall also be submitted to the aluminum cover system manufacturer.
4. Manufacturer's literature, illustrations, specifications and engineering data.
5. Flexible connections.
6. Other technical data related to the specified material and equipment as requested by ENGINEER.
7. Duct sealants.
8. Specifications for FRP resins and reinforcing material used.
9. Submit color samples of pigmented gel coat to ENGINEER for selection.
10. Specifications for fire-retardant epoxy FRP ductwork coating and reinforcing material used.
11. Submit FRP round duct schedule with laminate construction, sizes, thickness, vacuum pressure, weight per foot pressure, spans, joint type and flange data.
12. Submit FRP rectangular duct schedule with laminate construction, sizes, thickness, vacuum pressure, weight per foot pressure, spans, joint type and flange data.
13. Submit HDPE duct schedule indicating size, wall thickness, weight per foot, joint type and ring stiffness constant.
14. Gasket material.
15. Deviations from Contract Documents.

B. Test Reports: Submit the following test reports for approval where required.
1. Volume Damper leakage tests from an AMCA approved testing laboratory.

C. Submit a letter stating that the proposed resins proposed in the fabrication of the FRP ductwork will provide satisfactory performance under the specified service conditions or a corrosion resistance chart indicating same.

D. Manufacturer's calculations indicating the laminate sequence meets the proposed pressure and vacuum classification and deflection criteria indicated below.

E. Tabulation in check list forms to indicate compliance with ASTM D 2563 Table I, Level II visual acceptance levels.

F. Other calculations, dimensions or materials related to the specified product as requested by ENGINEER.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store equipment and materials so as to keep free from moisture, damage, and deterioration.

B. Manufacturer shall protect all flange faces and the more fragile appurtenances of the sub-assemblies, with padding between pieces in order to prevent one piece from impacting with another, and by crating or other means for shipment.

C. Duct sub-assemblies shall be unloaded with care and stored in a location where they will be free from damage. Impact of a tool or other heavy object may result in a fracture of the inner lining and affect the service life of the duct or equipment.

D. Large sub-assemblies shall be supported during unloading to prevent excessive deflection and overstressing.

E. Corrosion resistant ductwork shall be protected, by padding or bracing, from banding or ropes used in shipment. No chains are to be used to secure any corrosion resistant ductwork during transportation.

1.5 GENERAL REQUIREMENTS

A. The Drawings show general arrangement and extent of Work to be done, but the exact location and arrangement of all connections, fittings, dampers, supports and expansion joints shall be determined as the Work progresses, to conform in the best possible manner with its surroundings. The exact location of all parts of the Work must be governed by the general building plans and the actual building conditions. Piping, equipment, ducts, etc. found to interfere with the construction of the building, plumbing apparatus and piping, electrical wiring or other obstructions, etc. shall be located to clear such obstructions. Connections shown on the Drawings to the various units are intended as an indication only. The actual connections shall be made and to best suit each particular case, provide for expansion, circulation and minimize the amount of space required.

B. Drawings do not show all offsets, fittings, accessories and details which may be required. Examine all the Contract Documents for conditions which may affect the installation of the Work, and shall arrange the Work accordingly. Provide all required items to complete the systems to the extent required by the Contract Documents.

C. If piping or ductwork can be run to better advantage, CONTRACTOR, before proceeding with the Work, shall prepare and submit complete drawings showing all details of the proposed rearrangement for written approval by the ENGINEER.

D. Resin cure for all FRP ductwork shall be checked by Barcol hardness and acetone tests. Hardness shall be within 90 percent of resin manufacturer's specification. Barcol test shall be required for inside and outside surfaces of all fiberglass fabrications in accordance with ASTM D 2583. Acetone test shall be conducted on interior surfaces of ducts.

E. Prior to final inspection, all surfaces shall be made clean by brushing, wiping, or with a compressed-air blast to remove all loose foreign materials.

F. A thorough inspection of each piece of ductwork will be conducted upon arrival at construction site to inspect for damage incurred in transit. Any damage shall be immediately repaired by respective equipment fabricator's personnel (not a sales representative).

1.6 DUCTWORK FABRICATION

A. FRP ductwork and accessories shall be fabricated in a heated and well ventilated structure protected from weather and temperature extremes. Entire fabrication, curing and assembly process of any piece of FRP equipment shall occur under appropriate temperature and humidity conditions as recommended by the FRP fabricator and resin provider. Submit an affidavit certifying that all FRP equipment shall be fabricated, cured and assembled as described in this Section.

PART 2 - PRODUCTS

2.1 DESIGN CONDITIONS

A. Maximum allowable deflection for any size of corrosion resistant ductwork shall be 1/4-inch between supports and for any side of duct under worse case operating conditions.

B. Tolerances:
   1. Out-of-roundness of duct shall be limited to ±1/8-inch or ± one percent of duct inside diameter, whichever is greater for duct sizes 8-inch diameter and greater.
   2. Length of all flange pipe sections shall not vary more than ±1/8-inch at 70°F.
   3. All unflanged duct shall be square on the ends in relation to the pipe axis and ±1/8-inch up to and including 24-inch diameter and ±3/16-inch for all diameters greater than 24-inch.
   4. Fittings:
      a. The tolerance on angles of all fittings shall be ± one degree, up to and including 24-inch diameter and ±1/2 degree for 30-inch diameter and above.
   5. Flanges:
      a. Flange faces shall be perpendicular to the axis of the duct within 1/2 degree.
      b. Flange faces shall be flat to within ±1/32-inch, up to and including 18-inch diameter and flat within ±1/16-inch for 20-inch diameter and larger.
      c. Provide custom filler pieces as required to mate flanges squarely.

2.2 FIBERGLASS REINFORCED PLASTIC (FRP) DUCTWORK AND ACCESSORIES

A. The fiberglass reinforced plastic duct system shall be specifically designed, constructed, and installed as shown on the Drawings for the following minimum conditions.

1. Ambient Air Temperature: 20°F to 125°F.
2. Corrosion resistance to hydrogen sulfide, chlorine, mercaptans and other gases commonly encountered in wastewater treatment plants.
3. Vacuum Service: Minimum 10-inch water gage.
4. Pressure Service: 20-inch water gage.

B. Fiberglass reinforced plastic (FRP) ductwork shall be of filament wound or hand lay-up construction. FRP ductwork shall be of flame retardant material inside and outside in accordance with NFPA-91. All ducts shall be installed in accordance with manufacturer's recommendations.

C. FRP Duct Construction: Duct shall meet the applicable requirements of ASTM D 2310, Type 1, Grade 1 or 2, with Class "E" liner, 20 mils minimum thickness, and be manufactured in accordance with ASTM D 2996. Flanges and bolt drilling circles and diameters shall conform to NBS PS 15-69, except that flanges shall be a minimum of 0.75-inches thick. Ductwork shall be fabricated of vinylester resin as specified below. All interior and exterior surfaces of ducts, dampers and FRP accessories shall be coated with a minimum 90 percent resin, five percent antimony trioxide and nexus veil reinforcement. Exterior surfaces shall have a factory applied paraffinated pigmented gel coat finish with ultra-violet inhibitors.
   1. Ductwork shall be in accordance with SMACNA Thermoset FRP Duct Construction Manual.

D. Laminates shall consist of a 20 mil chemical resistant liner with a synthetic surfacing veil embedded in a resin rich surface. The corrosion barrier shall be a minimum of 100 mils and include no less than two layers of 1-1/2 ounce mat with 25 percent glass and 75 percent resin content. The structural layer shall be of sufficient thickness to meet the minimum thickness requirements specified. The exterior surface layer shall be resin rich appertured nexus veil not less than 20 mils thick. Outside finish shall have a parrafinated pigmented gel coat finish with an ultra violet inhibitor. Provide standard and custom color chart for color selection. The composition specified for the inner surface and interior layer is intended to achieve optimum chemical resistance.

E. Resins used in the laminate shall be premium corrosion resistant and fire retardant brominated biphenol-A vinylester resins such as Dow Chemical Company, Derakane 510A with five percent antimony trioxide, Reichhold Dion 9300 FR with five percent Antimony Trioxide or Ashland Chemical Company, Hetron FR 992 with three percent antimony trioxide or equal. The synthetic surfacing veil shall be Veil-Nexus 1012 (apertured) as manufactured by Burlington Industries.

F. All cut edges shall be sealed with a resin coating of the same resin as used in the fabrication. The resin shall contain paraffin.

G. Product and Manufacturer: Provide one of the following:
   1. Ceilcote Company, Inc.
   2. Ershigs Incorporated.

3. Sponstrand.
4. Daniel Mechanical.
5. Or equal.

H. All FRP ductwork installed within the interior of any building shall be additionally protected with a two-component catalytic epoxy intumescent fire-retardant coating.
   1. Reference: United States Military Specification, MIL-C-46081A.
   2. Surface Preparation: All mold release agents and other foreign matter shall be completely removed. All glossy surfaces shall be brush-blasted or sanded and cleaned.
   3. Product and Manufacturer: Provide one of the following:
      a. Flame Control Coatings, Incorporated, Flame Control No. 46081 Thermal Insulating (Intumescent) Epoxy Paint.
      b. Or equal.
   4. Laminate must be fully cured before application of fire-retardant coating.
   5. Apply first coating minimum eight to ten mil (wet) over duct.
   6. Immediately apply one layer of C-Veil onto wet coating. Brush or roll C-Veil to remove any creases and to completely wet C-Veil.
   7. Apply second layer of intumescent coating at eight to ten mil (wet) minimum thickness. Dry thickness of two coats plus C-Veil shall be not less than ten mils.
   8. Apply additional coats as required to ensure that C-Veil is completely immersed in the epoxy coating and completely wetted and that the total dry thickness will be greater than ten mils. There shall be NO exposed or dry C-Veil.
   9. The flame spread rating of the fire-retardant coating shall not exceed 25 and the smoke developed rating shall not exceed 50. The manufacturer shall submit test data indicating that the fire retardant system does not exceed listed ratings and has been tested by Factory Mutual Research Corporation.
   10. Provide standard and custom color chart for color selection.

I. Fittings and Joints: All fittings such as elbows, laterals, tees, and reducers shall be of the same resin as and equal or superior in strength to the adjacent duct section and shall have the same internal diameter as the adjacent duct. Round duct joints shall be butt wrapped or bell and spigot joints as shown on the Drawings or required. Bell and spigot joints shall be sealed with a standard butt joint overlay in accordance with PS 15-69. All interior surfaces of joint to be coated with a paraffinated resin-rich gel coat.

J. Total width of overlay for butt-wrap joints shall be not less than 6-inches for diameters from 8-inches up to and including 30-inches, 36-inch and larger shall be not less than 10-inches.

K. Standard Elbows:
   1. Standard elbow centerline radius shall be equal to a minimum of 1-1/2 times the diameter.
   2. Standard elbows up to 24-inch diameter shall be smooth radius molded elbows. Standard elbows 30-inch diameter and greater may be mitered sections as specified below.

3. 0 to 44 degree elbows shall contain one mitered joint and two sections. 45 to 80 degree elbows shall have a minimum of two mitered joints and three sections. Elbows greater than 80 degrees shall have a minimum of four mitered joints and five sections.

L. Maximum allowable deflection for any size ductwork shall be 1/2-inch between supports and for any side of duct under worse case operating conditions. Ductwork supports shown on the Drawings are a minimum number required. Additional sup-ports shall be provided as required to meet the specifications. Additional supports shall be the same as adjacent support details.

M. Tolerances:
1. Out-of-roundness of duct shall be limited to ±1/8-inch or ± one percent of duct inside diameter; whichever is greater for duct sizes 8-inch diameter and greater.
2. Length of all flange pipe sections shall not vary more than ±1/8-inch at 70°F.
3. All unflanged duct shall be square on the ends in relation to the pipe axis and ±1/8-inch up to and including 24-inch diameter and ±3/16-inch for all diameters greater than 24-inch.
4. Fittings:
   a. The tolerance on angles of all fittings shall be ± one degree, up to and including 24-inch diameter and ±1/2 degree for 30-inch diameter and above.
5. Flanges:
   a. Flange faces shall be perpendicular to the axis of the duct within 1/2 degree.
   b. Flange faces shall be flat to within ± 1/32-inch, up to and including 18-inch diameter and flat within ± 1/16-inch for 20-inch diameter and larger.
   c. Provide custom filler pieces as required to mate flanges squarely.

N. Calculations for wall thickness determination shall be based on the structural fiberglass reinforced wall only. FRP ductwork shall be designed using a safety factor of ten to one for pressure and five to one for vacuum service. Ductwork shall be designed by manufacturer to resist all system forces and meet specified deflection requirements, but in no case shall FRP be less than the thickness listed in the table below.

(The remainder of this page was left blank intentionally.)

MINIMUM FRP ROUND DUCT DIMENSION AND PERFORMANCE SCHEDULE

ID (in.)	Wall Thickness (min.) (in.)	Minimum Allowable Vacuum[1] (in. of water)	Minimum Allowable Pressure[1] (in. of) water)	Flange Thickness (in.)	Bolt Circle Diameter (in.)	Bolt Size and No. of Bolt Holes	Maximum Allowable Span[2] (ft)
2	0.125	405	705	3/4	4-3/4	5/16 /4	9
3	0.125	405	500	3/4	6	5/16 /4	11
4	0.125	210	410	3/4	7-1/2	5/16 /8	12
6	0.125	64	350	3/4	9-1/2	5/16 /8	15
8	0.187	182	693	3/4	11-3/4	5/16 /8	17
10	0.187	94	693	3/4	14-1/4	5/16 /12	19
12	0.187	55	693	3/4	17	5/16 /12	20
14	0.250	91	693	3/4	18-3/4	1 /12	20
16	0.250	61	693	3/4	21-1/4	1 /16	20
18	0.250	44	693	3/4	22-3/4	1-1/8 /16	20
20	0.250	33	693	3/4	25	1-1/8 /20	20
24	0.250	18	693	3/4	28-1/2	1-1/4 /20	20
30	0.312	20	693	3/4	36	1-1/4 /28	20
36	0.375	23	693	3/4	42-3/4	1-1/2 /32	20
42	0.375	15	693	3/4	49-1/2	1-1/2 /36	20
48	0.437	15	693	3/4	56	1-1/2 /44	20
54	0.437	15	693	3/4	62-3/4	1-3/4 /44	20
60	0.437	15	693	3/4	69-1/4	1-3/4 /52	20
96	0.750	15	693	1	(3)	(3)	20

NOTES:

1. These ratings were suitable for use up to 180°F (82.2°C) in pressure service and ambient atmospheric temperatures on vacuum service. For ratings at high temperatures, consult manufacturer.
2. Based on 1/4-inch span deflection on air conveying systems at 180°F maximum. Also, based on duct systems not subjected to more severe service conditions such as additional weight caused by liquid or solids build-up in duct system, effects of wind loading on outdoor installations, or possible failure of intermediate duct hangers. Provide as a minimum, the number of duct supports as shown on the Drawings. Support continuous at all non-flanged pipe end connections.
3. Submit for approval by the ENGINEER.

O. All connections to expansion joints, butterfly dampers, tanks, or other equipment shall be flanged. Duct flanges shall conform to the FRP Duct Schedule, above. Gaskets shall be EPDM. Bolts, nuts and washers shall be Type 316 stainless steel. Flanges shall be hand laid up to PS 15-69 thickness, except that minimum thickness shall be 3/4-inch. The flange shall be hand laid-up anchored to a waxed table to achieve the flatness tolerance outlined in Paragraph 2.4.M.5., above. The face shall be textured for use with full-face gaskets, as specified above, 1/8-inch minimum thickness. Pipe flange drilling shall be NBS PS 16-69. All FRP duct and pipe flange bolt holes shall be back spot faced for a washer seat. All flange bolts shall be torqued to values as recommended by manufacturer.

P. Hangers:
   1. All ductwork shall be supported from trapeze type hangers. Hanger rods shall be minimum 3/8-inch for all ducts with half perimeter up to 72-inches, and 1/2-inch diameter for all ducts with half perimeter larger than 72-inches. A pair of rods shall be provided at each duct support point.
   2. All hangers, rods, supports, bolts, nuts, washers, inserts, and appurtenances located in corrosive areas shall be Type 316 stainless steel.
   3. Hanger Construction and installation shall conform to SMACNA Standards, except as specified. No sheet metal duct hangers or straps will be allowed.
   4. Supports shall be provided at each fitting.

Q. There shall be not less than a 1/4-inch buildup of FRP over the duct at each support. Each support shall be furnished with a 1/8-inch thick teflon sheet to shield the duct from the support. The teflon sheet shall extend beyond the support plate at least 1/2-inch on all sides.

R. Furnish flexible connectors, as shown on the Drawings and details, with anchors and guides.
   1. Product and Manufacturer: Provide one of the following:
      a. Holz Rubber Company.
      b. Pathway Bellows Incorporated.
      c. Mercer Rubber Company.
      d. Or equal.

S. Round Fiberglass Reinforced Plastic Dampers:
   1. Furnish and install where shown on the Drawings manually operated round butterfly dampers.
   2. Rating Conditions:
      a. Velocity Through Damper: 340.5 fpm.
      b. Pressure Rating: 10-inches water column.
      c. Maximum Allowable Leakage: Three cfm per square foot at 10-inch w.g. pressure.
   3. Materials:
      a. Bearings: Teflon.
      b. Blade: FRP, reinforced.
      c. Frame: FRP channel.

d. Axles: Type 316L stainless steel rods, full length of damper size as shown on the Drawings.
e. Finish: FRP.
f. Handle: Type 316L stainless steel.
g. Pins: Type 316L stainless steel.
h. Bushings: Teflon.
i. Hardware: Hastelloy-C.
j. Angles: FRP.
k. Flanged ends with bolt holes drilled to match connecting ductwork.
l. Blade Stops: FRP angles with full circumference EPDM seal.

4. Dimensions: As required.
5. Leakage test and performance data from an AMCA approved testing laboratory shall be submitted.
6. Provide the dampers for manual operation with hand quadrant and shaft seals.
7. Product and Manufacturer: Provide one of the following:
   a. Swartwout, Phillips Industries, Model 914.
   b. Or equal.

T. FRP Transition Pieces:
1. Provide transition pieces as shown on Drawings and herein specified.
2. Construction:
   a. 1/4-inch minimum thickness FRP sheets and thickness not to be less than thickness of adjacent FRP ducting.
   b. All exposed hardware shall be Hastelloy-C screws, nuts, bolts and washers, as required.
   c. Flanges shall be designed as required to connect to fan or ductwork.
3. Pressure Classification: Manufacturer shall design transition pieces so that they shall be free from buckling, pulsing, warp age, sagging and to the following pressure ratings:
   a. Vacuum Service: 10-inchs water gage, minimum.
   b. Pressure Service: 20-inches water gage, minimum.

U. Install round pipe sleeves and mechanical seals for all round duct wall and floor penetrations as herein specified:
1. Non-metallic, non-corrosive, high-density polyethylene construction.
2. Integral formed water stop and anchor plate.
3. Sleeve and mechanical seal shall be manufactured by Thunderline Link-Seal or equal.

W. Tools, Spare Parts and Maintenance Materials:
1. The duct system shall be furnished with the following:
   a. Two sets of special tools required to maintain and repair the system.
   b. All materials in kit form to make or repair joints. Kits shall be in a number sufficient to repair ten percent of the joints.
   c. Names and addresses of all manufacturers of: Fiberglass reinforcements, resins, hardeners and components used to repair and maintain FRP duct system.

2. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location, until transferred to the OWNER at the conclusion of the Project.

2.3 HIGH DENSITY POLYETHYLENE PIPE AND ACCESSORIES

A. High density polyethylene pipe (HDPE) shall be used for underground odor control ductwork only. In this Section and on the Drawings HDPE pipe, HDPE duct and foul air duct shall be used interchangeably.

B. The pipe shall be manufactured by the continuous winding of a special profile onto suitably sized mandrels with bell and spigot ends. It shall be produced to constant internal diameters. The pipe wall profile shall be in accordance with the manufacturer's recommendation. If solid wall pipe is used it shall be manufactured by conventional extrusion and utilize field butt fused joints. The solid wall pipe proposed shall provide for a minimum inside diameter as shown on the Drawings. Wall thickness shall be based on depth of burial, and assuming an H-20 loading under construction conditions. Depth of duct burial shall be as shown on the Drawings.

C. Pipe wall construction shall present a smooth wall in the air stream, but may include exterior ribs that help brace the pipe against diametrical deformity. The Hazen-Williams friction factor shall be no less than a value of 155.

D. All HDPE pipe and fitting ends shall have bell and spigot end construction, except at transitions to dampers, appurtenances and to FRP duct. Fabricated flange connections shall be provided at connections to dampers, appurtenances and FRP duct. Field installed joining shall be accomplished by mechanical joints with centering ring EPDM gaskets or flanged connections with EPDM gaskets, as required.

E. The manufacturing of fittings shall be accomplished by cutting the required pieces from stock pipe and joining the pieces by thermal welding. Weld location for fittings shall be at the manufacturer's option.

F. The pipe and fittings shall be made of high density, high molecular weight polyethylene pipe material meeting the requirements of Type III, Class C, Category 5, Grade P34, as defined in ASTM D 1248 Standard Specification for Polyethylene Plastics Molding and Extrusion Materials. Materials conforming to the requirements of cell classification PE 334433C or higher cell classification in accordance with ASTM D 3350 are also suitable for making pipe products under these Specifications. Clean rework material generated by the manufacturers own production may be used so long as the pipe or fittings produced meet all the requirements of this Section.

G. Centering ring gaskets shall be provided and conform to the requirements of ASTM F 477 and be molded into a circular form or extruded to the proper section and then spliced into circular form and shall be made of a properly cured high grade

elastomeric compound. The basic polymer shall be EPDM and shall be suitable for constant exposure to wet hydrogen sulfide.

H. Lubricant used for installation of centering rings shall have no detrimental effect on the centering ring or on the pipe.

I. Material used for extrusion-welded pipe joints shall meet the requirements established for the basic pipe material as detailed above.

J. Pipe and fittings shall be homogenous throughout and free from visible cracks, holes, foreign inclusions or other injurious defects. The pipe shall be as uniform as commercially practical in color, opacity, density and other physical properties.

K. Fittings such as couplings, wyes, tees, adapters, etc. for use in laying HDPE pipe shall have laying length dimensions as recommended by the manufacturer, elbows shall be mitered as specified for FRP ductwork, herein. Field fabrication of any fittings shall not be permitted.

L. All connections, when joined in accordance with manufacturer's recommendations, shall show no sign of leakage when tested in accordance with ASTM D 3212, with the exception that the shear load transfer bars and supports shall be replaced with 6-inch wide support blocks that can be either flat or contoured to conform to the pipe's outer contour.

M. The manufacturer shall furnish a certificate of conformance, certified test results and copies of the test report in accordance with Division 1, General Requirements.

N. Each standard and random length of pipe in compliance with this standard shall be clearly marked with the following information:
   1. Pipe Size.
   2. Pipe Class.
   3. Production Code.
   4. Material Designation.

O. If the results of any tests do not conform to the requirements of this Section, the tests shall be conducted again. If upon retest, failure occurs, the quantity of product represented by the tests shall be rejected and replaced at no additional cost to the OWNER.

P. Product and Manufacturer: Provide one of the following:
   1. Plexco/Spirolite.
   2. Or equal.

2.4 SURFACE PREPARATION AND PAINTING

A. Surface preparation and painting shall conform to the requirements of Section 09900, Painting.

B. Certify, in writing, that the shop primer and shop finish coating system conforms to the requirements of Section 09900, Painting.

C. All FRP exterior surfaces of pipe duct and fittings shall be painted with an approved epoxy paint system conforming to the requirements of Section 09900, Painting.

D. Ductwork shall be factory painted in accordance with paint system specified below.

E. Provide a sample FRP panel not less than two square feet which shall be painted and allowed to dry for not less than 48 hours and then be checked for paint adhesion by the paint system manufacturer and submitted to the ENGINEER.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all ductwork in accordance with manufacturer's recommendations and instructions and as shown on the Drawings and specified.

B. All ductwork shall conform accurately to the dimensions shown on the Drawings, the ducts shall be straight and smooth inside with joints neatly finished; ductwork shall be installed so as to preclude the possibility of vibration under all operating conditions.

C. Elbows shall have a minimum centerline radius of 1-1/2 times the width of the duct. Turning vanes shall be provided at all square elbows. Turning vanes shall be double wall and shall be quiet and free from vibration when the system is in operation.

D. Test holes shall be provided at each duct connection at all air moving equipment. Test holes shall be factory installed with no exposed fibers.

E. Provide manual volume dampers where shown on the Drawings and as required to facilitate accurate volume control. Damper blades shall be reinforced to prevent vibration.

F. Fire dampers shall be provided and installed where shown on the Drawings and where required by U.L. and shall be approved by the Phoenix Building Code and in accordance with the requirements of the NFPA.

G. Provide access doors for all dampers for inspection and maintenance.

H. Install all ductwork and accessories to provide a system free from buckling, warping, breathing or vibration.

I. All expansion joints and ducts shall be suitably supported at each end by support guides within 12-inches of joint.

J. All ducts at flexible connections with fans shall be supported at free end within 12- inches of flexible connection.

K. Provisions shall be made for supporting all ductwork, dampers, and other ductwork accessories, where required.

L. All low points in the corrosion resistant ductwork shall be provided with 1-1/4-inch drains, unless otherwise noted. All drains shall be provided with a "P trap", unless otherwise noted. Above grade ductwork drains shall be piped to the nearest wastewater channel. Below grade condensate sumps shall be piped to the adjacent condensate eductor as shown on the Drawings.

M. All buried ductwork shall be bedded in sand. Sand shall extend a minimum of 6-inches below the bottom of the duct, 12-inches minimum on the sides of the duct, and shall be flush with the top of the duct, unless otherwise noted. Backfill with compacted selected fill in accordance with Section 15051, Buried Piping Installation.

N. Receive field assistance, if required, from the corrosion resistant ductwork manufacturer to ensure that the corrosion resistant ductwork is installed and jointed correctly.

O. All fittings, valves, expansion joints, specials and similar items shall be supported within 18-inches of the joint, unless otherwise noted.

3.2 ADJUSTMENT

A. Set volume control devices for approximate positions in preparation for final testing and balancing.

B. Start fan system and check for excessive leaks and vibration and correct.

3.3 CLEANING

A. Remove all loose materials and obstructions from interior of ducts.

B. Remove debris and waste materials resulting from installation.

3.4 INSPECTION OF DUCTWORK

A. ENGINEER reserves the right to reject any and all equipment found to have the following: blisters, chips, crazing, exposed glass, dry cracks, burned areas, dry spots, foreign matter, or entrapped air at the laminate surfaces which do not satisfy the tolerances specified in ASTM D 2563, Table I Acceptance Level II inside and

outside surfaces. Unacceptable Barcol hardness and acetone sensitivity shall also be cause for rejection.

+ + END OF SECTION + +

SECTION 15831

CENTRIFUGAL FANS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install centrifugal fans complete and operational with accessories.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience of producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Requirements of Regulatory Agencies: Comply with applicable provisions of regulatory agencies below and others having jurisdiction:
   1. National Fire Protection Association (NFPA).
   2. Underwriters' Laboratories, Incorporated (UL).
   3. National Electrical Code (NEC) current adoption.
   4. City of Phoenix – Amendments to the National Electrical Code.
   5. National Electric Manufacturers Association (NEMA).
   6. Phoenix Building Code.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. Air Movement and Control Association (AMCA) Standard: 210-74.
   2. National Fire Protection Association (NFPA).
   3. Underwriters' Laboratories, Incorporated (UL).
   4. National Electric Code (NEC) current adoption.
   5. City of Phoenix – Amendments to the National Electrical Code.
   6. National Electric Manufacturers Association (NEMA).
   7. Uniform Building Code as supplemented by the City of Phoenix, Building Construction Code.

D. Source Quality Control: Perform the following tests and inspections at factory:
   1. Fan wheels shall be statically and dynamically balanced.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's literature, illustrations, specifications, and engineering data to include the following:
      a. Dimensions.
      b. Materials of construction.
      c. Mounting details.
      d. Performance Data - AMCA approved fan curves, for each model specified.
      e. Prefabricated curb details.
   2. Drawings showing fabrication methods, assembly, installation details and accessories.

B. Test Reports: Submit the following test certifications for approval.
   1. AMCA Label.
   2. UL Label.

C. Operation and Maintenance Manuals:
   1. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation and spare parts information.
   2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01781, Operation and Maintenance Data.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of the Work.

B. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the site. Notify ENGINEER if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

C. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports, and in accordance with the manufacturer’s recommendations for long term storage. Protect steel members and packaged materials from corrosion and deterioration.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Product and Manufacturer: Provide one of the following:

1. Hartzell, Model A42-0-14—F100FGFQK3
2. Or equal.

C. Type: Single width, single inlet, backward inclined, non-overloading air foil blade centrifugal fan with fixed discharge. Arrangement 10.

D. Capacity: As shown on the Drawings.

E. Construction:
1. Housing: Seam welded heavy gauge construction.
2. Fan Wheel: Class F, non-ferrous.
3. Inlet Bell: Non-ferrous construction.
4. Fan Shaft: Monel, turned, ground and polished, keyed to fan wheel.
5. Shaft Bearings: Heavy duty, grease lubricated, self-aligning, ball bearings, B-10 minimum life rating of 100,000 hours.
6. Housing Supports: Heavy angle or channel members.

F. Motors:
1. Motors shall conform to the requirements of Section 11000, Electric Motors.
2. Enclosures: TEFC. Explosion-proof where shown on the Drawings.
3. Motors shall be in accordance with all current applicable standards of NEMA, IEEE, AFBMA, Phoenix Electrical Code, and ANSI.
4. Motors shall be normal starting torque, normal slip, squirrel cage induction type.
5. Motors shall be capable of carrying full load current continuously without injurious temperature rise in an ambient temperature of 50°C.
6. Motors shall be provided with a service factor of 1.15.
7. Motors shall be of sufficient size so that there will be no overload on the motor above rated manufacturer's nameplate horsepower under any condition of operation.
8. Motor thrust bearings shall be adequate to carry continuous thrust loads of fan operation.
9. Locked rotor currents shall be as specified in NEMA standards.
10. Lubrication may be grease or oil type.
11. Overload Protection: Provide integral overload protection on all single-phase motors.
12. Disconnects: Provide factory mounted, factory wired unfused disconnects for all single-phase motors.
13. Mountings:
    a. Base mounted.

G. Drive:
1. Direct through motor shaft.
2. V-belts and adjustable sheaves.
3. Multiple groove fixed pitch

H. Access Doors:

1. Latches: Quick opening cam type levers.
2. Conform to scroll radii.
3. Gasketed.

I. Drain: 1/2-inch pipe coupling welded to housing with threaded corrosion resistant plug.

J. Belt Guard: OSHA approved with tachometer hole.

K. Coatings:
1. Plastic coating with vinyl ester base.
2. Coat all portions of fans in airstream with protective coating mentioned above.
3. Coat entire fan with coating mentioned above.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine Pads to Receive Fans for:
1. Proper anchor bolt locations.
2. Unevenness, irregularities and incorrect dimensions.

3.2 INSTALLATIONS

A. Installation shall be in accordance with the manufacturer's instructions and recommendations.

B. Installation shall include furnishing and applying an initial supply of grease as recommended by the manufacturer.

C. Ductwork shall be supported independently of fan.

D. Check and align fan and motor.

3.3 START-UP ADJUSTMENT AND TESTING

A. Grease bearings, if required, prior to starting fans.

B. Check for proper rotation.

C. Adjust fans for proper air flow.

D. Leave fans in working order.

3.4 CLEANING

A. Clean dirt and marks and other debris from exterior of fans.

B. Remove debris and waste material resulting from installation.

+ + END OF SECTION + +

SECTION 16050

GENERAL PROVISIONS

PART 1 - GENERAL

1.1DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown on the Drawings, specified, and required to complete the electrical Work.
   2. Equipment shall be rated and labeled by the manufacturer for the environmental conditions in which it is installed including the power disconnects, control stations, and wiring systems.
   3. Conduits and circuits within electrical distribution or utilization equipment and cabinets shall be identified and labeled as specified and as shown.

B. Coordination:
   1. Review installation procedures, drawings and schedules under other Sections and coordinate with other trades the installation of electrical items that must be installed with or within formwork, walls, partitions, ceilings, and panels.
   2. Responsible for the installation of all conduits, inserts, and other items to be embedded in the concrete, or built into walls, partitions, ceilings or panels constructed by other contractors. Provide other contractors with detailed plans or sketches of the location of said conduits and other built-in items as may be required. Stay fully informed of the construction where conduits and other built-in items are to be installed. Install said conduits and other built-in items in such a manner and within such time periods as will not unnecessarily delay the work of the other contractors.
   3. Arc Flash Coordination: Review Electrical Pre-Submittal coordination efforts during the Pre-Construction Conference, Section 01301 with CONTRACTOR, STUDY FIRM, ARC FLASH FACILITATOR and the ENGINEER.
   . a. Agenda items for Pre-Construction Conference shall include:
      1) Submittal review routing protocols.
      2) Discuss procedures to handle equipment found to have an incident energy level that requires above a Level 2 PPE.
      3) Electrical safety label installation, as identified in specification 16215.
      4) Single Line Diagram and Power Panel Schedule Record Documents.

C. General:
   1. Interpretation of Drawings:
      a. Dimensions shown on the Drawings that are related to equipment are based on the equipment of one manufacturer. Confirm the dimensions of the equipment furnished to the space allocated for that equipment.

b. The Drawings show the principal elements of the electrical Work. They are not intended as detailed working drawings for the electrical Work, but as a complement to the Specifications to clarify the principal features of the electrical systems.
c. It is the intent of the Drawings and Specifications that all equipment and devices, furnished and installed under this Contract, be properly connected and interconnected with other equipment and devices so as to render the installations complete for successful operation, regardless of whether all the connections and interconnections are specifically mentioned in the Specifications or shown on the Drawings.
d. It also is the intent of the Contract Documents that similar products are provided by the same manufacturer for uniformity on the Project.

D. Work Installed by CONTRACTOR But Furnished By Others:
1. City of Phoenix

E. Temporary Power and Lighting:
1. Refer to Section 01511, Temporary Electricity, for temporary power during construction.
2. Refer to Section 01512, Temporary Lighting, for temporary lighting during construction.
3. If utilizing existing facility power, provide updated panel schedules and/or load summaries to Greeley and Hansen and the City of Phoenix identifying the recommended power sources and circuits for temporary services. ENGINEER and the City of Phoenix must provide approval prior to connecting to the services.

F. Utilities:
1. Furnish and install empty conduits and ground for telephone service per utility shop drawings. Plywood backboards and punch-blocks shall be furnished and installed for telephone service, as required for contractor's job-site trailers. Coordinate with City of Phoenix, Information Technology Services (ITS) Department and Telephone Utility. Plywood backboards shall be painted with approved fire-retardant paint. Coordinate with City of Phoenix ITS project requirements and apply for service. Submit all necessary documents and fees required to Telephone Utility.

1.2QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
1. Permits: Obtain all permits and pay fees required to commence Work and, upon completion of the Work, obtain and deliver to the ENGINEER a Certificate of Inspection and Approval from the authority having jurisdiction.
2. Codes: Material and equipment shall be installed in accordance with the current standards and recommendations of the National Electrical Code, the National Electrical Safety Code and with local codes which apply. Where discrepancies arise between codes, the most restrictive regulation shall apply.

3. Tests by Independent Regulatory Agencies: Electrical material and equipment shall be new and shall bear the label of the Underwriters' Laboratories, Inc., or other nationally-recognized, independent testing laboratory, wherever standards have been established and label service regularly applies.
4. Utilities:
   a. ARIZONA PUBLIC SERVICE (APS) Power Authority: Work in connection with the electric service and utility metering shall be done in strict conformance with the requirements of APS.
   b. XFINITY Communications Company: Work in connection with the communication lines for the communication service shall be done in strict conformance with the requirements of XFINITY. The communication system within the Plant is a private system and shall be coordinated with the City of Phoenix, Information Technology Department.
   c. City of Phoenix, Information Technology Department.

B. Reference Standards: Electrical material and equipment shall conform in all respects to the latest approved standards of the following:
   1. National Electrical Manufacturers Association (NEMA).
   2. The American National Standards Institute (ANSI).
   3. The Institute of Electrical and Electronic Engineers (IEEE).
   4. Insulated Cable Engineers Association (ICEA).
   5. National Electrical Code (NEC) current adoption.
   6. National Electrical Safety Code (NESC).
   7. American Society for Testing and Materials International (ASTM).
   8. The Instrumentation, Systems and Automation Society (ISA).
   9. National Fire Protection Agency (NFPA).
   10. Underwriter's Laboratories, Inc. (UL).
   11. Occupational Safety and Health Administration (OSHA).

C. Wiring Coordinator:
   1. Retain the services of a Wiring Coordinator who shall prepare complete point-to-point interconnection wiring termination sheets. The sheets shall identify all external interconnecting wiring associated with all new and modified existing equipment.
      a. Qualifications: Coordinator shall have experience in the development of the point-to-point interconnection wiring termination sheets and shall have served in a similar role on a project of similar size and complexity.
         1) Present qualifications and approach for the project at Pre-Construction Conference specified under Section 01301, Pre-Construction Conference.
         2) Prepare the items listed below for presentation at the Pre-submittal Meeting. Submit to ENGINEER three weeks prior to date of meeting.
            a) List of projects where the Wiring Coordinator developed point-to-point wiring termination sheets.
            b) Samples of diagrams that were developed for the listed projects.
            c) Example wiring diagram proposed for the Work with a preliminary list of drawings to be produced.

d) Plan of how information will be obtained and documented.

b. Responsibilities:
   1) Develop point-to-point interconnection wiring termination sheets for performance of the Work and to document terminations.
   2) Use information obtained from approved Shop Drawings, Record Drawings and field inspections as required to complete the sheets.
   3) Attend Pre-submittal Meeting and periodic coordination and progress meetings specified in Section 17001, Process Control System General Requirements for Process Instrumentation.
   4) Conduct point-to-point wiring checks to determine wires and terminations are per the point-to-point interconnection wiring termination sheets. CONTRACTOR to sign-off on the sheets to document the checks were performed. After confirmation by the CONTRACTOR, submit the signed sheets to the OWNER/ENGINEER.
      a) Point-to-Point Interconnection Wiring Termination Sheets: Include the following:
         i. External wiring for each piece of equipment, panel, instrument and other devices and conduit wiring to control stations, lighting panels and motor controllers.
         ii. Numbered terminal block identification for each wire termination.
         iii. Identification of the assigned wire numbers for all interconnections.
         iv. Identification of all conduit wiring by the conduit tag in which the wire is installed.
         v. Terminal and pull boxes through which wiring is routed.
         vi. Identification of all equipment and the Shop Drawing transmittal numbers for equipment from which the wiring requirements and termination information was obtained.

1.3SUBMITTALS

A. Refer to Section 01330, Submittals and Section 01332, Shop Drawing Procedures.

B. Shop Drawings shall include the following information to the extent applicable to the particular item:
   1. Manufacturer's name and product designation or catalog number, including environmental rating such as "Rated for Outdoor Use" or "Rated for Hazardous Location".
   2. Electrical ratings.
   3. Conformance to applicable standards or specifications of ANSI, ASTM, ICEA, IEEE, ISA, NEC, NEMA, NFPA, OSHA, UL, or other organizations.
   4. Dimensioned plan, section, elevations, and panel layouts showing means for mounting, conduit connection, and grounding.
   5. Materials and finish specification, including paints.
   6. List of components including manufacturer's names and catalog numbers.

7. Internal wiring diagram and drawings indicating all connections to components and numbered terminals for external connections.

1.4PROJECT CLOSEOUT

A. Operation and Maintenance Data: Submit complete manuals including:
   1. Copies of all Record Drawings and Wiring Diagrams, test reports, Power System Study, maintenance data and schedules, description of operation, and spare parts information.
   2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01781, Operation and Maintenance Data.

B. Record Drawings:
   1. Furnish two (2) copies of Record Drawings in accordance with the requirements of Section 01782, Record Documents, including:
      a. System Record Drawings: Include the following:
         1) One line wiring diagram of the distribution system.
         2) Accurate and detailed in place conduit and cable layouts with schedule of conduit sizes and number and size of conductors.
         3) Layouts of the power and lighting arrangements and the grounding system.
         4) Control schematic diagrams, with terminal numbers and all control devices identified, for all equipment.
         5) Point-to-Point Interconnection Wiring Termination Sheets
   2. The Record Drawings shall reflect final equipment and field installation information.

1.5PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials: Instruct the manufacturers and vendors as to the maximum shipping sizes of equipment that can be accommodated at the site.

B. Storage of Materials: Refer to and comply with the requirements of Section 01661, Storage of Materials and Equipment.

C. Handling of Materials: Refer to and comply with the requirements of Section 01651, Transportation and Handling of Materials and Equipment.

1.6JOB CONDITIONS

A. Existing Conditions:
   1. Examine the site and existing facilities in order to compare them with the Contract Documents with respect to the conditions of the premises, location of and connection to existing facilities and any obstructions which may be encountered.

2. Perform the Work with due regard to safety and in a manner that will not interfere with the existing equipment or in any way cause interruption of any of the functions of the plant.
3. Work shall be carried out with a minimum amount of disruption to the operation of the existing plant and with prior approval of OWNER. Submit for approval by OWNER, a detailed written procedure for work which affects operation of the existing plant, a detailed procedure for modifying any existing electrical equipment, including appropriate Personal Protective Equipment (PPE) required if equipment must remain energized while conducting work, anticipated time required to complete the Work, and the required shutdown time, if any.
4. Where the Work of CONTRACTOR ties in with existing installations, take prior precautions and safeguards in connecting the Work with the existing operating circuits so as to prevent any interruption to the existing operating circuits. The tying in of Work, installed under this Contract, with the existing circuits shall be performed only in the presence of OWNER. Advance notice will be required before any equipment is removed from service. Notify OWNER, in writing, of his intention to do such work, providing full details.

B. Demolition:
1. The demolition of electrical power distribution equipment, instrumentation/ control equipment, conduit, wire and appurtenances shall be in accordance with Section 02220, Demolitions.

1.7CONTROL CABINETS AND PANELS

A. All outdoor panels:
1. With electronics and temperature sensitive instruments, shall be provided with sunshade structures. Sunshade structures shall be constructed as shown on drawings.
2. Shall be Free-Stand Enclosures

B. All control cabinet and panel materials shall meet the area classifications as stated in Section 1.9, unless otherwise specified or noted on the Drawings.
Provide the following types of enclosures:
1. NEMA 3R, 4 or 12
2. Corrosive Locations, NEMA 4X
3. Hazardous Locations, NEMA 7

C. Provide the following enclosure features:
1. NEMA 3R, 4 or 12 Enclosures:
a. Fabricate enclosures using minimum 14 gage steel for wall or frame mounted enclosures and minimum 12 gage for free standing enclosures. Keep steel free of pitting and surface blemishes.
b. Continuously weld all exterior seams and grind smooth. Also, surface grind complete removal of corrosion, burrs, sharp edges and mill scale.
c. Reinforce sheet steel with steel angles where necessary to adequately support equipment and ensure rigidity and to preclude resonant vibrations.
d. Provide control panel with flatness within 1/16-inch over a 24-inch by 24-inch area, or flat within 1/8-inch for a larger surface. Verify flatness by using

a 72-inch-long straight edge. Limit out-of-flatness to gradual and in one direction only with no obvious depressions or wavy sections.

e. Use pan type construction for doors. Door widths are not to exceed 36-inches.
f. Mount doors with heavy duty hinge(s) with stainless steel hinge pins.
g. Provide handle-operated, oil-tight, key-lockable three-point stainless steel latching system with rollers on latch-rods for easy door closing.
h. Product and Manufacturer: Provide one of the following:
    1) Hoffman
    2) Hammond
    3) Or approved equal

i. Painting:
    1) Completely clean all interior and exterior surfaces so they are free of corrosive residue, oil, grease and dirt. Apply zinc phosphate for corrosion protection.
    2) Apply one coat of primer interior and exterior surfaces immediately after corrosion protection has been applied.
    3) Coat exterior surfaces with primer surface applied with sanding and cleaning between coats, until a Grade 1 finish can be produced on the finish coat.
    4) Paint all exterior surfaces minimum of three finish coats of polyurethane enamel to ultimately produce a Grade 1 finish (super smooth; completely free of imperfections). Color to be selected by ENGINEER from complete selection of standard and custom color charts furnished by the manufacturer. Provide one extra quart of touch-up paint for each exterior finish color.
    5) Provide compatible primer and finish paint with a low VOC, high solids polyurethane enamel. Paint interior surfaces with two coats of semi-gloss white polyurethane enamel.
    6) Product and Manufacturer:
        a) Hi-Solids Polyurethane B65 W300 Series as manufactured by Sherwin Williams, Inc
        b) Or approved equal.

3. NEMA 4X Enclosures:
    a. Provide enclosures with Type 316 stainless steel construction. Wall or frame mounted enclosures fabricate using a minimum 14 gage steel. Free standing enclosures fabricate using a minimum 12 gage steel. Enclosures smaller than 14”x 12”x 6” fabricate using a minimum of 16 gage steel. Keep steel free of pitting and surface blemishes. Provide all surfaces with a smooth brushed finish.
    b. Provide stainless steel fast-operating clamp assemblies on three sides of each door.
    c. Rolled lip around three sides of door and along top of enclosure opening.
    d. Provide a hasp and staple for padlocking.
    e. Provide 3-inch-high channel base assembly, with solid bottom, drilled to

mate the panel to its floor pad for free-standing panel.

f. Provide 5/16-inch diameter copper ground studs for the ground connection points for all panel equipment and panel doors.

g. Product and Manufacturer: Provide one of the following:
   1) Hoffman
   2) Hammond
   3) Or approved equal

4. NEMA 7 Enclosures;
   a. House monitoring and measuring devices located in hazardous environments in explosion-proof control enclosures.
   b. Enclosures rated for use in NEC Class 1, Groups C&D or Class II, Groups E, F & G applications and comply with UL and CSA standards.
   c. Required Features:
      1) Light weight and corrosion resistant copper-free aluminum
      2) Integral, cast-on mounting lugs
      3) Left side door hinges
      4) Viewing windows sized to suit internally mounted components
      5) Stainless steel cover bolts
      6) Cad-plated steel mounting pans
   d. Product and Manufacturer: Provide one of the following:
      1) Adalet
      2) Killark
      3) Crouse-Hinds
      4) Hoffman

1.8ELECTRICAL EQUIPMENT

A. All electrical equipment shall be capable of operating successfully at full-rated load, without failure, with an ambient outside air temperature range of -10°F to 131°F and an elevation of 1712 feet (MSL).

B. All electrical devices and equipment shall have ratings based on 75°C terminations.

C. Mounting of electrical equipment on handrails is not allowed.

1.9AREA CLASSIFICATIONS

A. Materials and equipment shall conform to the area classification(s) shown on the Drawings, specified, and required.

B. Corrosive Locations: The following areas shall be considered corrosive locations:
   1. Area (18 in.) above Wet Well

C. Hazardous Locations: The following areas shall be considered hazardous areas as shown on the Drawings.
   1. Wet Well Class 1, Division 1.

2. Biofilter Blower Class 1, Division 1.

Materials, equipment, and incidentals in areas identified as hazardous locations shall meet NEC requirements for the Class and Division designated.

1.10 SCHEMATIC DIAGRAMS

A. Schematic diagrams are provided for CONTRACTOR'S guidance in fulfilling the operational intent of the Contract Documents.

B. Responsibility belongs to CONTRACTOR to meet all safety and electrical codes, and to provide all equipment, appurtenances and specialty items required to provide for complete and operable systems.

C. Review of control schemes submitted by CONTRACTOR does not relieve CONTRACTOR of his contractual responsibility to provide complete and successfully operating systems.

PART 2 - PRODUCTS

2.1NAMEPLATES

A. Material: Laminated phenolic, engraved to show 1/2-inch-high letters, Arial Font, unless stated else where in the CONTRACT DOCUMENTS for a specific piece of equipment. The letters shall be black with white background or match existing.

B. Border: Minimum 1/8-inch around engraved print with extra length for fastening devices.

C. Fasteners: Secured with #4-40, roundhead, stainless steel, self-tapping screws.

2.2WIRE MARKERS

A. Refer to Section 16122, 600 Volt Cable.

2.3CONDUIT TAGS

A. Refer to Section 16131, Rigid Conduit.

PART 3 - EXECUTION

3.1EQUIPMENT IDENTIFICATION

A. Provide identification of each electrical item, in addition to the manufacturer's nameplates, to identify the item's function, and the equipment or system which it serves or controls.

B. Identify equipment by means of nameplates. Re-label existing equipment whose designation has been changed. Identify potential arc flash hazard levels on equipment with the label specified in Section 16215 – Power Study.

C. Identify pull and terminal boxes with nameplates. Identify each box by a unique number. Numbering system shall reflect the actual designations used in the field and as documented on wiring diagrams.

D. Process/Mechanical/Electrical equipment located outdoors shall be labeled by the manufacturer: "For Outdoor Use".

E. Equipment Voltage Labels.
   1. Voltage labels shall be installed on all equipment that has voltage in the equipment.
   2. Where applicable, install voltage label below the Arc Flash Warning label.
   3. If the equipment has access to the backs or side of the gear, apply voltage labels on all access panels.
   4. Provide standard 3.5-inch by 5-inch, Black/Red on White rectangular labels to match Figure 2.2.C below.
   5. Apply a "Danger High Voltage" label to all medium equipment greater than 600 volts.
   6. Product and Manufacture: Provide the following:
      a. BRADY
         1) DANGER 120 VOLTS, Part # 86784
         2) DANGER 480 VOLTS, Part # 86783
      b. Or Approved Equal.

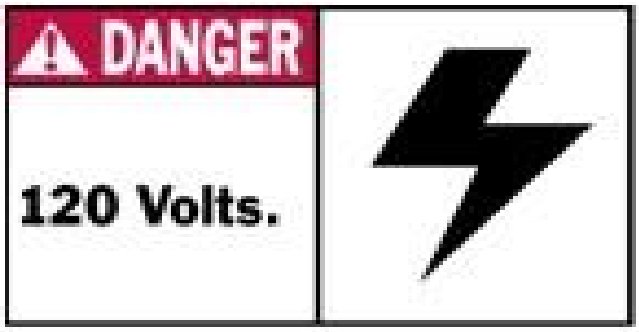

Figure 2.2.C

+ + END OF SECTION + +

SECTION 16061

GROUNDING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install complete grounding for the electrical systems, structures and equipment.
   2. Pump cans and buried piping shall be bonded to the existing ground grid.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
   1. National Electrical Code (NEC) Article 250, Grounding.
   2. Underwriters Laboratories (UL) Standard No. 467, Electrical Grounding and Bonding Equipment.
   3. ANSI-J-STD-607-A, Commercial Building Grounding [Earthing] and Bonding Requirements for Telecommunications.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for grounding materials proposed for use.
   2. Listing of grounding connector types identifying where they are to be used.
   3. Layouts of each structure ground grid.
   4. Test point construction details.
   5. Ground resistance test procedure.
   6. Results of ground resistance tests at each test point. Provide the test information and results as required on form 16000-N in Specification 01331 – Reference Forms.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Bare Ground Cable:
   1. Material: Annealed, bare, stranded copper.
   2. Product and Manufacturer: Provide ground cable of one of the following:
      a. Southwire Corporation.
      b. Service Wire Company.
      c. Encore Wire Corporation.

B. Ground Rods:
   1. Material: Copperclad rigid steel rods, 3/4-inch diameter, ten feet long.
   2. Manufacturer: Provide ground rods by one of the following:
      a. ERICO.
      b. A.B. Chance Co.
      c. South Atlantic, L.L.C.
      d. Harger Lighting and Grounding.

C. Grounding Connectors:
   1. Material: Pressure connectors shall be copper alloy castings, designed specifically for the items to be connected, and assembled with Durium or silicone bronze bolts, nuts and washers. Welded connections shall be by exothermic process utilizing molds, cartridges and hardware designed specifically for the connection to be made.
   2. Product and Manufacturer: Provide grounding connectors of one of the following:
      a. Pressure Connectors:
         1) O.Z./Gedney, Division of General Signal Corporation.
         2) Burndy Corporation.
      b. Welded Connections:
         1) Cadweld by Erico Products, Incorporated.
         2) Therm-O-Weld by Burndy Corporation.

D. Concrete Boxes:
   1. Material: High density reinforced concrete box with non-settling shoulders positioned to maintain grade and facilitate back filling with steel checker plate screw down cover.
   2. Size:
      a. Outside Locations: 15” x 22” minimum.
      b. Inside Locations: 10” x 17” minimum.
   3. Product and Manufacturer: Provide box assembly from one of the following:
      a. Concrete Box:
         1) Christy Concrete Products, Inc. Model #B1017.
         2) Or Approved Equal.
      b. Steel Cover:
         1) Christy Concrete Products, Inc. Model #B61JH labeled “GROUND”.
         2) Or Approved Equal.

PART 3 - EXECUTION

3.1 STRUCTURE GROUND SYSTEM

A. Provide ground grids as shown on the Drawings.

B. Install No. 4/0 AWG bare copper cable. Install the cable around the exterior perimeter of structures, minimum 2 feet-6 inches below grade, unless otherwise shown on the Drawings.

C. Install ground rods as shown on the Drawings. Install additional ground rods, if necessary, to attain a resistance to ground of less than twenty-five (25) ohms for each ground grid.

D. For structures with steel columns, install 4/0 AWG ground cable. Install cable from grid to each column around the perimeter of the structure. Connect cable to steel using exothermic welds.

E. Connect grids to a continuous underground water pipe system, when practical.

F. Provide concrete ground test wells for measuring the ground resistance of each separately derived power source, including generators, prior to terminating in equipment. Provide 12" ground conductor slack loop in each well. Route ground conductor from test well to equipment in PVC conduit.

G. Weld all buried connections. Test points connections shall utilize pressure connectors.

3.2 EQUIPMENT GROUNDING

A. Ground all electrical equipment in compliance with the National Electrical Code and the City of Phoenix Electrical Code.

B. Equipment grounding conductors shall be bare stranded copper cable of adequate size installed in metal conduit where necessary for mechanical protection. Ground conductors, pulled into conduits with non-grounded conductors shall be insulated, with green insulation.

C. Panel Grounding:
   1. A minimum size of 4/0 AWG bare stranded copper cable shall be installed between the ground grid and the panel enclosure grounding lug. The mounting frame for panels shall be grounded to the ground grid.
   2. A minimum size of 6 AWG insulated green stranded copper cable shall be installed between the ground grid and the isolated DC Ground Bus located on the enclosure sub-panel. Ground shall be installed in all panels that provide an isolated DC Ground Bus.

D. A separate green insulated ground conductor sized per conduit schedule as shown on DRAWINGS or NEC requirements shall be pulled into conduits and connected utilizing grounding conduit bushings.

E. Connect ground cable to piping by welding or brazing. Use copper bonding jumpers on all gasketed joints.

F. Connect ground cable to equipment by means of lug compressed on cable end. Bolt lug to equipment frame using holes or terminals provided on equipment specifically for

grounding. Do not install with hold down bolts. Where grounding provisions are not included, drill suitable holes in locations designated by ENGINEER.

G. Connect to motors by bolting directly to motor frames, not to sole plates or supporting structures.

H Connect to service water piping by means of copper clamps. Use copper bonding jumpers on gasketed joints.

I. Scrape bolted surfaces clean and coat with a conductive oxide- resistant compound.

J. Test all system grounding conductors for continuity of connection and electrical equipment. Provide in the final report a statement on equipment that was tested and document any discrepancies noted during the tests.

3.3 GROUND GRID TESTING

A. The CONTRACTOR shall contract the preferred firm as the Testing Firm to provide testing of the grounding electrode system as shown on DRAWINGS.
   1. Performing the following ground single point test:
      a. Conduct test at the testing point(s) locations as shown on the DRAWINGS using a clamp-on ground tester.
         1) Utilize the following test equipment:
            a) Fluke, Model 1625 Kit
      b. Visually inspect the installed ground reference electrode or ground rods. Verify that they are intact and accessible. Measure the ground system at these test points with the clamp-on meter. The results shall be recorded on the Ground Test Point Data Sheet 16000-N as provided in Specification 01331 – Reference Forms.
      c. Proved a Serial Key number for each test point shown on the DRAWINGS. Coordinate with OWNER to determine the Serial Key number. Update the RECORD DRAWINGS with the Serial Key number.
      d. Install metal ground test point tags identified with a Serial Key number at each test point using stainless steel wire and zinc wire clamps. For any test points within equipment, attach test point tag to exterior of equipment with epoxy.
      e. Digitally Photograph clamp-on meter in place during test and include with test data sheets. Digital images shall have the Serial Key identified for reference. Digital images of these test points with the clamp-on tester in place are to provide a visual representation of the proper clamp-on testing placement and method and shall be inserted into the ground test sheet document.

B. The grounding system maximum resistance shall not exceed twenty-five (25) ohms under normally dry conditions when measured by the resistance tester.

C. Install grounding test tags for each grounding test. Provide the following for each tag. Install tag with epoxy if unable to utilize wire and clamp.

Item	Description	Part No.	Manufacturer
1	Two Part Non-Sag Epoxy		Hardman
2	Stainless Steel Wire/ 30 ft roll	38091	Brady
3	Zinc Wire Clamps 50/pk	38090	Brady
4	Aluminum Tag - Green	49908	Brady

D. Tests shall be witnessed by the ENGINEER and the City of Phoenix.

+ + END OF SECTION + +

SECTION 16121

CONTROL (INSTRUMENTATION) CABLE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown on the Drawings, specified and required to furnish and install instrumentation, telephone cables and security system fiber cables.
   2. The types of cable include the following:
      a. Single Conductor Control Cable
      b. Shielded Cable
      c. Unshielded Cable

1.2 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for instrumentation cable proposed for use.
   2. Manufacturer’s technical information for telephone cable and underground splicing for approval by the City of Phoenix, Information Technology Department.

PART 2 - PRODUCTS

2.1 MATERIALS

A. 120 Volt or less Single Conductor Control Cables see Section 16122.2.1.A

B. Single Shielded Pair Cable:
   1. Tinned copper, nineteen strand, PVC insulated conductors, No. 16 AWG minimum, twisted with aluminum-polyester shield, stranded tinned 16 AWG copper drain wire and PVC black or gray outer jacket. Wire conductor colors shall be black (-neg) and red (+pos). 600 Volt Tray Cable (TC) rated.
   2. Product and Manufacturer: Provide one of the following:
      a. Belden Inc. (No. 9342).
      b. Okonite Company.
      c. Dekoron Wire and Cable LLC.

C. Multipaired Shielded Cable:
   1. To be utilized only for wiring between Remote Terminal Units and Intermediate Terminal Panels as shown on drawings.

2. Bare, soft annealed copper, seven strand, tinned copper conductors, PVC insulated conductors, No. 16 AWG minimum, twisted in pairs with aluminum-mylar shield over each pair, tray cable rated, silicone rubber fiberglass fire barrier tape, tinned copper drain wire, pairs shall be individually numbered, aluminum mylar overall shield, PVC outer jacket. Color shall be black and red. Rated for 600 volts. Multi conductor cable shall only be utilized in cable tray applications or unless specified on drawings.
3. For control circuits provide a minimum number of spare conductors per cable (1 spare)
4. Product and Manufacturer: Provide one of the following:
   a. Belden, No. 1043B.
   b. Or approved equal.

D. Multipaired Unshielded Cable:
1. To be utilized only for wiring between Remote Terminal Units and Intermediate Terminal Panels as shown on drawings.
2. Tinned copper conductors, No. 16 AWG seven strand, PVC insulated, 16 twisted pairs. Rated for 600-volt. Conductor colors shall be black and white. Overall Shield with 100 percent coverage and tinned copper drain wire. Jacket shall be PVC and UL Type TC. Multi conductor cable shall only be utilized in cable tray applications or unless specified on drawings.
3. Product and Manufacturer: Provide one of the following:
   a. Belden, No. 1073B.
   b. Or approved equal.

E. Cable Terminals:
1. Provide ferule compression fittings or UL listed fork type copper compression terminals with nylon insulation for termination of cable at all terminal blocks.
2. For Panels provided under 17260, see Section 17260 – Field Wire Termination for termination methods, product and manufacturer.
3. Product and Manufacturer: Provide one of the following:
   a. T&B Sta-Kon.
   b. Burndy Insulug.

F. Cable/Wire Markers:
1. Provide only heat shrinkage type cable/wire identification, which shall be type-written.
2. Wire number shall include the conduit number and be a consecutive number based on the number of wires in a conduit, starting with number 1; example C18J – 1, where as C18J is the conduit number and 1 is the first wire. If ten wires are in a conduit, the numbering would be C18J-1 through C18J-10. No two wires are to have the same number.
3. Product and Manufacturer: Provide the following:
   a. W.H. Brady Company. (Part # PSPT-187 for a single conductor)
   b. W.H. Brady Company. (Part # PSPT-500-1W for a twisted pair shielded cable)

c. Or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Separation Requirements:

1) Instrumentation Cables shall not be installed within the same conduits, raceways or cable trays with cables identified in Sections 16122, 16123 and 16124.

2) Additional separation requirements:

a) Class 1 Control circuits (limited to 120 V, see NEC Section 725 Parts I & II for Class 1 Circuits) are to be routed separately from other cables. (Lights and starter circuits)

b) Class 2 Control circuits (limited current and less than 50 V, see NEC Section 725 Parts I & III for Class 2 Circuits) are to be routed separately from other cables. (Analog signal, digital communications, Discrete Inputs and Outputs)

c) Class 3 Control circuits (limited current and less than 120 V, see NEC Section 725 Parts I & III for Class 3 Circuits) are to be routed separately from other cables. (Discrete Inputs to and Outputs from OPTO 22 modules to or from contacts and interposing relay coils.)

B. Install all cables complete with proper identification and terminations at both ends. Cable outer installation shall be dressed at the end of the cables with heat shrink tubing prior to terminations. Utilizing electrical tape is not allowed for dressing.

C. Ground shield of shielded cables at one end only and as recommended by instrument manufacturer. When multiple shielded cables are terminated on a designated analog terminal strip an insulated green with yellow strip wire is used to jumper between the shield terminals and at the end of the terminal strip terminate the shields to the isolated DC ground bar mounted in the panel.

D. Terminate stranded conductors with pre-insulated crimp type spade or barrel compression fitting terminals properly sized to fit fastening device and wire size.

E. Install and terminate vendor furnished cable in accordance with vendor equipment requirements.

F. Install in conformance with the National Electrical Code and the City of Phoenix Electrical Code.

G. Identification:
   1. Each cable and conductor shall be identified with identification markers, which shall include the conduit number and/or cable number. The markers shall be self-laminating vinyl on white background and shall be printed using a Brady "XC Plus" printer or equal.

3.2 TESTING

A. Test all 600-volt wiring in accordance with the requirements of Section 16122, 600 Volt Cable.

B. Test shielded instrumentation cable shields with an ohmmeter for continuity along the full length of the cable and for shield continuity to ground. The tests shall be witness by the OWNER and ENGINEER.

C. Connect shielded instrumentation cables to a calibrated 4 to 20 mA DC signal transmitter and receiver. Test at 4, 12 and 20 milliamp transmitter settings.

+ + END OF SECTION + +

SECTION 16122
600 VOLT CABLE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown on the Drawings, specified and required to furnish and install 600-volt cable.
   2. The types of cable required include the following:
      a. Insulated cable for installation in raceways.
      b. Cable for installation in trays.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Comply with applicable provisions of Regulatory Agencies below and others having jurisdiction:
   1. Codes: Install cable in accordance with the Phoenix Electrical Code and applicable local codes.
   2. Tests by Independent Regulatory Agencies: Cable shall bear the label of the Underwriters' Laboratories, Inc.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
   1. ASTM B 3, Soft or Annealed Copper Wire.
   2. ASTM B 8, Concentric-Lay-Stranded Copper Conductors, Hard, Medium-hard or Soft.
   3. ICEA S-66-524, Cross-linked-thermosetting- polyethylene-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
   4. National Electrical Code (NEC) current adoption.
   5. City of Phoenix – Amendments to the National Electrical Code.
   6. UL Standard No. 44, Wires and Cables, Rubber-Insulated.
   7. UL Standard No. 83, Wires and Cables, Thermoplastic-Insulated.
   8. IEEE Standard 971.

C. Factory Production Tests:
   1. All wire and cable shall be factory tested in accordance with the requirements of Underwriters' Laboratories.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's literature, specifications, and engineering data for 600 volt insulated cable proposed for use.

2. Manufacturer's literature for cable markers.

B. Test Records: Submit for review copies of written records of field insulation resistance test results.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Insulated Cable In Raceways:
1. Material: Single conductor copper cable conforming to ASTM B 3 and B 8 with flame-retardant, moisture and heat resistant cross-linked polyethylene or thermoplastic insulation rated 90°C in dry locations and 75°C in wet locations and listed by UL as Type XHHW-2. Multi conductor cable shall only be utilized in cable tray applications or unless specified on drawings.
2. Application: Use Type XHHW-2 for all sizes, unless otherwise indicated.
3. Wire Sizes: Not smaller than No. 12 AWG for power and lighting and No. 14 AWG for 120-volt control circuits
4. Stranding: All 600-volt cable shall be stranded.
5. Product and Manufacturer: Provide one of the following:
   a. Okonite Company
   b. Encore Wire Corporation
   c. The Southwire Company
   d. Service Wire Company
   e. General Cable
   f. Or approved equal

C. Cable Connectors, Solderless Type:
1. For wire sizes up to and including No. 6 AWG, use compression type. Alarm and control wire shall be terminated using forked type connectors at terminals. If terminal block is crimp type, then the wire shall be terminated with a crimped ferrule or solder dipped.
2. Product and Manufacturer: Provide one of the following:
   a. Phoenix Contact – Clipline
   b. Thomas & Betts
   c. Weidmuller
   d. Burndy Hylug.
   e. Or Approved Equal
3. For wire sizes No. 4 AWG and above, use either compression type or bolted type with tinned-plated contact faces.
4. For wire sizes No. 250 kcmil and larger, use connectors with at least two cable clamping elements or compression indents and provision for at least two bolts for joining to apparatus terminal.
5. Properly size connectors to fit fastening device and wire size.

D. Cable/Wire Markers:
   1. Provide only heat shrinkage type cable/wire identification, which shall be type-written.
   2. Wire number shall include the conduit number and be a consecutive number based on the number of wires in a conduit, starting with number 1; example C18J – 1, where as C18J is the conduit number and 1 is the first wire. If ten wires are in a conduit, the numbering would be C18J-1 through C18J-10. No two wires are to have the same number.
   3. Product and Manufacturer: Provide the following:
      a. By W.H. Brady Company. (Part # PSPT-187 for a single conductor)
      b. Or Approved Equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all cables complete with proper identification and terminations at both ends. Check and correct for proper phase sequence and proper motor rotation.

B. Pulling:
   1. Use insulating types of pulling compounds containing no mineral oil.
   2. Pulling tension shall be within the limits recommended by the wire and cable manufacturer.
   3. Use a dynamometer where mechanical means are used.
   4. Cut off section subject to mechanical means.

C. Bending Radius: Limit to a minimum of six times cable overall diameter.

D. Slack: Provide maximum slack at all terminal points.

E. Identification:
   1. Each cable and conductor shall be identified in each pull box and manhole with identification markers, which shall include the conduit number and/or cable number. The markers shall be self-laminating vinyl on white background and shall be printed using a Brady "Tagus T300" printer or equal.

F. Phase Identification/Color Coding:
   1. All three phase circuits shall be identified, which shall include the conduit number and phase, at switchgear, motor control centers, manholes (5 KV), cables and panelboards as "PHASE A"," PHASE B", and "PHASE C". All conductors not identified with a tag number shall be identified with a tag indicating the source.
   2. Three phase 480 volt systems shall be color coded as follows:
      a. Phase A - Brown.
      b. Phase B - Orange.

c. Phase C - Yellow.
d. Neutral (if applicable) - White.

3. Single phase, 120/240 volt circuits shall be color coded as follows:
   a. Phase A - Black.
   b. Phase B - Red.
   c. Neutral - White.
4. Three phase, 208 volt systems shall be color coded as follows:
   a. Phase A - Black.
   b. Phase B - Red.
   c. Phase C - Blue.
   d. Neutral - White.
5. No. 6 AWG and Smaller: Provide colored conductors.
6. No. 4 AWG and Larger: Apply general-purpose, flame-retardant tape at each end, wrapped in overlapping turns to cover an area of at least 2-inches.
7. All field wiring color shall be black unless otherwise noted.

3.2 TESTING

A. Test each electrical circuit after permanent cables are in place to demonstrate that the circuit and connected equipment perform satisfactorily and that they are free from improper grounds and short circuits.

B. Individually test 600-volt cable mechanical connections after installation and before they are put in service with a calibrated torque wrench. Values shall be in accordance with manufacturers' recommendations.

C. Individually test 600-volt cables for insulation resistance between phases and from each phase to ground. Test after cables are installed and before they are put in service with a Megger whose rating is suitable for the tested circuit. Tests shall meet with the applicable specifications of IPCEA S-66-524 and NEMA WC7-1971. Tests shall be witnessed by the ENGINEER.

D. The insulation resistance for any given conductor shall not be less than the value recommended by the IPCEA or a minimum of one megohm for 600 volt and less service, if not IPCEA listed. Any cable not conforming to the recommended value or which fails when tested under full load conditions shall be replaced with a new cable for the full length.

E. Install in accordance with the National Electrical Code and the City of Phoenix Electrical Code.

+ + END OF SECTION + +

SECTION 16131

PVC COATED RIGID METAL CONDUIT, RIGID NONMETALLIC CONDUIT, ELECTRICAL METALLIC TUBING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. Provide all labor, materials, equipment, and incidentals as shown on the Drawings, specified and required to furnish and install conduit and fittings to provide complete, coordinated and grounded raceway systems.
   2. Conduit routings for various systems within buildings and other areas may not be shown on the Drawings. Responsibility to establish single line, riser and interconnection diagrams and any other related information shown on the Drawings, belongs to CONTRACTOR. Provide for the proper installation of all conduits for each system. Submit conduit routing and tagging meeting all specifications of Submittals Section 1.3-A and Section 2.1-G below to Engineer/Owner for review and approval prior to construction.
   3. The following type and installation methods shall conform to the following:

      a. Rigid Polyvinyl Chloride Conduit: Type PVC. (NEC Article 352)
         1) For masonry walls.
         2) For concrete encased duct bank runs.
         3) For conduits embedded in structural concrete slabs.
         4) For under structural slabs.
         5) Corrosive areas.
         6) For exposed indoor conduit runs.
         7) For exposed conduit runs in all outdoor areas.
         8) For all underground bends (horizontal and vertical) in duct banks that are 45º or more.
         9) For non-encased underground conduit.

B. Coordination:

1. Conduit runs shown are diagrammatic. Coordinate conduit installation with piping, ductwork, and other systems and equipment and locate so as to avoid interferences.
2. For conduits to be embedded in concrete slabs, confirm adequate slab thickness and coordinate location of conduits with placement of reinforcing steel, water stops and expansion joints.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
   1. National Electrical Code (NEC) current adoption.
   2. UL Standard No. 6, Rigid Metal Electrical Conduit.
   3. UL Standard No. 651, Schedule 40 and 80 PVC Conduit.
   4. ANSI C80.4, Fittings for Rigid Metal Conduit and Electrical Metal Tubing
   5. NEMA TC2, Electrical Plastic Tubing, Conduit and Fittings.
   6. NEMA TC3, PVC Fittings for Use with Rigid PVC Conduit and Tubing.
   7. NEMA RN 1, Polyvinyl Chloride (PVC) Externally Coated Rigid Metal Conduit and Intermediate Metal Conduit
   8. TIA-569-B, Commercial Building Standard for Telecommunications Pathways and Spaces
   9. BICSI Customer-Owned Outside Plant Design Manual

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's catalog cuts for the conduit, fittings, supports, conduit identification tags, orange electrical ID tape, and warning ribbon proposed for use. Provide engraved samples of conduit identification tags.
   2. Construction details of conduit racks and other conduit support systems.
   3. Layout drawings showing proposed routing of exposed conduits, conduits embedded in structural concrete and conduits directly buried in earth. Drawings shall show locations of intermediate termination panels (ITP's), pull boxes and penetrations in walls and floor slabs. Drawings of embedded conduits shall include cross-sections showing the thickness of the concrete slabs and the locations of conduits with respect to reinforcing steel and waterstops. Tag conduits per conduit schedule shown on drawings.
   4. Drawing shall be electronically produced to maintain quality and clarity of presentation when re-produced, even when reduced to half size (11" x 17").
   5. Provide manufacturer's proof of certification for PVC coated rigid metal conduit for all installer's supervisors.

B. Record Drawings: Show the actual routing of exposed and concealed conduit runs on the Record Drawings conforming to the requirements of Section 01782-1.1, Record Documents.

PART 2 – PRODUCTS

2.1 MATERIALS - CONDUIT AND CONDUIT FITTINGS

A. PVC Coated Rigid Metal Conduit:
   1. Conduit, Elbows and Couplings:

a. Material: Rigid, heavy wall, mild steel, interior coating of 2-mil thick urethane, tapered threads, carefully reamed ends, 3/4-inch NPS minimum size for exposed, 1 inch for embedded, encased, or otherwise inaccessible, with a factory exterior coating of 40-mil thick polyvinyl chloride.
b. Color: All PVC coated materials shall be standard dark gray.
c. Tools: Power drives, chucks, z-wrenches, vises, and cutting or bending tools shall follow recommendations for tooling in manufacturer's installation guide. Use touch-up compounds recommended by the manufacturer for repair of minor damage to interior urethane or exterior PVC factory coatings.
d. Manufacturer: Provide conduit and fittings of one of the following:
   1) Robroy Industries, "Perma-Cote".
   2) Robroy Industries, "Plasti-Bond".
   3) OCAL Inc.
   4) Or Approved Equal

2. Fittings and Outlet Bodies:
   a. Material and Construction: Cast gray iron alloy, cast malleable iron bodies and covers with a factory coating of 40-mil thick polyvinyl chloride, an interior coating of 2-mil thick urethane and Form 7 tongue-in-groove V-seal gasket on sizes ½" through 2". Conduit or fittings having areas with thin or no coating shall be unacceptable. Do not use "LB" fittings for conduit sizes of 1¼" or larger. Use type "LBD" fittings wherever the use of fittings for conduit sizes of 1¼" or larger is unavoidable. All units shall be threaded type with five full threads. Material shall conform to ANSI C80.4.
   b. Use: Provide conduit fittings and outlet bodies in all corrosive locations.
   c. Manufacturer: Provide PVC coated conduit fittings and outlet bodies of one of the following:
      1) Robroy Industries, "Perma-Cote".
      2) Robroy Industries, "Plasti-Bond".
      3) OCAL Inc.
      4) Or Approved Equal
3. Conduit Hubs:
   a. Material: Threaded conduit hub, vibration proof, weatherproof with captive O-ring seal, zinc metal with insulated throat and factory coating of 40-mil thick polyvinyl chloride and smooth urethane interior coating.
   b. Use: Provide for all PVC coated conduit terminations to boxes, cabinets and other enclosures located in all areas.
   c. Locknuts are not allowed. Use hubs only.
   d. Manufacturer: Provide one of the following:
      1) Robroy Industries, "Perma-Cote".
      2) Robroy Industries, "Plasti-Bond".
      3) OCAL Inc.
      4) Or Approved Equal

B Rigid Nonmetallic Conduit:

1. PVC Plastic Conduit:
    a. Conduit Material: Schedule 40 PVC plastic, 90°C rated, conforming to NEMA TC-2 and UL No. 651.
    b. Fittings: Elbows, bodies, terminations, expansions and fasteners of same material and manufacturer as base conduit. Materials shall conform to NEMA TC-3 and UL No 514.
    c. Provide cement and primer by same manufacturer as base conduit.
    d. Manufacturer: Provide conduit and fittings of one of the following:
        1) PW Eagle
        2) Prime Electrical Products
        3) Cantex
        4) Or Approved Equal

C. Electrical Metallic Tubing:
1. Elbows, Fittings, and Couplings:
    a. Material: Rigid-type mild steel, galvanized (zinc) exterior, organic lubricated interior, threadless 3/4-inch NPS minimum size.
    b. Couplings and connections: Compression or threaded type only. Set screw type shall not be permitted.
    c. Elbows: Factory formed of same material specified for EMT conduit.
    d. Certifications: Material shall conform to UL-797, ANSI C80.3. Conduit, elbows, couplings, etc. shall bear UL listing and manufacturer's name.
    e. Use of EMT type raceway systems shall only be permitted where specified in Paragraph 1.1.A.4.c, above.
    f. Manufacturer: Provide EMT conduit, elbows, fittings and couplings of one of the following:
        1) Allied Tube and Conduit.
        2) LTV Steel Tubular Products Company.
        3) Wheatland Tube Company.
        4) Or Approved Equal

2.2 MATERIALS - MISCELLANEOUS FITTINGS

A. Conduit Bushings:
1. Insulated Bushings: Malleable iron body with plastic liner, threaded type with steel clamping screw. Provide with bronze grounding lug, as required.
2. Use: Provide for all conduit terminations to boxes, cabinets, other enclosures and raceways not requiring a hub.
3. Manufacturer: Provide one of the following:
    a. O-Z/Gedney.
    b. Appleton Electric Company.
    c. Thomas and Betts.
    d. Or Approved Equal

B. Conduit Tags:

1. Tag all conduits at the ends and in all intermediate boxes, chambers, hand holes and other enclosures.

2. Conduit tags shall be yellow, 1-1/2-inch diameter, round, aluminum tags, laser engraved or standard engraving with the conduit number as shown on the Conduit and Cable Schedule. Punched or stamped lettering is not allowed. Font shall be 1/4-inch Arial or Helvetica. The conduit tags shall be manufactured by Brady, Catalog No. 49900, Or Equal.
   3. Each tag shall be attached with nylon-coated 48-mil stainless steel wire and fasteners, as manufactured by Brady, Catalog No. 38091, and zinc wire clamps, double ferrule design, as manufactured by Brady Catalog No. 38090 to secure the stainless steel wire. Where this method is not practical, fasten to the adjacent masonry by means of expansion bolts.

C. Warning Ribbon:
   1. Over all underground duct banks and direct cables, install warning ribbon approximately 12-inches below finished grade and centered on direct buried cables, electrical ductbanks and conduits without ductbank encasement. Provide 6-inch wide, 4-mil thickness underground metallic-lined marking tape with red polyethylene film on top and with clear polyethylene film on the bottom. The tape shall be permanently imprinted with "CAUTION BURIED ELECTRIC LINE BELOW".
   2. Manufacturers: Provide one of the following:
      a. Brady "Identoline"; Services and Materials "Buried Underground Tape"
      b. Somerset (Thomas & Betts) "Protect-A-Line"
      c. Or Approved Equal

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install in conformance of NEC, Articles 344, 352 and 358. Cap all conduits, ducts and raceways during construction to protect from debris entering and blocking the circuit installation.

B. Supports:
   1. Rigidly support conduits by clamps, hangers or strut channels.
   2. Support single conduits by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the support surface. Support multiple runs of conduits on trapeze type hangers with Type 316 Stainless Steel horizontal members and Type 316 Stainless Steel threaded hanger rods, Kindorff or equal. Rods shall be not less than 3/8-inch diameter.
   3. PVC coated rigid metal conduit runs, beam clamps, U-bolts, pipe straps, clamp back spacers, clamp hangers and supports shall have a factory applied

PVC coating or be stainless steel. Hardware shall be Type 316 Stainless Steel.

4. Right angle beam clamps and U bolts shall be specially formed and sized to snugly fit the outside diameter of the coated conduit.

C. Fastenings: Fasten raceway systems rigidly and neatly to supporting structures by the following methods:
   1. To Wood: Type 316 Stainless Steel wood screws.
   2. To Hollow Masonry Units: Type 316 Stainless Steel toggle bolts.
   3. To Brick Masonry: Type 316 Stainless Steel Price expansion bolts, or equal.
   4. To Concrete: Refer to spec section 05051.
   5. To Steel: Type 316 stainless steel welded threaded studs, beam clamps or bolts with lock-washers or locknuts.

D. PVC Coated Rigid Metal Exposed Conduit:
   1. Install in strict accordance with manufacturer's recommendations and installation manual. Installers shall be certified by the manufacturer before installation begins.
   2. Install with manufacturer's installation tools and compounds to prevent damage to the PVC coating.
   3. Repair minor damage to interior urethane and exterior PVC coating with manufacturers recommended touch-up compound.
   4. Install parallel or perpendicular to structural members or walls.
   5. Wherever possible, run in groups. Provide conduit racks of suitable width, length and height and arranged to suit field conditions. Provide support at manufacturer's recommended distances, or at every ten feet minimum.
   6. Install on structural members in protected locations.
   7. Locate clear of interferences.
   8. Maintain 6-inches from hot fluid lines and 1/4-inch from walls.
   9. Install vertical runs plumb. Unsecured drop length not to exceed 12 feet.
   10. Provide necessary reducers where equipment furnished cannot accept 3/4-inch conduit.

E. Conduit Embedded in Structural Concrete:
   1. Separation: Three times outer diameter of larger conduit center to center.
   2. Minimum Slab Thickness: Confirm that concrete slab thickness is sufficient for embedding conduits.
      a. For embedding conduit sizes up to 1-1/2 inches, the minimum slab thickness shall be 7-inches plus the outer diameter of the conduit or conduits, where conduits cross.
      b. For embedding conduits larger than 1-1/2 inches, the minimum slab thickness shall be five times the outer diameter of the conduit where conduits do not cross and six times the outer diameter of the larger conduit where conduits do cross.

3. Concrete shall have a minimum 28-day compressive strength of 2,000 PSI. Concrete used for ductbanks shall be Type 2 with red color added as specified in "Cast-in-Place Concrete" Section 03300.
4. Run conduits in center of slab, where applicable.
5. Run conduits in spacers to maintain recommended minimum, even spacing.
6. Run conduits above waterstops.
7. Before concrete is placed, make the necessary location measurements of the conduits to be embedded so that the information is available to prepare Record Drawings.
8. All conduits entering or exiting concrete shall be PVC coated galvanized rigid metal, for a minimum of 12-inches from the concrete edge.

F. Underground Conduits that are non-encased: PVC coated rigid metal conduits.
1. Install individual underground conduits a minimum of 24-inches below grade, unless otherwise shown on the Drawings or as required to avoid existing obstructions.
2. Perform all excavation, bedding, backfilling and surface restoration including pavement replacement, where required.
3. Install warning ribbon 12-inches below finished grade over all conduits.
4. Make conduit connections watertight by applying PVC touch-up compound at the sealing sleeve joints.

G. Empty Conduits:
1. Spare conduits shall be cleaned, swabbed, and mandreled to verify viability for future use.
2. Install a true tape or mule tape in each empty conduit and cap conduits not terminating in boxes with permanent fittings designed for the purpose. Pulling rope or tape shall be constructed of polyester and factory lubricated. Nylon is not allowed.
3. Identify each empty conduit with a conduit tag conforming to the requirements of Paragraph 2.1.G., above, showing the conduit number shown on the Drawings.

H. Field Bends: Use manufacturer supplied field bends whenever possible. No indentations. Diameter of conduit shall not vary more than 15 percent at any bend. Maximum total amount of bends shall not exceed 270°.
Length of run between manholes shall be limited to:
1. 300 feet with 270° in bends.
2. 600 feet with 180° in bends.
3. 1000 feet with 90° in bends.

I. Joints:
1. Make joints tight and ground thoroughly.
2. Use standard tapered pipe threads for conduit and fittings.
3. Cut conduit ends square and ream to prevent damage to wire and cable.
4. Use a degreasing spray to thoroughly clean field cut threads, and internal reams to ensure the touch-up compound will adhere to the unprotected metal.

5. Apply urethane touch-up compound to all joints, field cut threads, and internal reams before assembly for corrosion protection and visible identification of proper installation.
6. Use full threaded couplings. Split couplings not permitted.
7. During installation, install with manufacturer's installation tools to prevent damage to PVC coating. Replace conduit with wrench marks.

J. Moisture Protection:
1. Plug or cap conduit ends at time of installation to prevent entrance of moisture or foreign materials.
2. Make underground and embedded conduit connections water-tight.
3. Through Wall Seals and Conduit Sealing Bushings: Install for all conduits passing through concrete slabs, floors, walls or concrete block walls.
   a. For conduits and cables in new construction and passing through exterior subsurface walls and exterior concrete walls, use Type WSK and WSCS through wall seals as manufactured by O-Z/Gedneyl.
   b. For conduits and cables in new construction and passing through concrete floors and floor slabs, use Type FSK and FSCS floor seals, as manufactured by O-Z/Gedney.
   c. For conduits passing through new exterior block walls or through core-drilled holes in existing exterior subsurface walls, exterior concrete walls, floor slabs and roof slabs, use Type CSMI sealing bushing at the inside of the structure and Type CSMC sealing bushing at the outside of the structure. Sealing bushings shall be as manufactured by O-Z/Gedney.
   d. For conduits passing through existing interior concrete walls or floors and interior block walls, provide CSMC or CSMI type sealing bushings as manufactured by O-Z/Gedneyl.
4. Drainage: Pay particular attention to drainage for conduit runs. Wherever possible, install conduit runs so as to drain to one end and away from buildings. Avoid pockets or depressions in conduit runs. Where conduits enter buildings below grade, seal inside of conduit to form a watertight seal around cables to prevent the entry of water into building.
   a. Product and Manufacturer: Provide one of the following:
      1) Type DUX - Duct Sealing Compound, as manufactured by O-Z/Gedney
      2) Type FST Foam Sealant, as manufactured by American Polywater Corp
      3) Or Approved Equal
5. Seal all conduit openings within control and instrumentation panels and distribution equipment with Type DUX - Duct Sealing Compound, as manufactured by O-Z/Gedney, to provide a water/bug-tight seal.
   a. Product and Manufacturer: Provide one of the following:
      1) Type DUX - Duct Sealing Compound, as manufactured by O-Z/Gedney

2) Type FST Foam Sealant, as manufactured by American Polywater Corp
3) Or Approved Equal

K. Corrosion Protection:
1. Conduit Curb:
a. For conduits routed in concrete slabs or floors and stub-ups through the floor, provide a 2-inch high concrete curb, extending 2-inches from the outer surface of the conduit penetrating the floor, to prevent corrosion. For floor-mounted equipment, the concrete equipment base shall be in lieu of the concrete curb.
b. Conduit stub-ups shall be a 90 degree PVC coated rigid metal conduit elbow. PVC coated elbow shall extend slightly above the top of the concrete curb or equipment base. Should the elbow not reach this height, provide PVC coated conduit extension to accommodate requirements. Provide PVC coated coupling/fitting for transition from conduit in slab to elbow.
c. For conduits stubbing up and terminating at equipment enclosure mounted on a concrete equipment base, provide RNC stub-up and bell end.
d. For conduits stubbing up and extending to boxes, cabinets and other enclosures above the concrete curb in wet and dusty areas provide PVC coated conduit coupling/fittings between the PVC coated elbow and PVC coated rigid metal conduit for transition between the two conduit types.
e. For conduits stubbing up and extending to boxes, cabinets and other enclosures above the concrete curb or equipment base in corrosive areas, continue the conduit system with PVC coated rigid metal conduit.
f. Conduit into a protected base or equipment enclosure shall be RNC with RNC bell end.
2. Dissimilar Metals: Take every action to prevent the occurrence of electrolytic action between dissimilar metals

L. Reused Existing Conduits:
1. Pull rag swab through conduits to remove water and to clean conduit prior to installing new cable.
2. Repeat swabbing until all foreign material is removed.
3. Pull mandrel through conduit, if necessary, to remove obstructions.

M. Core drill for individual conduits passing through existing concrete slabs and walls. Obtain authorization from OWNER prior to core drilling. Prior to core drilling, drill sufficient number of small exploratory holes to establish that the area to be core drilled is free of existing embedded conduits. Seal spaces around conduit in accordance with Section 01723, Cutting and Patching, and the wall penetration details as shown on the Drawings.

N. Non-metallic Conduit:

1. Install in accordance with manufacturer's recommendations.
2. Join sections in accordance with manufacturer's installation procedures for push-fit, bell and spigot type joints, if applicable, or with manufacturer's recommended cement and primer.
3. During installation provide expansion fittings for expansion and contraction to compensate for temperature variations. Expansion fittings shall be watertight and of the type suitable for direct burial.
4. Make transition to PVC coated galvanized rigid metal conduit before making turns into enclosures, cabinets, termination boxes, pull boxes, etc.
5. For expansion/deflection fittings as shown on CONTRACT DRAWINGS.

O. Wall Penetrations:
1. CONTRACTOR shall ensure conduits that penetrate walls allow for the maintenance of minimum bend radius during the installation of cable.
2. Submit shop drawings for approval for each wall penetration.

3.2 TESTING

A. Test conduits by pulling through each conduit a cylindrical mandrel not less than two pipe inside diameters long, having an outside diameter equal to 90 percent of the inside diameter of the conduit.

B. All conduits greater than 1.5 inches in size shall be swabbed and mandrel cleaned. This process shall be 100 percent witness inspected and each conduit inspection shall be identified and documented.

+ + END OF SECTION + +

SECTION 16132

FLEXIBLE CONDUITS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown on the Drawings, specified and required to furnish and install flexible metallic conduit and fittings.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
   1. Phoenix Electrical Code, Article 351, Liquid-Tight Flexible Metal Conduit.
   2. UL Standard No. 360, Liquid-Tight Flexible Steel Conduit.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's catalog cuts and technical information for flexible conduit and fittings proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Flexible Conduit (Non-hazardous Areas):
   1. Material: Flexible galvanized steel core with smooth, abrasion resistant, liquid-tight, polyvinyl chloride cover and color to be black. Continuous copper ground built in for sizes 3/4-inch through 1-1/4-inch. Material shall be UL listed.
   2. Product and Manufacturer: Provide one of the following:
      a. Sealtite UA by Anaconda Sealtite, Anamet Electrical Inc.
      b. Liquatite Type L.A. by Electric-Flex Company.
      c. Or Approved Equal.

B. Flexible Conduit (Class 1, Group D, Division 1, Hazardous Areas):
   1. Material: Flexible brass inner core with bronze outer braid. Steel, brass or bronze end fittings. Minimum of 12-inches in length.
   2. Product and Manufacturer: Provide one of the following:

a. Type ECGJH or ECLK by Crouse Hinds Company.
b. Type EXGJH or EXLK by Appleton Electric Company.
c. Or Approved Equal.

C. Flexible Conduit Fittings:
1. Material and Construction: Malleable iron with zinc electroplating finish. Fittings shall adapt the conduit to standard threaded connections, shall have an inside diameter not less than that of the corresponding standard conduit size and shall be UL listed.
2. Use: Provide on flexible conduit in non-hazardous and Class 1, Division 2 hazardous areas.
3. Product and Manufacturer: Provide one of the following:
a. Crouse-Hinds Company.
b. Appleton Electric Company.
c. Or Approved Equal.

D. PVC Coated Conduit Fittings:
1. Material and Construction: Malleable iron with standard finish and 40-mil PVC exterior coating. Fittings shall adapt the conduit to standard threaded connections, shall have an inside diameter not less than that of the corresponding standard conduit size.
2. Use: Provide on flexible conduit in areas designated as corrosive locations.
3. Product and Manufacturer: Provide one of the following:
a. Perma-Cote - Robroy Industries
b. OCAL Incorporated.
c. Or Approved Equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install at motors, transformers and equipment which are subject to vibration or require movement for maintenance purposes. Provide necessary reducer where equipment furnished cannot accept 3/4-inch size flexible conduit. Limit flexible conduit length to three feet maximum.

B. Install in conformance with Phoenix Electrical Code requirements.

+ + END OF SECTION + +

SECTION 16133

SEALING FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install conduit sealing fittings.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
   1. Phoenix Electrical Code, Article 500, Hazardous (Classified) Locations.
   2. UL Standard 886, Electrical Outlet Boxes and Fittings for Use in Hazardous Locations, Class 1, Groups A, B, C and D and Class II, Groups E, F and G.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's catalog cuts and technical information for sealing fittings proposed for use.
   2. Listing of locations where fittings are to be used.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials and Construction:
   1. Cast gray iron alloy or cast malleable iron or copper free aluminum bodies with zinc electroplate and lacquer or enamel finish.
   2. Ample opening with threaded closure for access to conduit hub for making dam.
   3. In corrosive locations, fittings shall include a factory applied 40-mil PVC coating.

B. Sealing fiber for forming the dam within the hub and the sealing compound shall be approved for use with the fittings furnished and shall be products of the fitting manufacturer.

C. Product and Manufacturer: Provide one of the following:
   1. Crouse-Hinds/Eaton Company.

2. Appleton/Emerson Electric Company.
3. Or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install for hazardous locations as required by Phoenix Electrical Code, and where shown on the Drawings.

B. Select a fitting for the proper use in respect to the mounting position.

C. Use oversized fittings with reducing bushings when necessary to maintain cable fill requirements of the conduit system.

+ + END OF SECTION + +

SECTION 16134

EXPANSION/DEFLECTION FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown on the Drawings, specified and required to furnish and install conduit expansion and deflection fittings.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
   1. Phoenix 2018, National Electrical Code (NEC) current adoption.
   2. UL Standard 514, Electrical Outlet Boxes and Fittings.
   3. UL Standard 467, Electrical Grounding and Bonding Equipment.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's catalog cuts and technical information for expansion and deflection fittings proposed for use.
   2. Listing of locations where fittings are to be installed.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cast gray iron alloy or bronze end couplings, malleable iron or hot dipped galvanized body, stainless steel clamps and tinned copper braid bonding jumper. Fitting to be watertight, corrosion-resistant UL listed and compatible with the conduit system.

B. Features:
   1. Expansion/Deflection Fittings.
      a. Axial expansion or contraction up to 3/4-inch.
      b. Angular misalignment up to 30 degrees.
      c. Parallel misalignment up to 3/4-inch.
   2. Expansion Fittings.
      a. Expansion/Contraction, 8-inch total movement.

C. Product and Manufacturer: Provide one of the following:

1. Type DX for expansion/deflection or AX for expansion only by O-Z Gedney Company.
2. Type XD for expansion/deflection or XJ for expansion only by Crouse Hinds Company.
3. Type DF for expansion/deflection or XJ for expansion only by Appleton Electric Company.
4. Or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fittings in conformance with NEC.

B. Install expansion fittings on exposed conduit runs crossing structural expansion joints and where necessary to compensate for thermal expansion and contraction. Install expansion fittings on exposed conduit runs exceeding 200 feet.

C. Install expansion/deflection fittings on embedded conduit runs crossing structural expansion joints. Install fittings above waterstops.

D. In addition to as stated above, install expansion/deflection fittings as shown on CONTRACT DRAWINGS.

E. Where required in non-metallic conduit and duct systems, provide rigid metal conduit nipples and metal rigid to PVC adapters for connection to fittings. Ensure that joints exposed to water are made watertight.

+ + END OF SECTION + +

SECTION 16135

PULL BOXES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install pull boxes.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
   1. Phoenix Electrical Code, Article 370, Outlet, Switch and Junction Boxes, and Fittings.
   2. UL Standard No. 50, Electrical Cabinets and Boxes.
   3. UL Standard No. 886, Electrical Outlet Boxes and Fittings for Use in Hazardous Locations.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for pull boxes proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Pull Boxes: Provide boxes based upon location in accordance with NEMA requirements and as required for the area classification specified in Section 16050, General Provisions.
   1. Material and Construction:
      a. Cast gray iron alloy with hot-dip galvanized finish or cast malleable iron bodies and covers.
      b. Neoprene gaskets. Gaskets shall be of an approved type designed for the purpose. Improvised gaskets are not acceptable.
      c. Stainless steel cover bolts.
      d. External mounting lugs.
      e. Drilled and tapped conduit holes.
      f. Boxes where conduits enter a building below grade shall have 1/4-inch drain hole.

2. Product and Manufacturer: Provide pull boxes of one of the following:
   a. Appleton/Emerson Electric Company.
   b. O-Z/Gedney Company.
   c. vNent/Hoffman Engineering Company.
   d. Or approved equal.
3. Large boxes not generally available in cast construction may be fabricated of copper-free aluminum alloy or Type 316 stainless steel as required by location.
4. Boxes for installation in areas classified as hazardous locations shall be explosion-proof and shall comply with the requirements of UL Standard No. 886.
5. For flush-mounted pullboxes in slabs or pavement, provide vehicular traffic-bearing covers, where shown on the Drawings.
6. Pull boxes embedded in concrete slabs shall be cast iron. Pull boxes located in wet, corrosive or outdoor areas shall be NEMA 4X, Type 316 stainless steel. All other areas shall be NEMA 12.
7. All boxes shall be identified in accordance with Section 16050, General Provisions.
8. All inside plant pull boxes used for communications, signal, or fiber optic cabling shall meet the requirements listed in table below:

Maximum Trade Size of Conduit (inches)	**Minimum Box Size (inches)**			**For Each Additional Conduit Increase Width (Inches)**
	Width	Length	Depth	
1	4	16	3	2
1.25	6	20	3	3
1.5	8	27	4	4
2	8	36	4	5
2.5	10	42	5	6
3	12	48	5	6
3.5	12	54	6	6
4	15	60	8	8

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount boxes so that sufficient access and working space is provided and maintain a minimum of 1/4-inch from walls.

B. Securely fasten boxes to walls or other structural surfaces on which they are mounted. Provide independent stainless steel or FRP supports where no walls or other structural surface exists. Do not locate pull boxes on handrails.

C. Install pull boxes where shown on the Drawings. In addition, install pull boxes in conduit runs containing more than three 90-degree bends and in runs exceeding 200 feet. For communications, signal, and fiber optic cabling conduit runs install pull boxes in runs containing more than two 90-degree bends and in runs exceeding 100 feet.

D. Provide removable, flame-retardant, insulating cable supports in all boxes with any dimension exceeding three feet.

E. Field apply PVC touch up to scratched PVC boxes damaged as a result of installation. All touch up work shall be in strict conformance with manufacturer's recommendations and instructions.

F. Size pull boxes in accordance with the requirements of the Phoenix Electrical Code.

+ + END OF SECTION + +

SECTION 16137

UNDERGROUND DUCT BANKS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install underground duct banks.

B. Coordination: Duct bank routing on the Drawings is diagrammatic. Coordinate installation with piping and other underground systems and structures and locate clear of interferences.

C. Standard conduit chairs shall be used for all conduit raceway supports.

C. Definition: A duct bank is one or more buried electrical conduits.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the National Electrical Code.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Layouts showing the proposed routing of duct banks and the locations of manholes, handholes and areas of reinforcement.
   2. Profiles of duct banks showing crossings with piping and other underground systems.
   3. Typical cross sections.
   4. Installation procedures.

B. Record Drawings: Include the actual routing of underground duct runs on Record Drawings in accordance with Section 01782, Record Documents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Duct: Schedule 40 PVC conduit and fittings in accordance with Section 16131 - PVC Coated Rigid Metal Conduit, Rigid Nonmetallic Conduit, and Electrical Metallic Tubing.

B. Exposed: PVC Coated Galvanized Rigid Metal Conduit: PVC coated rigid metal conduit and fittings in accordance with Section 16131, Rigid Conduit, if required.

C. Backfill: Select backfill in accordance with Section 02315, Structural Excavation and Backfill.

D. Reinforcement: In accordance with Section 03200, Concrete Reinforcement.

E. Concrete: In accordance with Section 03300, Cast-In-Place Concrete.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Duct banks shall be installed as follows:
   1. For small direct burial duct banks (3 conduits or less) use of PVC coated rigid metal conduit. Concrete and reinforcement are not required. Warning tape is required.
   2. For larger duct banks, use PVC conduit, to be encasement, reinforcement, and warning tape. All bends (vertical and horizontal) of 45º or more require PVC coated rigid metal conduit.

B. Excavation and backfilling required for duct bank installation.

C. All duct bank installations and penetrations through foundation walls shall be watertight and in accordance with Section 16131 - PVC Coated Rigid Metal Conduit, Rigid Nonmetallic Conduit, and Electrical Metallic Tubing.

D. Top of duct banks shall be a minimum of 24-inches below grade, unless otherwise approved by the ENGINEER.

E. Assemble duct banks using non-magnetic saddles, spacers and separators. Position the separators to provide 3-inch minimum concrete separation between the outer surfaces of the ducts. Side forms are only required to prevent excessive widening of the duct bank where over excavation has occurred.

F. Provide a 3-inch minimum concrete covering on sides, top and bottom of concrete envelopes around conduits. Concrete covering size shall be as shown on the Drawings. Add red oxide to concrete for easy identification during subsequent excavation. The red oxide is to be added in the concrete truck prior to the concrete being placed. Red oxide concrete shall include the entire duct bank, top and bottom unless under a slab.

G. Firmly fix ducts in place during placing of concrete. Carefully place and vibrate the concrete to ensure filling of all spaces between ducts.

H. Conduits entering floor mounted equipment, such as, switchgear compartments, motor control centers, transformers shall terminate with PVC coated rigid metal conduit factory 90º elbows, RNC risers and bell ends.

I. Reinforce all duct banks.
   1. Unless otherwise shown on the Drawings, reinforce with No. 4 longitudinal steel bars placed at each corner and along each face at a maximum parallel spacing of 18-inches on centers, and No. 3 tie-bars transversely placed at 18-inch maximum longitudinal intervals. Overlap of No. 3 tie-bars shall be a minimum of 4-inches.
   2. Maintain a maximum clearance of 1-inch from bars to the edge of the concrete encasement.
   3. Install dowel reinforcement rebar where duct bank meets other concrete structures.

J. Do not backfill with material containing large rock, paving materials, cinders, large or sharply angular substances, corrosive material or other materials which can damage or contribute to corrosion of ducts or cables or prevent adequate compaction of fill.

K. Slope duct runs for drainage toward manholes and away from buildings with a slope of approximately 3-inches per 100 feet.

L. Install a bare stranded copper duct bank ground cable (4/0 or as shown on drawings) in each duct bank envelope. Make ground electrically continuous throughout the entire duct bank system. Connect ground cable to building and station ground grid or to equipment ground buses. In addition, connect ground cable to steel conduit extensions of the underground duct system. Provide ground clamp and bonding of each steel conduit extension, where necessary to maintain continuity of the ground system. Terminate ground cable at last manhole or handhole for outlying structures.

M. After completion of the duct bank or utilizing existing ducts and prior to pulling cable, pull a mandrel, not less than 12-inches long and with a cross section approximately 1/4-inch less than the inside cross section of the duct, through each duct. Then pull a rag swab or sponge through to make certain that no particles of earth, sand or gravel have been left in the duct.

N. Pulling Rope/Tape
   1. Pulling rope or tape shall be constructed of polyester and factory lubricated. Nylon is not allowed.

O. Warning Ribbon:
   1. Provide as stated in Specification Section 16131.

P. Plug and seal empty spare ducts entering buildings and structures. Install pulling tape in all empty spare ducts. Seal watertight all ducts in use entering buildings and structures in accordance with Section 16131 - PVC Coated Rigid Metal Conduit, Rigid Nonmetallic Conduit, and Electrical Metallic Tubing.

+ + END OF SECTION + +

SECTION 16143

DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown on the Drawings, specified and required to furnish and install disconnect switches.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
   1. National Electrical Code (NEC) current adoption.
   2. City of Phoenix – Amendments to the National Electrical Code.
   3. UL Standard No. 98, Enclosed Switches.
   4. NEMA KS-1, Enclosed Switches.
   5. NEMA 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for disconnect switches proposed for use.
   2.
   3. Listing of the switches to be furnished with an identification of their location, rating and NEMA enclosure type.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Service Disconnect Switches:
   1. Type: Fused, heavy-duty, single throw, quick-make, quick-break mechanism, visible blades in OFF position and safety handle.
   2. Rating: Voltage, current and short circuit ratings and number of poles as shown on the Drawings. Switch shall bear a UL label certifying suitability for use as service equipment.
   3. Provide auxiliary dry contacts to indicate switch position.

B. Single Throw, Circuit Disconnect Switches:

1. Type: Fused or unfused, horsepower rated, heavy-duty, single throw, quick-make, quick-break mechanism, visible blades in the OFF position and safety handle.
2. Rating: Voltage and current ratings and number of poles as required for motor or equipment circuits being disconnected. Switches shall bear a UL label.
3. Provide auxiliary dry contacts to indicate switch position.

D. Enclosures:
1.
2. In all other locations except wet or corrosive, NEMA 4X 304 stainless steel. For wet or corrosive locations, NEMA 4X 316 stainless steel.
3. NEMA 7 for explosion proof areas.

E. Identification:
1. Identify all enclosures in accordance with Section 16050, General Provisions.
2. Manufacturer's nameplates identifying equipment, include identification of the equipment served and source of power, for which switches serve as the disconnecting means. Manufacturer's nameplates shall be permanently fastened to enclosures.
3. Comply with the requirements of Section 01630, Computerized Maintenance Management System Tags.

F. Product and Manufacturer: Provide one of the following:
1. Schneider/Square D Company.
2. ABB
3. Rockwell/Allen Bradley.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

B. Securely fasten equipment to walls or other structural supports on which they are mounted. Provide independent stainless-steel supports where no wall or other structural surface exists.

C. Furnish one set of spare fuses for each fused disconnect switch to be installed.

D. Install in conformance with Phoenix Electrical Code.

+ + END OF SECTION + +

SECTION 16215

POWER SYSTEM / ARC FLASH ANALYSIS

PART 1 - GENERAL

1.1 DESCRIPTION

A. General:
   1. Conduct a Power System Short Circuit Study, Protective Device Coordination Study, and Arc Flash Hazard Analysis for the new Lift Pumps and Bio Filter System, as specified in the CONTRACT DOCUMENTS.
   2. The software used to conduct the study and analysis shall be the latest version of SKM Power*Tools, by SKM Systems Analysis, Inc.

1.2 SCOPE

A. CONTRACTOR Scope:
   1. The CONTRACTOR shall be responsible for providing the following data to the ANALYSIS FIRM:
      a. Project Schedule.
      b. Electrical Utility contact information.
      c. Division 16000 Engineer approved submittals, including the ENGINEERS review comments.
      d. Additional equipment information as requested by the ANALYSIS FIRM per Section 1.2.A3.
      e. Marked up single line diagram(s) with installed conductor lengths, sizes and count.
      f. Changes in design as a result of RFI's, Addendums, Engineer Clarifications, Sketches or revisions, which may affect the Power System / Arc Flash Analysis.
   2. CONTRACTOR shall provide ANALYSIS FIRM a minimum of a 2-week notice of the following construction milestones:
      a. Electrical Equipment Delivery.
      b. Electrical Equipment Energization.
      c. Electrical Equipment Testing.
      d. Substantial Completion.
   3. Based upon outcome of analysis additional equipment information may be required by the CONTRACTOR for upstream or downstream equipment in the electrical distribution system.
   4. CONTRACTOR shall be responsible for implementation of the protective device settings. Implementation of recommended settings outside of the project

scope of work resulting from system coordination changes is the responsibility of the OWNER.

5. CONTRACTOR shall provide ANALYSIS FIRM with safe access to all equipment on site throughout construction for the purpose of verifying the EDS protective device information.
6. CONTRACTOR shall install labeling as required by specification 16050 section 3.1 for voltage labeling and other labels as required.

B. ANALYSIS FIRM Scope

1. Conduct a Power System/Arc Flash Hazard Analysis for new and modified areas of the EDS as specified in the CONTRACT DOCUMENTS. The analysis shall be performed in accordance with IEEE and shall utilize the ANSI method of short circuit analysis. An SKM model of the EDS shall be developed or modified using ENGINEER'S approved Equipment Submittals, site collected data, and Utility short circuit data. Deliverables shall include a short circuit analysis results, a protective device coordination analysis results, and arc flash / shock hazard analysis results and work tasks required by the CONTRACTOR. The ANALYSIS FIRM shall coordinate new protective devices with existing protective devices in the EDS as required.
2. Where additional electrical equipment is being added or modified and upon request from the ANALYSIS FIRM, the ENGINEER will transmit the existing Arc Flash Documentation to the ANALYSIS FIRM for use in completing the required updates.
3. ANALYSIS FIRM shall acquire the Electrical Utility Company's published available Short Circuit current tables for use in the studies. For larger service sizes greater than 480VAC, the ANALYSIS FIRM is to coordinate with the ENGINEER and Utility Company for calculated available short circuit current.
4. ANALYSIS firm shall verify that protective devices are correct per SKM model and analysis results.
5. ANALYSIS FIRM shall install Arc Flash Hazard Warning labels per this specification.
6. ANALYSIS FIRM shall install the updated laminated Single Line Diagram's, Panel Schedules, and Load Summaries. Updates will be made by the ANALYSIS FIRM based on as-build documentation provided by the CONTRACTOR.
7. ANALYSIS FIRM shall deliver the final SKM Model and all associated data and library files used in the model to the OWNER. The ANALYSIS FIRM shall relinquish all rights of the SKM model and all associated data and library files to the OWNER.

1.3 REFERENCES

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
   1. IEEE 141-1993, Recommended Practice for Electric Power Distribution for Industrial Plants (IEEE Red Book).
   2. IEEE 242-2001, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book).
   3. IEEE 1584-2018, Guide for Performing Arc Flash Hazard Calculations
   4. NFPA 70E, Standard for Electrical Safety in the Workplace.
   5. IEEE 551, Recommended Practice for Calculating Short-Circuit Currents in Industrial and commercial Power Systems (IEEE Violet Book).
   6. NFPA 70, National Electrical Code (NEC).

1.4 SUBMITTALS

A. Preliminary Technical Memorandum:
   1. ANALYSIS FIRM shall provide a preliminary submittal review and a technical memorandum providing comments for equipment submitted on. This will be submitted for approval by the ENGINEER and OWNER. Submittal shall include:
      a. Technical Memorandum
         1) Review for adequate installation based on available fault current.
         2) Recommendations for alternate equipment based on system coordination.
         3) Recommendations for alternate design considerations based on energy levels.
   2. Preliminary Technical Memorandum shall be submitted and reviewed by the ENGINEER to ensure EDS electrical equipment order being released for manufacturing meets the requirements of the project.

B. Final Report:
   1. ANALYSIS FIRM shall submit a final sealed report to the CONTRACTOR upon project substantial completion. Final report shall be in PDF format and include all documents as noted in section 1.4.B.2 below.
   2. ANALYSIS FIRM to provide the following documents in the final report:

a. Final Report
b. SKM Single Line Diagrams – Power Study Management Scenario
c. SKM Time Current Curves
d. Arc Flash Labels

C. Submittals shall be delivered in pdf format, unless otherwise specified. CONTRACTOR shall provide 2 USB flash drives containing printable files of the final deliverable report to the ENGINEER.

PART 2 - PRODUCTS

2.1 POWER SYSTEM / ARC FLASH ANALYSIS FINAL REPORT

A. Professional Certified Report:
1. ANALYSIS FIRM shall provide a certified report that shall include but is not limited to:
a. An executive summary.
b. Methods, assumptions, and procedures used in the analysis.
c. Results of short-circuit analysis listing equipment that is applied above its short-circuit current rating, and recommendations if appropriate.
d. Results and recommendations of the protective device coordination and time-current analysis, including time-current curves (TCC's).
e. Documentation of all study input data, including utility available fault currents; cable sizes, types and lengths; motor data; breaker types and settings; fuse sizes and types, etc.
f. Findings and recommendations requiring actions not within the ANALYSIS FIRM scope of work.
g. Electrical Distribution System Overview as illustrated on the CONTRACT DOCUMENTS.
h. Appendices with the SKM documents of the equipment data used in the analysis and the analysis results.
2. Report shall be reviewed and sealed by a Professional Engineer registered in the state of Arizona.

B. SKM Single-Line Diagram(s):
1. SKM Single-Line Diagram(s) legible on 11" x 17" sheet size, landscape view. Include the following information:

a. Location and function of each protective device in the system, such as relays, direct-acting trips, fuses, etc.
b. Type designation, current rating, range or adjustment, manufacturer's style or type for all protective devices.
c. Power, voltage ratings, impedance, primary and secondary connections of all transformers.
d. Type, manufacturer, and ratio of all current transformers energizing each relay.
e. Manufacturer’s nameplate data of all motors and generators.
f. Sources of short circuit currents such as utility ties, generators, synchronous motors, and induction motors.
g. All significant circuit elements such as transformers, cables, breakers, fuses, reactors, etc.
h. Normal switching conditions where possible.
i. The final settings of adjustable breakers, relays and direct-acting trips.

C. Short Circuit Study:
1. The short circuit analysis shall be performed to determine the adequacy of circuit breakers, surge arresters, busways, switches, and fuses by tabulating and comparing the short circuit ratings of these devices with the available fault currents. Short circuit momentary duties and interrupting duties shall be calculated on the basis of worst case scenario / maximum available fault current at the switchgear busses and motor control centers.
2. Normal system operating method, alternate operation, and operations which could result in maximum fault conditions shall be thoroughly addressed in the analysis. The analysis shall assume all motors operating at rated voltage. Redundant/standby motors shall be excluded where known system limitations prevent simultaneous operation. Electrical equipment bus impedance shall be assumed zero (SKM default setting).

D. Protective Device Coordination Study:
1. The protective device coordination analysis shall be performed to determine the required settings/sizes of the protective devices to maximize selectivity. The phase over-current and ground-fault protection settings shall be included as well as settings for all other adjustable protective devices, excluding vendor supplied packaged equipment. Areas lacking complete coordination shall be identified and justification provided for allowing condition to remain or the ENGINEER shall provide solution to resolve situation.
2. SKM Time-Current Curve(s) legible on 11” x 17” sheet size, landscape view on 10- cycle, green log-log graph paper. Include the following information for each time-current curve:

a. Protective device, relay, or fuse showing graphically that the settings provide protection and selectivity within industry standards. Each curve shall be identified, and the tap and time dial settings shall be specified.
b. Each device shall be positioned to provide maximum selectivity to minimize system disturbances during fault clearing. Where selectivity cannot be achieved, the ENGINEER shall be notified as to the cause.
c. Points for cable and equipment damage.
d. Circuit interrupting device operating and interrupting times based on the amperage.
e. A SKM Single line sketch of bus and breaker arrangement for each time-current curve.

3. Provide breaker setting table with sign off form for CONTRACTOR use during implementation of breaker settings.

E. Arc Flash/Shock Hazard Analysis:
1. The arc flash / shock hazard analysis shall be conducted in accordance with the methods outlined in IEEE Standard 1584 and stated hereinafter. Work shall be in accordance with NFPA 70E which includes the fabrication of labels with the Arc Flash / Shock Hazard analysis results, the calculated Incident Energy (cal/cm^2), Equipment Name, Owner and Owner contact information, and the date the analysis was performed.
2. The analysis shall include the following IEEE 1584 analysis process steps:
a. Collect current and accurate system and installation data.
b. Determine modes of operation.
c. Determine bolted fault current.
d. Determine arc fault current.
e. Determine protective device characteristic and arc fault duration.
f. Document system voltages
g. Select working distances.
h. Calculate Incident Energy (cal/cm^2).
i. Calculate the Arc Flash Boundary.
3. Within the final report, provide a copy of each installed Equipment Specific Arc Flash label on 8½" x 11" sheet size, portrait view in actual size and color as printed and installed on the actual field equipment.

2.2 LABELS

A. Arc Flash Hazard Warning Labels:
1. PPE Category Label:

a. A standard Arc Flash Hazard Warning label (Category Label) shall be installed on all equipment that meets the NFPA 70E Category 1 or 2 parameters, including a maximum of 25 kA available fault current and arc-duration parameters (clearing time). All other components must have an equipment specific label generated from SKM using calculated values as described in 2.2.A.2.

b. Provide a 2" x 4" label format with coloring to match the labels shown on Figure 2.2.B.1 below.

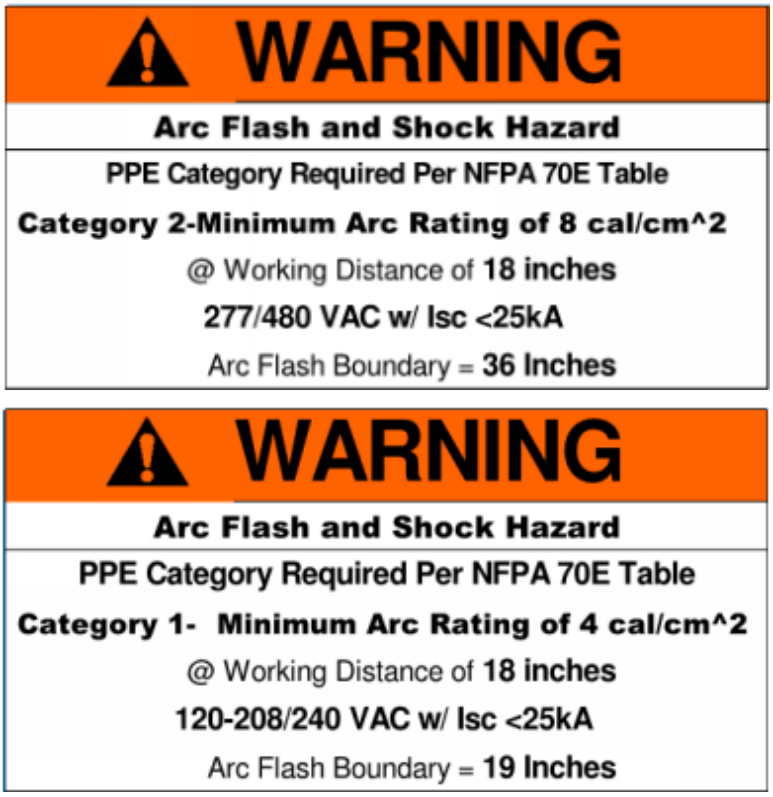

Figure 2.2.B.1

2. Calculated Equipment Specific Labels:

a. Arc Flash and Shock Hazard Warning labels shall be installed on all equipment with an SKM calculated Incident Energy level.

b. Label shall have an orange header with the wording, "WARNING, Arc Flash and Shock Hazard," and shall include the following information taken directly from the arc flash hazard analysis:

1) Equipment designation.
2) Nominal system voltage.
3) Protection boundaries:
   a) Arc Flash Boundary.
   b) Limited approach boundary.

c) Restricted approach boundary.

c. Calculated available incident energy in cal/cm^2 and the corresponding working distance.
d. Owner: City of Phoenix
e. Contact Info Phone Number: (602) 495-7692
f. Study Date.
g. Labels shall be machine printed, with no field-applied markings.
h. Provide standard 4" x 5" rectangular labels.
i. Provide a label with coloring and formatted to match Figure 2.2.B.2 below.

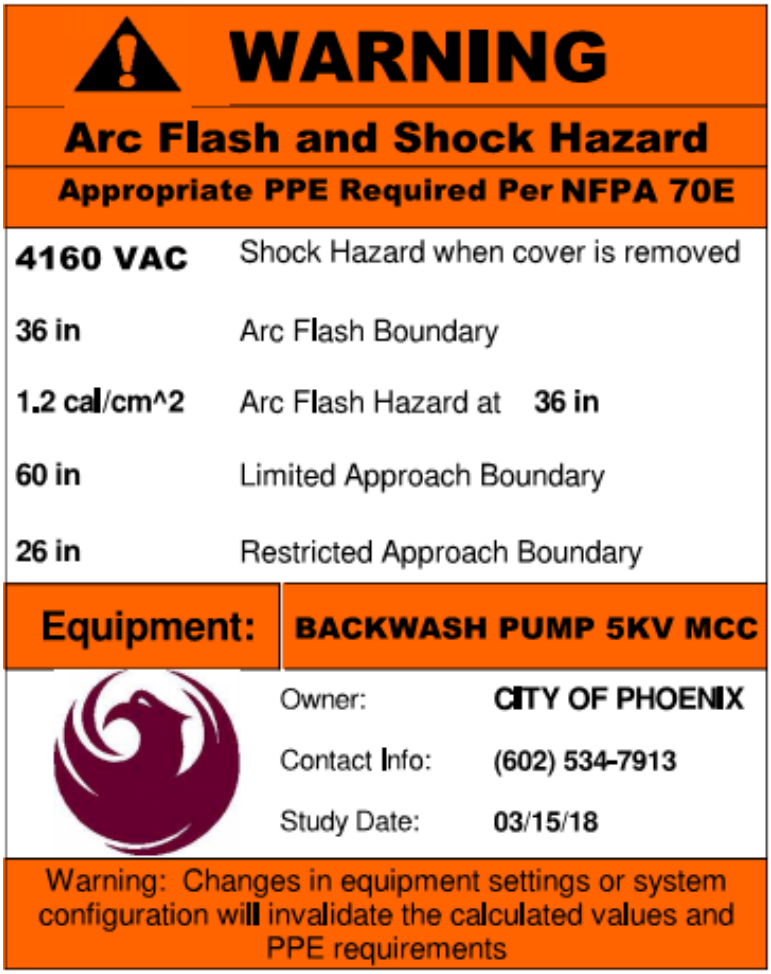

Figure 2.2.B.2

3. Label Material:
   a. Label shall be an indoor/outdoor high performance, pressure sensitive safety sign.
   b. Materials shall be UV rated surface printed polyester with polyester over-laminate. Labels shall be abrasion, chemical and heat resistant (-40°C to 110°C), with an average outdoor durability of five to eight years.
   c. Comply with ANSI Z535.4 for safety signs and labels.
   d. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
   e. Product Manufacture: Provide the following:
      1) Printer and Label Materials
         a) BRADY Powermark Printer, BRADY Label Part# 13651
         b) Or Approved Equal.

PART 3 - EXECUTION

3.1 GENERAL

A. ANALYSIS FIRM shall inspect all installed equipment for conformance with the fully executed POWER SYSTEM / ARC FLASH ANALYSIS. Any deviations found shall immediately be brought to the OWNER and ENGINEERS attention.

3.2 BREAKER SETTINGS

A. The CONTRACTOR shall coordinate with the ENGINEER and ANALYSIS FIRM to implement the breaker settings defined in the approved preliminary report submittal.
   1. The CONTRACTOR shall complete form 16215 – A – Power System / Arc Flash Analysis Sign-off Form for each breaker.

B. The ANALYSIS FIRM shall inspect all breaker settings implemented in the field by the CONTRACTOR. If the recommended breaker setting(s) are adjusted, the ANALYSIS FIRM will update the final report with the actual settings. CONTRACTOR or ENGINEER is to provide written justification for any deviations.

3.3 BREAKER TESTING

A. The CONTRACTOR shall coordinate the final settings of the breakers during the start-up and functional testing of the process systems EDS. If the breaker settings require adjustment, the CONTRACTOR will coordinate with the ENGINEER and ANALYSIS FIRM to update the Power System Arc Flash Analysis Report with the final settings.

3.4 LABELING

A. All Service Entrance Sections (SES), switchboards, switchgear, Motor Control Centers (MCC), transformers, distribution boards, panel boards, disconnects and control panels shall have both an Arc Flash Hazard Warning label and a voltage label as identified in specification section 16050. The ANALYSIS FIRM shall determine the proper Arc Flash Hazard Warning label.

1. Install all labels level and in an upright position. Do not cut or alter in any way. Install labels in a professional manner. Clean surface as needed to allow for good adhesion.
2. Labels shall not be installed atop any manufacturer name plate data or equipment tag labels.
3. Labels shall not be installed atop any existing voltage warning or Arc Flash Hazard Warning labels that may already exist on the equipment. Existing voltage and Arc Flash Hazard Warning labels shall be removed and the surface thoroughly cleaned before application of any new labels.
4. Where equipment does not have sufficient space for an Arc Flash Label the CONTRACTOR shall furnish a fabricated mounting plate constructed of stainless steel sheet metal per direction from the ENGINEER. Mounting plate shall be affixed to the equipment using stainless steel screws. Installation shall maintain the equipment NEMA rating of the equipment. Mounting plate shall not interfere with equipment operation and shall be readily visible.
5. In the case of more than one source of power to a piece of equipment, the highest voltage label shall be applied, and an additional label shall be applied indicating more than one source of power located inside the equipment.
6. For outdoor switchgear, place a single Arc Flash Hazard Warning label on the outside of the access door nearest to the main breaker, and one inside on the respective breaker enclosure. All other Arc Flash Hazard Warning labels shall be placed inside the access doors on the respective breaker enclosure or cover. If there are back access panels to the equipment, the arc flash labels placed at the front of the gear shall be duplicated and placed on the back access panels at the same relative location.
7. For disconnect switches, panel boards, distribution boards, load centers, and control panels, the labels should be applied in plain view on the front cover.

+ + END OF SECTION + +

SECTION 16423

MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish, install, and modify existing motor control centers.

B. Coordination: Obtain motor nameplate data on equipment being furnished for properly sizing starters and overloads.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
   1. UL Standard 845, Motor Control Centers.
   2. NEMA ICS2-322, AC General Purpose Motor Control Centers.
   3. National Electrical Code (NEC) current adoption.
   4. City of Phoenix – Amendments to the National Electrical Code.
   5. NFPA National Fire Protection Association 79, Annex "D" Standards.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for motor control centers proposed for use.
   2. Outline and summary sheets with schedules of equipment in each unit.
   3. Unit control schematic and elementary wiring diagrams showing numbered terminal points, interconnections to other units, wire colors and wire labels.

B. Operation and Maintenance Manuals:
   1. Submit complete installation, operation and maintenance manuals including copies of all Record wiring diagrams, test reports, maintenance data and schedules, description of operation, and spare parts information.
   2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01781, Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Motor control center lineups shall be provided as shown on the Drawings. Motor control centers including structures, appurtenances, and all major components (contactors, circuit breakers, etc.) therein shall be the product of one manufacturer.
   1. Service: Voltage rating and number of wires shall be as shown on the Drawings. Motor control centers shall operate from a 3 phase, 60 Hertz system. 480/277 volts, 3 phase, 4 wire. UL rated as suitable for service entrance.
   2. Wiring: NEMA Class II, Type B. Color coding shall conform to NFPA 79.
   3. Enclosure: 600A Rated NEMA.
   4. Motor control centers, which contain variable frequency drives, shall be manufactured by the same manufacturer as the variable frequency drives.
   5. Main and hall have a symmetrical interrupting rating of 65,000 amps.3R

B. Construction:
   1. Totally enclosed structure, dead front, consisting of nominal 21-inch deep, 20-inch wide, 90-inch high vertical sections bolted together to form a unit assembly.
   2. Removable lifting angles for each shipping section.
   3. Two removable floor sills for mounting.
   4. Horizontal wireways top and bottom, isolated from horizontal bus and readily accessible.
   5. Isolated vertical wireways with cable supports, accessible through hinged doors, for each controller section.
   6. All non-conducting metal parts electrically continuous.

C. Bus System and Conductors:
   1. Rating: Bus bracing of 65,000 amps symmetrical and bus current capacities as shown on the Drawings.
   2. All bus bars shall be tin-plated copper rated to UL heat rise standards.
   3. Bus bar connections shall be easily accessible with simple tools.
   4. Main Horizontal Bus: Continuous edge mounted and isolated from wireways and working areas.
   5. Vertical Bus: Continuous and isolated by a glass polyester barrier.
   6. Grounding Bus: Full length mounted across the bottom, drilled with lugs of appropriate capacity, as required.
   7. Neutral Bus: Insulated continuous through control center drilled with lugs of appropriate capacity, as required.
   8. All control conductors shall be Type SIS, No. 14 AWG minimum.

D. Unit Compartments:
   1. Individual front door for each unit compartment with engraved manufacturer's nameplates identifying equipment. Manufacturer's nameplates to be 1-inch by 3-inches minimum, secured to unit door with two stainless steel screws.

2. Starter and feeder-unit doors interlocked mechanically with the unit disconnect device to prevent unintentional opening of the door while energized and unintentional application of power while door is open, with provisions for releasing the interlock for intentional access and application of power.
3. Padlocking arrangement permitting locking the disconnect device in the OFF position, with at least three padlocks, with the door closed or open.
4. NEMA 1 minimum motor starter size. Starter units completely draw-out type in Sizes 1 and 2 and draw-out type after disconnecting power leads only in Sizes 3 and 4.
5. Motor starters shall include a magnetic contactor, NEMA rated with encapsulated magnet coils. Wound coils not acceptable.
6. Reversing Starters: Single speed full voltage with two contactors and extra interlocking contacts.
7. Reduced Voltage Starters: Autotransformer, closed-transition type with embedded type over-temperature protection. Set on 65 percent starting tap, unless otherwise noted.
8. Individual control power transformers for all starters, capacity as required for all control circuit devices, 100 VA minimum, Class A insulation, two primary fuses, 120 volts secondary, one secondary fuse and the other secondary leg grounded.
9. Separate Control: Where control power to starter is provided by a separate power source, a control power fuse shall be provided in the unit and the main disconnect shall be equipped with a normally open contact to isolate the control circuit from the source when the controller disconnect is open. Power source should be identified by yellow conductors, if the source is separated or foreign to the starter cubicle.
10. Motor horsepower shown are preliminary. Circuit breaker trips and starter overload heaters to be coordinated with the actual equipment installed.
11. Auxiliary contacts, relays, timers as required for specified control functions and those shown on the Drawings.
12. All starter devices, including spare contacts wired to numbered terminal blocks.
13. Control devices shall be 600-volt heavy duty, NEMA A600. Relays shall have convertible contacts. Pilot devices shall be oil tight. Pilot lights shall be 120 VAC, push-to-test.
14. Feeder Circuit Breakers: Thermal magnetic type, 65,000 amps symmetrical interrupting capacity.
15. Motor Starter Circuit Breakers: Magnetic trip only motor circuit protectors, 65,000 amps symmetrical interrupting capacity.
16. Provide the following diagrams and tables on the inside of the door for each compartment:
    a. Elementary wiring diagram.
    b. Table of overload heater sizes with the correct heater highlighted.
    c. Table of the motor circuit protector settings with the correct setting highlighted.
17. Sections shown on the Drawings as "SPACE" shall be complete with all necessary hardware for the future installation of a plug-in unit.

19. Where required by the Drawings, furnish automatic transfer switches integrally mounted within the motor control center. Automatic transfer switches shall be in accordance with Section 16412, Automatic Transfer Switches.

F. Spare Parts:
   1. Provide the following spare parts for each motor control center lineup:
      a. Two fuses of each size and type used.
      b. One auxiliary control relay with at least two normally open and two normally closed contacts.
      c. One control transformer of each size used.
      d. 4 indicating lamps.
   2. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the OWNER. Deliver spare parts at the same time as the motor control centers. Comply with the requirements of Section 01783, Spare Parts and Maintenance Materials.

G. Manufacturer's Nameplates:
   1. Factory installed engraved manufacturer's nameplates, mounted on the face of the assembly, and shall be furnished for all main, tie and feeder breakers. These nameplates shall be laminated plastic with1-inch minimum, 2-inch, black characters on a white background or match existing, secured with stainless steel screws. These nameplates shall also contain item designation, equipment breaker frame size and breaker trip rating.
   2. All control components within the assembly shall be identified in correspon-dence to appropriate designations on the manufacturer's wiring diagrams.

H. Product and Manufacturer: Provide motor control centers of one of the following:
   1. Square D Company.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Field verify two new starters can be installed in existing MCC as indicated on contract documents.

C. Provide no openings in top or side of units not required for conduit.

D. Cable circuits together within enclosures and identify with durable tag secured to cabling twine.

E. Set motor circuit protectors at lowest setting possible which permits motor starting without nuisance tripping.

F. Field test all motor control center components.

G. Verify that wiring diagrams on inside of door of each compartment reflects the "as-built" circuitry and that the correct overload heater size and motor circuit protector setting are noted.

H. Install in conformance with Phoenix Electrical Code.

I. Furnish new manufacturer's nameplates on all new motor control centers.

3.4 MANUFACTURER'S SERVICES

A. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of (1 visits, minimum 2 hours on-site for each visit, to the site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation and start-up of the system. The third visit shall be as described under Section 01821, Instruction of Operations and Maintenance Personnel. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the motor control centers conform to requirements. Representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

B. All costs, including travel, lodging, meals and incidentals, shall be considered as included in CONTRACTOR'S bid price.

+ + END OF SECTION + +

SECTION 17001

PROCESS CONTROL SYSTEM

GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Provide all labor, materials, equipment and incidentals as stated in the specified in the CONTRACT DOCUMENTS and install, calibrate, test, start-up, commission and place in satisfactory operation a complete Process Control System (PCS). PCS shall be as specified by Division 17, Process Controls Sections and all controls systems provided by others in all Divisions as specified on the CONTRACT DOCUMENTS.

B. The PCS is designed to control and monitor equipment operation and information. The unit processes, which the PCS shall control, and monitor are shown and described in the CONTRACT DOCUMENTS.

C. EQUIPMENT SUPPLIERS are defined as suppliers or vendors who provide instrumentation, panels, equipment, or services that interface with the PCS as specified in Division 17, Process Control System or other Divisions of the CONTRACT DOCUMENTS. EQUIPMENT SUPPLIERS shall coordinate with the PCS COORDINATOR (responsibilities as defined below).

D. PCS COORDINATOR/SYTEM INTEGRATOR shall configure all Computer Control System (CCS)/SCADA and PLC software for the supplied CCS. However, the CONTRACTOR shall be responsible for all hardware configurations, loop testing of signals, and communications testing for new and modified existing control equipment through the CCS.

E. All control loops shall function as described in Section 17051, Process Control Descriptions or other Divisions and Drawings of the CONTRACT DOCUMENTS.

F. All instruments shall be field calibrated and witnessed by the ENGINEER as stated in Specification 17052 – Process Control System Primary Sensors and Field Instruments.

1.2 QUALITY ASSURANCE

A. General:

1. The CONTRACTOR shall acquire the services of a PCS COORDINATOR/SYTEM INTEGRATOR for coordination of the furnishing, approval, installation, testing, commissioning, and training for all aspects of the PCS. The PCS COORDINATOR/SYTEM INTEGRATOR shall be the CONTRACTOR's representative for all subcontractors providing PCS equipment.

2. CONTRACTOR in conjunction with the PCS COORDINATOR/SYTEM INTEGRATOR shall be responsible for coordination and supervision of the supply, storage, installation, testing, startup, commissioning and training of all electrical equipment, instrumentation, panels and services defined in the CONTRACT DOCUMENTS to produce a fully functional PCS.

3. THE CONTRACTOR in conjunction with the PCS COORDINATOR/SYTEM INTEGRATOR shall be responsible for proper operation of the PCS with related equipment and materials furnished by other suppliers stated in the CONTRACT DOCUMENTS.

B. PCS COORDINATOR's Qualifications:

1. Have experience at designing, supplying, installing, testing, start-up and commissioning PCS's.

2. Have experience in coordinating, reviewing and the handling of equipment submittals.

3. Have experience with integration, implementation and have supported standard lines of digital and analog processing control instrumentation equipment.

4. Have working knowledge in hardware application, data highway systems and computer control systems software programming procedures.

5. Have experience in coordinating or providing standard training course offerings in general process control applications and in operation, programming and maintenance of the control systems and related equipment.

6. Have a thorough working knowledge of water treatment processes and control philosophy in accordance with standard practices of the water treatment industry.

7. Have thorough knowledge of relevant NEC, OSHA, MIL, NRC, ISA, SAMA, NFPA, UL and API standards and all relevant state and local codes.

8. Have experience in coordinating, reviewing, handling of and presenting equipment operations and maintenance training materials.

C. PCS COORDINATOR's Responsibilities:

1. General:

a. Attend the Pre-Construction Conference as required in Section 01301 – Pre-Construction Conference for the presentation of the responsibilities of the PCS COORDINATOR.

b. Coordinate with the CONTRACTOR in the generation of the Progress Schedule as required in Section 01321 – Progress Schedule (CPM) to incorporate PCS construction activities into the Progress Schedule.

c. Attend the project Construction Progress Meetings required in Section 01312 – Progress Meetings.

d. Coordinate PCS Progress Meetings as described in Paragraph 1.3 below.

e. Maintain a punch list of items to be completed / corrected for the PCS. Provide an updated copy of this punch list to the ENGINEER at each construction progress meeting.

2. Reviews:

a. Review CONTRACT DOCUMENTS (Specifications, P&ID's, Process Drawings, Electrical Drawings, Installation Details, etc,) and develop a list of concerns or problems noted for the completion of the complete operating PCS. Submit list to the ENGINEER prior to review of equipment submittals.

b. Coordinate and review all PCS submittals and related equipment submittals in accordance with the CONTRACT DOCUMENTS, prior to submission of submittal to the ENGINEER. Complete Submittal Transmittal Form 01332-A included in Section 01331 – Reference Forms for inclusion with each submittal.

3. Installation:

a. Verify delivery and proper storage of all PCS equipment per the requirements of Sections 01651 - Transportation and Handling of Materials and Equipment and 01661 – Storage of Materials and

Equipment. Complete 01661-A - Equipment Delivery Inspection Report included in Section 01331 – Reference Forms for submittal to the ENGINEER.

b. Supervise the installation of the CCS instruments, panels, consoles, cabinets, wiring and other components required.

c. Coordinate with the CONTRACTOR in the development of all Maintenance of Plant Operations plans (MOPO's) affecting PCS equipment installation or activities as required in Section 01143 – Coordination with Owner's Operations.

d. Coordinate proper interfacing of CCS hardware, software, field devices and panels, including required interfacing with packaged control systems furnished by other equipment suppliers, and with the plant electrical system.

4. Testing:

a. Coordinate all calibration, testing, start-up and commissioning of the PCS as outlined in the Contract Documents.

b. PCS COORDINATOR/SYTEM INTEGRATOR shall submit to the ENGINEER a schedule with proposed start dates and test procedure guidelines for start-up, commissioning and field testing at least four weeks in advance of the test start date. Prior to testing each process area, coordinate with the CCS/SCADA/PLC VENDOR to ensure that the installation of the CCS software, including any modifications and software configuration testing is completed prior to testing each process area.

c. Complete testing of each process loop through the CCS shall be documented by PCS COORDINATOR/SYTEM INTEGRATOR as listed in Section 17226 – Process Control System I/O list and submit the signed document to the ENGINEER upon successful completion of tests.

d. Coordinate all testing documentation in accordance with Section 01331, Reference Forms. Maintain a copy of Field Calibration Forms, Loop Test Forms, Equipment Test Reports, Loop Commissioning Forms, Factory Acceptance Test forms and other related forms from Section 01331 – Reference Forms in a single binder for submittal to the ENGINEER to be transmitted to the OWNER at the conclusion of the project.

e. Attend all factory tests required by Division 17 Specifications and other Division Specifications of the CONTRACT DOCUMENTS that are inclusive of the overall PCS.

5. Commissioning and Substantial Completion:

   a. Coordinate and provide review comments of all PCS Vendor Equipment Operations and Maintenance Manuals (VEOMM) prior to submission of manual to the ENGINEER. Complete Submittal Review Form 01781-B – Operations & Maintenance Data Review Checklist included in Section 01331 - Reference Forms for inclusion with each VEOMM submittal.

      1) Maintain a red-line of the VEOMM 's electrical drawings and schematics used during construction to reflect changes or deviations that occur during installation, start-up and commissioning for incorporation into the final VEOMMs. Submit the red-lined electrical drawings and schematics to the provider of the equipment for updates as VEOMM Record Documents for submittal to the ENGINEER to be transmitted to the OWNER prior to Substantial Completion of the project.

   b. Maintain red-line ISSUED FOR CONSTRUCTION DRAWINGS used during construction to reflect changes or deviations that occur during installation, start-up and commissioning for incorporation into the final Record Drawings. Submit the red-lined ISSUED FOR CONSTRUCTION DRAWINGS to the ENGINEER prior to Substantial Completion of the project.

   c. Coordinate and supervise training of OWNER'S personnel in operation and maintenance of the process control system as required in Division 17 Specifications and other Divisions of the CONTRACT DOCUMENTS as per Section 01821 – Instruction of Operations and Maintenance Personnel.

D. Reference Standards:

1. The following organizations have generated standards that are to be used as guides in assuring quality and reliability of components and systems; govern nomenclature; define parameters of configuration and construction, in addition to specific details in the CONTRACT DOCUMENTS.

   a. ISA, The Instrumentation, Systems and Automation Society.

   b. API, American Petroleum Institute.

   c. UL, Underwriters' Laboratories, Inc.

   d. AWWA, American Water Works Association.

   e. Nuclear Regulatory Commission.

f. NEMA, National Electrical Manufacturers Association.

g. OSHA, Occupational Safety and Health Administration.

h. ANSI, American National Standards Institute.

i. MIL, Military Standards.

j. NFPA, National Fire Protection Association.

k. SAMA, Scientific Apparatus Manufacturers Association.

l. NFPA, National Fire Protection Association 79, Annex "D" Standards.

m. IEEE, Institute of Electrical and Electronic Engineers.

n. NEC, National Electrical Code.

o. FM, Factory Mutual.

1.3 COORDINATION AND PROGRESS MEETINGS

A. Schedule and coordinate the system installation with regard to all other Work on the site and in accordance with the provisions of the General Conditions. Said coordination shall be documented on the Project Schedule.

B. PCS coordination and progress meetings will be scheduled by the PCS COORDINATOR/SYTEM INTEGRATOR. The CONTRACTOR, ENGINEER, OWNER and appropriate EQUIPMENT SUPPLIERS shall be required to attend meetings during the time of active work on the PCS. A representative of the CCS VENDOR shall be required to attend meetings during the time of active work on the CCS. PCS COORDINATOR/SYTEM INTEGRATOR shall provide meeting minutes and updates to the project schedule.

1. The purpose of the meetings shall be to review the progress of the Work involving the PCS and provide coordination for installation, testing, commissioning, and training of the equipment to ensure that the Project Schedule is met.

2. Representatives at the meetings shall have the competence and authority to make any and all necessary decisions. Decisions and statements made at the meetings shall commit CONTRACTOR to agreed procedures and schedules.

1.4 SUBMITTALS

A. Shop Drawings:

1. General:

a. Shop Drawing submittals are to be in accordance with the requirements of the CONTRACT DOCUMENTS and shall conform to the requirements of Section 01330 - Submittals and as required in other Division 17 Sections.

b. Manufacture or shipment of the PCS components shall not commence until related submittals have been reviewed by ENGINEER.

c. Shop Drawings shall be submitted in complete packages grouped to permit review of related items.

d. Review of Shop Drawings will be for conformance with CONTRACT DOCUMENTS and with regard to functions specified to be provided.

2. Submittal Requirements:

a. Product information for all PCS equipment. Include the following:

1) Manufacturer's product name and complete model number.

2) Equipment CMMS Tag and loop number as provided in Section 01630 – Computerized Maintenance Management System Tags and from the CONTRACT DOCUMENTS.

3) Manufacturer's data sheets and catalog literature. Provide data sheets as shown in ISA-20-1981. For instruments not included in ISA-20, submit data sheets using a similar format.

4) Description of construction features.

5) Performance and operation data.

6) Installation and mounting details, instructions and recommendations.

7) Service requirements.

8) Dimensions.

9) List of recommended spare parts.

10) UL/UR Listing Numbers.

11) Electrical control schematics and field wiring diagrams

12) Ranges and set points of field and control panel instruments

B. System Operation and Maintenance Manuals:

1. Furnish Operations and Maintenance Manuals for the PCS in accordance with Section 01781, Operation and Maintenance Data.

C. Report Forms:

1. Five (5) copies of the Field Calibration Forms, Loop Test Forms, Equipment Test Reports, Loop Commissioning Forms, Factory Acceptance Test forms and other related forms from Section 01331 – Reference Forms shall be submitted to the PCS COORDINATOR/SYTEM INTEGRATOR.

1.5 EQUIPMENT DELIVERY, HANDLING AND STORAGE

A. Comply with the requirements of Section 01651, Transportation and Handling of Materials and Equipment and Section 01661, Storage of Materials and Equipment.

B. All arrangements for transportation, delivery and storage of the equipment and materials to be in accordance with the requirements of the CONTRACT DOCUMENTS and the requirements of equipment manufacturers.

C. PCS equipment shall be packaged at the factory prior to shipment to protect each item from damage during shipment and storage. Containers shall be protected against impact, abrasion, corrosion, discoloration or other damages. Clearly label contents of each container and provide information on the required storage conditions necessary for the equipment. Keep OWNER and ENGINEER informed of equipment delivery.

D. All equipment shall be handled and stored in accordance with manufacturer's instructions and relevant organization standards. Equipment shall be protected from weather, moisture and other conditions that could cause damage. Items that require a controlled environment for storage such as panels and microprocessor units shall be stored in a climate-controlled warehouse or facility. EQUIPMENT SUPPLIER shall notify CONTRACTOR and PCS COORDINATOR/SYTEM INTEGRATOR, in writing, with copies to OWNER and ENGINEER of the storage requirements and recommendations for the equipment prior to shipment.

E. Provide shop as-built control panel drawings upon delivery of the control panel.

1.6 GENERAL REQUIREMENTS

A. Power Supplies:

1. All electrically powered equipment and devices shall be suitable for operation on 115-volt 60 Hz power. If a different voltage, a suitable transformer shall be provided if approved by ENGINEER and OWNER.

2. Appropriate power supplies shall be furnished by CONTRACTOR for all two wire transmitters, loops for monitoring discrete inputs and all necessary outputs.

3. Power supplies shall be mounted in enclosures and installed in the appropriate control room or field panel.

4. Design all power supplies for a minimum of 130 percent of the maximum simultaneous current draw.

B. Signal Requirements:

1. The control system shall be designed to use 4 to 20 mADC analog signals, unless otherwise specified.

2. Provide signal converters and repeaters, where required. In addition, analog inputs to the computer control system shall be through appropriate repeaters to provide signal isolation where series looped with other devices, and to allow the loop to maintain integrity even if the CCS is out of service. Power supplies shall be sized adequately for signal converter and repeater loads.

3. Signals shall be isolated from ground.

4. The system and associated input/output wiring will be used in a plant environment where there can be high energy AC fields, DC control pulses, and varying ground potentials between the sensors/transducers or input contact locations and the system components. The system design shall be adequate to provide proper protection against interferences from all such possible situations.

C. Miscellaneous:

1. All instrumentation and PCS components shall be heavy-duty types, designed for continuous service in a municipal water treatment plant environment. The system shall contain products of a single

manufacturer, where possible, and consist of equipment models, which are currently in production. All equipment provided shall be of modular construction and be capable of field expansion through the installation of plug-in circuit cards and additional cabinets as necessary.

2. Design all logic and control loops to fail-safe. Fail-safe is to protect system if a field wire becomes disconnected.

3. All field-mounted instruments and PCS components shall be designed for installation in humid and corrosive service conditions. All field mounted instrument enclosures and appurtenances shall conform to NEMA ratings listed in Division 16000, Section 16050 – General Requirements, unless otherwise specified.

4. Ranges and scales specified herein shall be coordinated to suit equipment actually furnished.

5. Field-mounted devices shall be protected from exposure to freezing temperatures and shaded from direct sunlight.

D. Environmental Conditions:

1. The control system shall be designed and constructed for continuous operation under the following temperature and humidity conditions:

a. Control Rooms:

1) Ambient Temperature: 60°F to 80°F normal range; 40°F to 105°F occasional maximum extremes.

2) Relative Humidity: 80 percent, normal; 95 percent maximum.

b. Indoor locations for digital processing equipment hardware, control panels and instruments:

1) Ambient Temperature: 40°F to 120°F.

2) Relative Humidity: 98 percent maximum.

c. Outdoor locations for instruments:

1) Ambient Temperature: -10°F to 131°F.

2) Relative Humidity: 100 percent maximum.

E. System Designs:

1. Range, scale and setpoint values specified in other Division 17, Process Control System Sections are for initial setting and configuration.

Modifications to these values may be required based on actual equipment furnished and as necessary to implement proper and stable process action and that is determined as systems are placed in operation. These modifications shall be done at no additional cost to OWNER.

2. For any items where ranges, scales and setpoints may not have been specified, CONTRACTOR shall submit a recommendation to ENGINEER for review.

1.7 SYSTEM START-UP, COMMISSIONING AND FIELD TESTING

A. Comply with the requirements of Section 01752 – Equipment and System Start-up and Performance Testing and include the additional requirements:

1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install all equipment and coordinate all activities required to perform start-up, commissioning and field testing of the Process Control System. Field testing shall include an integrated system field test and operational availability demonstration.

2. Retain the services of the EQUIPMENT SUPPLIERS and CCS/SCADA/PLC VENDOR to supervise and/or perform start-up, commissioning and field testing of all system components. As part of these services, the EQUIPMENT SUPPLIERS shall include for the equipment items not manufactured by the EQUIPMENT SUPPLIER, the services of an authorized manufacturer's representative to check the equipment installation and place the equipment in operation. The manufacturer's representative shall be thoroughly knowledgeable about the installation, operation and maintenance of the equipment.

B. System Check-Out and Start-Up

1. With the aid of the EQUIPMENT SUPPLIERS, responsibility belongs to CONTRACTOR to perform the following:

a. Check and approve the installation of all computer control system components and all cable and wiring connections between the various system components prior to placing the various processes and equipment into operation. Check-out shall include the following items as a minimum:

1) All wiring shall be checked at each termination point for correct wire size, type, color, termination, and wire number.

2) Analog wiring shall be checked for correct polarity and ground continuity at each termination point in the loop.

3) All control and monitoring loops shall be checked for signal continuity from source (such as field instrument/equipment, control panel, etc) to end destination.

b. Conduct a complete system checkout and adjustment, including calibration of all instruments, tuning of control loops, checking operation functions, and testing of final control actions. When there are future operational functions included in this Work, they should be included in the system checkout. All problems encountered shall be promptly corrected to prevent any delays in start-up of the various unit processes.

c. All instruments and devices shall be checked to verify compliance with the Specifications and approved Shop Drawings.

2. Provide all test equipment required to perform the testing and field calibration of instruments during system checkout and start-up.

3. Furnish to the ENGINEER certified calibration reports provided in Section 01331, Reference Forms for field instruments and devices as soon as calibration is completed. Factory calibrations are not acceptable as a replacement for field calibrations. All instruments must be field calibrated and witnessed by the ENGINEER and OWNER.

a. Receipt of any calibration certificate shall in no way imply acceptance of the work or instrument.

b. Each calibration certificate shall be signed and dated by an authorized representative of CONTRACTOR. Three copies of each completed certificate shall be submitted to ENGINEER.

4. Furnish to the ENGINEER two copies of an installation inspection report 01620-A - Manufacturer's Installation Certification Form in Section 01331 – Reference Forms certifying that all equipment has been installed correctly and is operating properly. The report shall be signed by authorized representatives of both CONTRACTOR and the EQUIPMENT SUPPLIER.

5. All spare parts must be on-site and accepted prior to commencing integrated system field tests.

C. Commissioning

1. Following the Process Control System checkout and initial operation, CONTRACTOR, with the aid of the EQUIPMENT SUPPLIERS and CCS VENDOR, perform a complete system test in the presence of the ENGINEER to verify that all equipment is operating properly as a fully

integrated system, and that the intended monitoring and control functions are fully implemented and operational.

a. Commissioning can only begin when all instruments and control panels are installed and wired. Operation and Maintenance manuals and a schedule for training must be approved prior to Commissioning.

b. All spare parts must be on-site and accepted prior to Commissioning.

c. Submit to the ENGINEER a schedule for Commissioning, including a proposed start date and Commissioning test sheet examples at least three weeks in advance.

2. Commissioning shall exercise field signals between field equipment or instrumentation and each Input/Output Panel though the SCADA HMI workstation graphic display. As a minimum, perform the following checks for each test:

a. All wiring shall be checked at each termination point for correct wire size, type, color, termination and wire number.

b. All instruments and devices shall be checked to verify compliance with the Specifications and approved Shop Drawings. The calibration of analog devices shall be verified including the zero and span.

c. Analog wiring shall be checked for correct polarity and ground continuity at each termination point in the loop.

d. All analog loops shall be verified at each termination point at 0%, 25%, 50%, 75% and 100% signal levels.

3. Provide the following documentation for use during the Commissioning effort.

a. Complete panel schematic and internal point-to-point wiring interconnect drawings.

b. Complete electrical control schematics.

c. Complete panel layout drawings.

d. Complete field wiring diagrams.

e. Complete instrument loop diagrams.

f. Completed calibration certificates for all field and panel devices which require adjustment and/or calibration.

e. Provide one set of Commissioning documentation for the OWNER'S personnel, one set for the ENGINEER'S use, one set for field use, and the required number of sets for CONTRACTOR'S use.

4. The Drawings corrected and modified during Commissioning shall form the basis for the "As-Built" Record Drawing requirement as specified in this Section.

5. Any defects or problems found during the Commissioning effort shall be corrected by CONTRACTOR and then retested to demonstrate proper operation.

D. Integrated System Field Test

1. Following the completion of Process Control System checkout and initial operation and CCS software testing the CONTRACTOR, with the aid of the EQUIPMENT SUPPLIER and CCS/SCADA/PLC VENDOR, shall remain on-site and be available during this period to correct instrumentation and control system hardware problems. The integrated field test shall be performed to verify all equipment/instrumentation is operating properly as a fully integrated system with the CCS, and that the intended monitoring and control functions are fully implemented and operational.

2. Following software testing and demonstration of all system functions, the Process Control System including field sensors/transducers and instruments shall be running and fully operational for a continuous 48 hour period. The Operational Availability Demonstration specified below shall not begin until the continuous 48 hour integrated system test has been successfully completed and OWNER and ENGINEER agree that the Operation Availability Demonstration can begin.

3. Any defects or problems found with the instrumentation, control system hardware, control panel components/wiring and field devices during the integrated field testing effort shall be corrected by CONTRACTOR and then retested to demonstrate proper operation.

1.8 PROCESS CONTROL SYSTEM TRAINING

A. Requirements and Responsibilities

1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to perform and coordinate all required training at times acceptable to OWNER and ENGINEER.

2. Retain the services of all PCS EQUIPMENT SUPPLIERS to provide operation and maintenance training for all Process Control System equipment as specified herein.

3. For equipment items not manufactured by the EQUIPMENT SUPPLIERS, the EQUIPMENT SUPPLIER shall provide for on-site training by an authorized representative of the equipment manufacturer as part of the Supplier's services. The manufacturer's representative shall be fully knowledgeable in the operation and maintenance of the equipment.

4. Responsibility for all costs associated with training both on-site and at the EQUIPMENT SUPPLIER'S facilities, including all required materials, texts and required supplies, belongs to CONTRACTOR.

5. All training shall be conducted in the normal eight hour working days until conclusion of the training course.

B. Submittals

1. Submit training plans conforming to the requirements of Section 01821, Instruction of Operations and Maintenance Personnel. Included in the plan shall be course outlines and schedules for training to be provided at the EQUIPMENT SUPPLIER'S facilities.

C. On-Site Training

1. Training Covering the Control Equipment:

a. The EQUIPMENT SUPPLIERS shall provide 16 hours of operations training covering all system components.

b. Training course shall accomplish the following:

1) Provide all instructions required to operate and utilize all system components.

2) Provide all instruction required to monitor and control the system processes from the designated control panel.

3) Explain procedures for control of the system during scheduled or rescheduled shutdown and the subsequent start-up.

4) Provide instructions for routine preventative and troubleshooting maintenance.

2. SCADA/PLC Training:

a. The CCS/SCADA/PLC VENDOR shall provide 16 hours of training that covers the CCS as follows:

1) Provide an overview of system hardware and software.

2) It shall train people in configuration, operation and programming the CCS/SCADA/PLC.

3) The emphasis shall be placed on how to perform set point changes, minor programming changes, range changes, diagnostics and upkeep of documentation.

4) Instruction for hardware and software maintenance, troubleshooting and maintenance planning.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials or products which can contact drinking water or a water treatment chemical furnished and installed under this division shall require NSF/ANSI 61, Drinking Water System Components Health Effects, approval or comply with Arizona Administrative Code R18-4-213, Standards for Additives, Materials, and Equipment.

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 17051

PROCESS CONTROL DESCRIPTIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section describes all of the anticipated control strategies under this Contract. The required control strategies for the various unit operations is a combination of the representation shown on the CONTRACT DRAWINGS and the requirements specified herein. The CONTRACT DRAWINGS do not show all the required internal diagnostic indications. In addition to the signals shown on the CONTRACT DRAWINGS, the following process control descriptions shall be provided, as a minimum:
   1. Analog Signals:
      a. Analog signals shall be 4 to 20 mADC unless otherwise stated.
      b. Analog signals that are connected to multiple devices in the loop shall be wired in series unless otherwise stated in the loop description.
      c. Loop power for all analog instruments shall be provided in the Local Control Panel (LCP) or Motor Control Panel (MCP). If there is no LCP or MCP, loop power shall be derived from the Computer Control System - Remote Input/Output Panels (RIO)
   2. Discrete Signals:
      a. Discrete signals for all field wires shall be designed to be fail safe.
         1) If a field wire for a control circuit device fails the equipment should be designed to shut down.
         2) If a field wire for an alarm circuit fails, the alarm shall be activated.
   3. Indication of a communications failure between any of the Programmable Logic Controllers (PLC) with the respective Computer Control System Field Control Unit (FCU) shall be programmed as an alarm in the Computer Control System. The broken communications link must be identified individually to assist in troubleshooting.
   4. Indication of a power failure at any of the PLC's and/or FCU panels shall be programmed as an alarm in the Computer Control System and identified individually to assist in troubleshooting.
   5. Mismatch alarms for all motorized equipment (e.g., pumps and gates, etc.). If the status feedback does not agree with the command after a time delay, annunciate the alarm in the Computer Control System.
   6. Runtimes shall be programmed in the Computer Control System for all pieces of equipment unless elapse Time meters are shown on the P&ID’s or listed in the loop descriptions.

7. Digital and analog signals provided from Vendor supplied equipment that are not shown on the CONTRACT DRAWINGS but are provided by the Vendor shall be verified and incorporated into the control systems.

B. The process control descriptions are written descriptions of the basic configuration and/or programming required to implement the sequential control of the unit processes shown on the CONTRACT DRAWINGS and as specified. The control descriptions do not, in all cases, describe the process characteristics fully. Finalizing and tuning of strategies, as required, by the process characteristics shall be accomplished during start-up.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 West Anthem Lift Station 76

A. General:
1. P&ID's — I Sheets 4 and 5.

B. Overview:
1. New Sewage Lift Pumps - The sewage lift station Remote Telemetry Unit LCP- PLC-LS76 uses the Modicon M580 PLC platform. Control and monitoring of the new sewage lift pumps will be accomplished using existing LCP-PLC- LS76 and LCP-PCP-LS76. Two modes of operation are required - PLC and backup. Both modes utilize level to start and stop the pumps. In backup mode pump 1 starts first and pump 2 starts second based upon level. Both stop at a determined level. In PLC mode, the PLC will alternate lead and lag rotation at each pump start. Associated equipment alarms are used for interlocking pump operation and are sent discretely to an autodialer located in LCP-PCP-LS76 for remote callout.
2. Biofilter – A new packaged Biofilter odor control system consisting of a local control panel and a Motor Control panel shall be install as part of the Phase II expansion. The Biofilter Blower shall be controlled locally by the LCP-BIO-LS76 and powered by the MCP-BIO-LS76. The LCP-BIO-LS76 connects to LCP-PLC-LS76 and relays alarms, interlocks and signals as depicted on Biofilter P&ID (contract drawing I-6)
3. LCP-PCP-LS76 modifications: Contractor to reuse existing switch, pushbuttons and wiring as much as possible. Contractor to demo existing level displays/transmitters and return the demoed equipment to client. Contractor to reuse existing panel cutouts to install new level displays/transmitters being installed as part of the phase II expansion.

C. Monitoring and Control:
1. Field Instrumentation and Controls:
a. Loop 100 (New Wetwell Level Transmitter (MR1) — New Wetwell level signal (LIT-100) shall be displayed at LCP-PCP-

LS76 and goes to LCP-PLC- LS76 for monitoring and control. Wetwell Low Level (LSL-100) goes to the autodialer located in LCP-PCP-LS76 for remote callout. Contractor to demo existing LIT display and reuse existing location on the LCP-PCP-LS76 to install new LIT-100 display, refer to contract drawing I04.

b. Loop 200 (Wetwell Level Transmitter (MR2) — New Wetwell level signal (LIT-200) shall be displayed at LCP-PCP-LS76 and goes to LCP-PLC- LS76 for monitoring. Wetwell High-High Level (LSHH-200) shall be connected to LCP-PLC-LS76 for monitoring and control and to each lift pump for interlocking, to the autodialer located in LCP-PCP-LS76 for remote callout, and to illuminate a High-High Level Alarm light on LCP- PCP-LS76. Wetwell High Level (LSH-200A) shall connect to lift pump no. 1 for control and Wetwell High Level (LSH-200B) shall connect to lift pump no. 2 for control. Wetwell High-High Level shall be reset using the reset button (HS-200) at LCP-PCP-LS76 or LCP-PLC-LS76 shall send a reset (HS-200). Contractor to demo existing LIT display and reuse existing location on the LCP-PCP-LS76 to install new LIT-200 display, refer to contract drawing I04.

c. Loop HS-102 (Local/PLC Mode Selector Switch) — Station operating mode is selected using the existing selector switch located at LCP-PCP-LS76 and PLC mode status goes to LCP-PLC-LS76 for monitoring and control. When PLC mode is selected, LCP-PLC-based on level.

d. Loop F-100 (New Sewage Lift Pump No. 1 Discharge Flow) — Station discharge flow (FIT-100) and total flow (FQI-100) shall be displayed at LCP-PCP-LS76 and sent to LCP-PLC-LS76 for monitoring.

e. Loop F-200 (New Sewage Lift Pump No. 1 Discharge Flow) — Station discharge flow (FIT-200) and total flow (FQI-200) shall be displayed at LCP-PCP-LS76 and sent to LCP-PLC-LS76 for monitoring.

f. Loop 100 & 200 (New Sewage Lift Pump No. 1/2) — High Temperature (TSH-100/200) and Seal Leak (GSH-100/200) statuses shall be used by LCP-PCP-LS76 for monitoring and control. They shall be hardwired to interlock the pump and to provide visual indication at LCP-PCP- LS76 using a High Temperature alarm light (TAH-100) and Seal Leak alarm light (GAH-100). The alarms will seal-in and shall be reset using the reset button (HS-100C/200C) located at LCP-PCP-LS76. The alarm statuses are also used by the autodialer in LCP-PCP-LS76 for remote callout.

g. Pump mode selection shall be made using a three-position selector switch (HS-100/200) located at LCP-PCP-LS76. When Hand is selected, the pump will run except when the High Temperature and/or Seal Leak alarms are energized. When the Off mode is selected the pump cannot be started. When Auto mode is selected, the pump will run as described below and Auto status goes to LCP-PLC-LS76 for monitoring and control.

Pump run status (MN- 100/200) shall be connected to LCP-PLC-LS76 for monitoring and control. Pump runtime (RTM-100/200) is accumulated and reset (HMS-172) locally at LCP-PCP-LS76. Pressing this button shall reset both the local runtime and flow totals and runtime totals in LCP-PLC-LS76. Both flow and runtime can be reset from LCP-PLC-LS76.

h. Pump discharge pressure (PIT-100/200) shall be displayed at LCP-PCP-LS76 and sent to LCP-PLC- LS76 for monitoring.

i. Loop 103 (Lamp Test Button) — Lamp test pushbutton (HS-130) tests all the lights associated with LCP-PCP-LS76.

j. Loop 140 (LCP-PCP-LS76 Temperature) — LCP-PCP-LS76 temperature transmitter (TT-140) sends cabinet temperature to LCP- PLC-LS76 for monitoring. LCP-PLC-LS76 will use the temperature to generate a High Temp alarm based on an adjustable internal setpoint.

k. Loop 150 (LCP-PCP-LS76 Control Power) — LCP-PCP-LS76 Control Power Loss (JA-150) is displayed at LCP-PCP-LS76 and is sent to LCP-PLC-LS76 for monitoring. It is also sent to the autodialer in LCP-PCP-LS76 for remote callout.

l. Loop 190 (Standby Generator) — When the station is using the standby generator for power, status is displayed at LCP-PCP-LS76 and sent to LCP-PLC-LS76 for monitoring and control. It's also sent to the LCP- PCP-LS76 autodialer for remote callout.

2. Motor/Local Control Panel - Controls:

a. Station PLC mode (HS-102) of operation:

1) LIT-100 (MRI) shall provide the primary lift station process variable control in LCP-PLC-LS76 based on 4-20mA level signal. LCP- PLC-LS76 logic shall operate the lift station sewage pumps based on level setpoints in LCP-PLC-LS76 for starting and stopping the pumps. The pumps will operate in a lead/lag sequence. The pumps will alternate at each start. If the lead pump is not available, the lag pump will run in its place until the lead pump returns to normal at the next start request. If level in the Wetwell rises to a High-High Level (LSHH-200) as measured by LIT- 200 (MR2), the lift station sewage pumps shall automatically be placed into a backup mode until the level returns to normal and the high-level reset button has been pushed. This shall be done with relay logic at LIT-200 and LCP-PCP-LS76.

(a) Normal Operation: Pump start and stop level setpoints shall be set in the PLC function block logic. Level setpoint adjustments can be made at LCP-PLC-LS76 through a laptop connection. As liquid level rises, the lead pump will be started when the level reaches the Lead Pump Start Level setpoint. The lead pump will continue to run until Wetwell level drops below the Lead/Lag Pumps Stop Level setpoint. If the level

reached the Lag Pump Start Level setpoint, the lag pump will be started and will continue to run until the level drops below the Lead/Lag Pumps Stop Level setpoint.

2) LIT-200 (MR2) provides backup lift station control based on hardwired device contacts. The 4-20mA level signal shall be provided to LCP-PLC-LS76 for monitoring. The following hardwired device contacts for lift station sewage pump operation shall be provided from the level sensor: Pump 1 Start/Stop (LSH-200A), Pump 2 Start/Stop (LSH-200B) and High-High Level (LSHH- 200). The setpoints for LIT-200 (MR2) shall be integral to LIT-200 and configured on the transmitter itself. LIT-200 shall provide individual alarm contacts that are activated at the LSH-200A, LSH-200B and LSHH-200 level setpoints.

(a) Backup Operation: When there is a High-High Level alarm (LAHH-101) condition or when the station is manually switched from PLC to LIT-200 (MR2) position using HS-102, the station will be placed into backup mode of operation. The pumps shall be started and stopped by hardwired contacts from LIT-200 (MR2). Pump start and stop levels can be set at LIT-200 (MR2) using the manufacturer provided ultrasonic level sensor programming device. As liquid level rises, the pump 1 shall be started at the Pump 1 Start Level setpoint. Pump 1 shall continue to run until Wetwell level drops to the Pumps 1 and 2 Stop Level setpoint. The Hydroranger 200 shall be programmed to alternate the operation of Pumps 1 and 2 while in backup mode. The sewage pumps shall remain in backup mode until the high-level alarm reset pushbutton is pressed if that is what placed the station into backup mode of operation. If backup mode was selected it will be unselected when placed from LIT-200 (MR2) mode to PLC mode of operation.

3. Computer Control System - Controls:
PLC control logic is described above. SCADA front-end integration shall be done by the client.

4. Equipment Set Points / Ranges

Device	Set Point / Range - Typical Value
LCP-PCP-LS76 High Temp	120 Deg F
LIT-100	0-33 FT
LIT-200	0-33 FT
PIT-100	0-100 PSIG

PIT-200	0-100 PSIG
FIT-100	0-2500 GPM
FIT-200	0-2500 GPM
Lead Pump Start Level	7 FT
Lag Pump Start Level	8 FT
Lead/Lag Pump Stop Level	4 FT
New Wetwell Level High High (LSHH-200)	9 FT
Lead Pump Start Level (LSH-200A)	7 FT
Lag Pump Start Level (LSH-200B)	8 FT
Pumps 1 and 2 Stop Level (LSH-200A, LSH-200B)	4 FT
Wetwell Low Level (LSL-100)	3.5 FT

D. Interlocks:
1. Interlock #1: High Motor Temp (TSH-100) — Lift Pump 1
2. Interlock #2: High Motor Seal Leak (GSH-100) — Lift Pump 1
3. Interlock #3: Motor Overload (MA-100) — Lift Pump 1
4. Interlock #4: High Motor Temp (TSH-200) — Lift Pump 2
5. Interlock #5: High Motor Seal Leak (GSH-200) — Lift Pump 2
6. Interlock #6: Motor Overload (MA-200) — Lift Pump 2

+ + END OF SECTION + +

SECTION 17052

PROCESS CONTROL SYSTEM
PRIMARY SENSORS AND FIELD INSTRUMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, adjust, commission and place into satisfactory operation all primary sensors and field instruments furnished under this Section.
   2. Contract Documents illustrate and specify functional and general construction requirements of the sensors and field instruments and do not necessarily show or specify all components, wiring, piping and accessories required to make a completely integrated system. Provide all components, piping, wiring, accessories, and labor required for a complete, workable and integrated system.

B. Coordinate the installation of all items specified herein and required to ensure the complete and proper interfacing of all the components and systems.

1.2 QUALITY ASSURANCE

A. Comply with the requirements of Section 17001, Process Control System General Requirements for Process Instrumentation.

B Acceptable Manufacturers:
   1. Furnish primary sensors and field instruments by the named manufacturers.
   2. Obtain all sensors and field instruments of a given type from the same manufacturer.

C. Manufacturers' Responsibilities and Services:
   1. Design and manufacture the primary sensors and field instruments in accordance with the applicable general design requirements specified in Section 17001, Process Control System General Requirements for Process Instrumentation, and the detailed Specifications herein.
   2. Field supervision, inspection, and start-up in accordance with the requirements of Section 17001, Process Control System General Requirements.

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements specified in Section 17001, Process Control System

General Requirements for Process Instrumentation.

B. Primary sensors and field instruments shall not be delivered to the site until all product information and Shop Drawings for the sensors and instruments have been approved by ENGINEER.

1.4 SUBMITTALS

A. Comply with the requirements specified in Section 17001, Process Control System General Requirements for Process Instrumentation.

1.5 CHEMICAL SERVICE

A. Where a primary element is designated for chemical service, all wetted components and appurtenances for that primary element shall be resistant to corrosion by that chemical. Chemicals referred to commonly as "caustic", "sodium hypochlorite", "hydrochloric acid", "ferric chloride", and "methanol" shall mean the following:
   1. "CAUSTIC": Sodium hydroxide (NaOH), 50 percent solution, Specific Gravity = 1.53.
   2. "SODIUM HYPOCHLORITE": Sodium Hypochlorite (NaOCl), 15 percent solution, Specific Gravity = 1.23.
   3. "HYDROCHLORIC ACID": Hydrochloric Acid (HCl), 38 percent solution, Specific Gravity = 1.4.
   4. "FERRIC CHLORIDE": Ferric Chloride (FeCl3), 43 percent solution, Specific Gravity = 1.46.
   5. "POLYMER": Polymer Solution, 0.2 to 0.5 percent solution, Specific Gravity = 1.00.
   6. “METHANOL”: Methanol (CH3OH), 99 percent solution, Specific Gravity = 0.792.

1.6 MATERIALS OF CONSTRUCTION FOR WETTABLE PARTS

A. Provide the following materials of construction for primary sensors and field instrument (wetted) parts that come in contact with the following list of process fluids:

PROCESS FLUID	ELASTOMER	METAL	PLASTIC	OTHER
Air		Type 316 SS	Teflon	
Alum	Buna-N	Type 316 SS		
Ammonia		Type 316 SS	Teflon	
Carbon	Buna-N	Type 316 SS		
Chemical Sump Drainage			Teflon Polypropylene	
Chlorine Gas or Liquid	Viton	Hastelloy C, Monel, or Tantalum		
Digester Gas	Viton	Alloy C276 Type 316 SS		
Ferric Chloride		Tantalum	Teflon Polypropylene	Ceramic
Fluoride	Viton	Hastelloy C		
Glycerine Oil	Neoprene Viton Buna-N	Type 316 SS	Teflon Polypropylene PVC/CPVC	
Halocarbon	Neoprene	Type 316 SS	Teflon	
Hydrochloric Acid	Viton	Tantalum Zirconium Platinum	Teflon	Ceramic
Lime		Type 316 SS	Teflon	
Methanol		Type 316 SS	Teflon	
Non Potable Water	Neoprene	Type 316 SS	Teflon	Ceramic

PROCESS FLUID	ELASTOMER	METAL	PLASTIC	OTHER
Odor Control Scrubber Solution		Platinum	Teflon Tefzel	Ceramic
Polymer	Buna-N	Type 316 SS		
Potassium Permanganate	Viton	Carpenter 20		
Raw Sewage	Viton	Type 316 SS	PTFE Polypropylene	
Sodium Chloride			Teflon	
Sodium Hydroxide		Hastelloy B Zirconium Platinum	Teflon Polypropylene PVC/CPVC	Ceramic
Sodium Hypochlorite		Hastelloy C Tantalum Titanium Platinum	Teflon PVC/CPVC Kynar	Ceramic
Silicone Oil	Viton Buna-N	Type 316 SS	Teflon Polypropylene	
Sludge	Neoprene Buna-N	Type 316 SS	PTFE	Ceramic

1.7 IDENTIFICATION TAGS

A. All sensors and field instruments shall have an identification tag conforming to the following requirements:
   1. Provide CMMS Tags for all instruments as specified under Section 01630, Computerized Maintenance Management System Tags.

1.8 SUNSHADES

A. Instruments and analyzers installed outdoors shall be firmly supported and protected by sun / rain shades, as specified or shown on DRAWINGS.
   1. Product and Manufacturer: Provide one of the following:
      a. Obrien – VIPAK
      b. Alumaline
      c. Or Equal

PART 2 PRODUCTS

2.1 PROCESS TAPS, SENSING LINES AND ACCESSORIES

A. Water Pressure Sensing Lines and Accessories for Flow and Pressure Transmitters:
   1. Material: Type 316 stainless steel; .049 wall thickness.
   2. Pressure Rating: 250 psi.
   3. Size: 1/2-inch outside diameter or as shown on the Drawings.
   4. Connections: Type 316 stainless steel compression type, "Swagelok", as manufactured by Crawford.
   5. Shut-off Valves:
      a. Type: Full port ball.
      b. Pressure Rating: 250 psi.
      c. Body, Ball and Stem: Type 316 stainless steel.
      d. Packing: High Density TFE.
      e. Handle: Nylon with metal travel stops.
      f. Support Rings: Stainless steel.
      g. End Connections: Removable "Swageloks".
      h. Product and Manufacturer: Provide one of the following:
         1) 45 Series, as manufactured by Whitey.
   6. Manifolds:
      a. Type: Five valve and three valve meter manifolds.
      b. Materials: Type 316 stainless steel body, bonnets and stems, delrin seats, Teflon packing.
      c. Product and Manufacturer: Provide one of the following:
         1) Whitey.
         2) Anderson-Greenwood

B. Air Pressure Sensing Lines and Accessories for Air Flow/Pressure Transmitters:
   1. Material: Type 316 stainless steel tubing, ASTM A 269, .049 wall thickness.
   2. Pressure Rating: 250 psi.
   3. Size: 1/2-inch outside diameter or as shown on the Drawings.
   4. Connections: Type 316 stainless steel compression type, "Swagelok" as manufactured by Crawford.
   5. Shut-off Valves:
      a. Type: Full port ball.
      b. Pressure Rating: 250 psi.
      c. Body, Ball and Stem: Type 316 stainless steel.
      d. Packing: High density TFE.
      e. Handle: Nylon with metal travel stops.
      f. Support Rings: Stainless steel.
      g. End Connections: Removable "Swageloks"
      h. Product and Manufacturer: Provide one of the following:
         1) 43 Series, as manufactured by Whitey.

6. Manifolds:
   a. Type: Five valve and three valve meter manifolds.
   b. Materials: Type 316 stainless steel body, bonnets and stems, delrin seats, teflon packing.
   c. Product and Manufacturer: Provide one of the following:
      1) Whitey.

C. Pressure Tap Sensing Lines and Accessories for Pressure Gages and Pressure Switches:
   1. For Process Sensing Taps in Ductile Iron, Steel and Stainless Steel Piping Systems:
      a. Material and Fittings: Type 316 stainless steel pipe (ASTM A 312) and threaded fittings and adapters (ASTM A 403) in accordance with Section 15103, Stainless Steel Pipe.
      b. Sizes: ½-inch minimum for main sensing piping and ¼-inch gage and switch connections or as shown on the Drawings.
      c. Pressure Rating: Equal to or greater than the applicable system test pressure as specified in Section 15050, Piping Systems.
      d. Accessories:
         1) For applications not requiring diaphragm seals, provide separate ¼-inch Type 316 stainless steel threaded gage cocks for each gage and switch.
         2) For applications requiring diaphragm seals, provide a separate 1/2-inch threaded Type 316 stainless steel ball valve for seal process side shutoff for each gage and switch. Ball valves shall be provided in accordance with the requirements of Section 15115, Ball Valves, Operators and Appurtenances.
   2. For Process Sensing Taps in Copper and Thermoplastic Piping Systems:
      a. Pipe Material and Fittings: Use same type of pipe material and fittings as that used in the process piping system. Copper pipe and fittings shall be provided in accordance with the requirements of Section 15105, Copper Pipe. CPVC pipe and fittings shall be provided in accordance with the requirements of Section 15106, Thermoplastic Pipe.
      b. Sizes: 1/2-inch minimum for main process sensing piping and for gage and switch connections.
      c. Pressure Rating: Equal to or greater than the applicable system test pressure as specified in Section 15050, Piping Systems.
      d. Accessories:
         1) For copper piping system taps with or without seals, provide a separate ¼-inch minimum threaded brass or bronze gage cock for each gage and switch.
         2) For CPVC piping systems with or without diaphragm seals, provide a separate 1/2-inch threaded ball valve for process sensing line shutoff for each gage and switch. Ball valves shall be provided in accordance with the requirements of

Section 15113, Thermoplastic Valves, Operators and Appurtenances.

2.2 INSTRUMENTATION

INSTRUMENT TYPE F1 - MAGNETIC FLOWTUBE AND TRANSMITTER

A. Functions:
   1. Flowtube: Produce low level, high impedance pulsed DC signal proportional to the rate of fluid flow using the principle of electromagnetic induction.
   2. Pulsed DC Magnetic Flow Transmitter: Drive the flowtube coils with pulsed DC power and convert the flowtube output signal into a DC current output linear to the flow rate.

B. System (Flowtube and Transmitter) Performance Requirements:
   1. System Accuracy (with Analog Output): ±0.5 percent of flow rate or better over range from 1 fps to 31 fps; ±.005 fps or better at flows below 1 fps flow range. System accuracy shall be proven by submittal of flow test curves of the actual meters being furnished. Test curves shall show a minimum of three flow points. Tests shall be performed using water and a weight or volume tank. A "Master Meter" used, as a reference standard is not acceptable. The test setup shall be submitted and approved prior to testing.
   2. System Repeatability: ±0.15 percent of flow rate or ±.0015 fps, whichever is greater.
   3. Drift: Complete zero stability.
   4. Minimum Fluid Conductivity Limit: Five microsiemens per centimeter or less.
   5. Fluid Property Effects: Accuracy unaffected by changes in fluid velocity, density, pressure, temperature or conductivity (above minimum conductivity limits).

C. Transmitter:
   1. Output: 4 to 20 mADC, direct acting and isolated, into 0 to 700 ohms.
   2. High accuracy, field adjustable scaled pulse output (2 to 800 Hz or greater) to drive local totalizer and provide scaled pulse output with a durations width of 0.5ms to 2 sec.
   3. Power Consumption: Not to exceed 50 watts for flowtube and transmitter combined.
   4. Operating Temperature: Suitable for operation with process fluid temperature from 0 to 140°F.
   5. Interchangeability: Ratio of flow velocity to voltage reference signals generated identical for all meter sizes to permit interchangeability with transmitter without requiring circuit modifications.
   6. Solid state construction.

7. Pulse and analog outputs galvanically isolated from input and earth ground.
8. Automatic zeroing feature making it unnecessary to zero the instrument before or after placing it in operation.
9. Precalibrated span adjustment providing continuous span adjustment over entire range. Range adjustment: Integral pushbuttons continuously adjustable for full-scale settings from 1 to 31 feet per second.
10. Signal Conditioning: Adjustable damping circuit with response times of 1 to 25 seconds minimum.
11. Low Flow Cutoff: Provide automatic low flow cutoff circuitry to stop pulse output and local totalization when flow drops below 0.5 percent ±0.2 percent of the calibrated upper range valve.
12. Enclosure:
    a. Die cast, low-copper aluminum alloy, NEMA 4.
    b. Finish: Epoxy coating.
13. Mounting:
    a. All transmitter and driver electronics shall be remotely mounted from the flow tubes at locations shown on the Drawings.
    b. Provide complete Type 316 stainless steel mounting hardware.
    c. Type of mounting (wall, support frame or pipe stand), as required.

14. Local Indication:
    a. 3-1/2 digit minimum LCD meter with field selectable engineering units; or analog multi-meter with linear 0 to 100 percent scale for flow rate indication. The engineering units shall be as specified in the Instrument List.
    b. 7-digit electromechanical totalizer or 8 digit electronic LCD totalizer with reset and lithium battery backup. Count scaling shall be as specified in the Instrument List. Totalizer shall be integral with transmitter and visible through viewing window, or shall be externally mounted in a separate NEMA 4X enclosure or condulet with viewing window and installed adjacent to the transmitter.
15. Power Requirements: Designed for operation on 120 VAC ± ten percent, 60 Hz, ±3 Hz power supply.
16. Accessories: Coordinate Accessories as required for the project.
17. Provide shielded cable assemblies of sufficient length to met mounting locations as shown on DRAWINGS for connection between flowtube and transmitter electronics.
    a. Protect magnetic flow meter transmitter to flowtube shield cable from the sun and weather.

D. Construction and Required Features:
1. Flowtube:
    a. Type: Lined metal flowtubes.
    b. Liner Material: PFTE.

c. NFS APPROVAL REQUIRED FOR POTABLE WATER SERVICE.

- Krohne America Incorporated has NFS Approval on the following:
  - Hard Rubber for sizes 1" to 80"
  - Polyurethane for sizes 3/8" to 40"
  - PTFE – None Available

- Endress + Hauser have NFS Approval on the following:
  - Hard Rubber for sizes 3" to 78", 0 to +80 °C (+32 to +176 °F)
  - Polyurethane for sizes 1" to 12", –20 to +50 °C (–4 to +122 °F)
  - PTFE for sizes ½" to 24", –20 to +90 °C (–4 to +194 °F)

2. Tube Material:
   a. Meter tubes 12-inch and smaller: Type 304 stainless steel.
   b. Metering tubes 14-inch and larger: Type 304 stainless steel, .125-inch wall thickness.
3. Pressure Rating: Greater than or equal to test pressure specified in Section 15050, Piping Systems, for appropriate piping system.
4. Electrodes:
   a. Conical or elliptical shaped.
5. Enclosure:
   a. Materials and Rating: Cast low-copper aluminum alloy or fabricated sheet steel, NEMA 6 rated.
   b. Finish: Finish exterior, except for flange faces, with a high build epoxy paint.
   c. End Connections:
      - For up to 24" line size - ANSI Class 150 suitable for mating with pipe specified.
      - For over 24" line size – AWWA Class D Flanges
      - For Higher Pressures – AWWA Class E & F Flanges
6. Electrical Connections: 1/2 inch minimum to 3/4-inch maximum NPT tapped holes for power conduit fitting and signal conduit fittings.
7. Type 316 stainless steel grounding rings for flowtubes.
8. Type 316 stainless steel grounding straps.

E. Provide one calibrator suitable to calibrate all flow tubes provided.

F. Product and Manufacturer: Provide one of the following:
   1. Series W ProMag Magnetic Flow tube and Remote Transmitter, as manufactured by Endress + Hauser.

2. Optiflux 2100 Magnetic Flow tube and IFC 100 Signal Converter, as manufactured by Khrone America Incorporated.

INSTRUMENT TYPE L1 - LEVEL TRANSMITTER – ULTRASONIC TYPE

A. Type: Non-contact system using transducer to convert electrical pulses from the transmitter into sonic pulses directed towards the metered surface and receives the reflected sonic pulses and converts them back into electrical pulses for reception by the transmitter. Transmitter shall generate and time the electrical pulses, and count and convert the pulse travel times into an analog output signal linearly proportional to level/flow.

B. System Performance Requirements:
   1. Accuracy: Not less than ± 0.25 percent of full-scale range.
   2. Linearity and Repeatability: Not less than ±1 percent of full scale.
   3. Resolution shall be 0.1 percent of range of 2mm (0.08") whichever is greater.
   4. Minimum Operating Distance from Transducer (Deadband): 12-inches.
   5. Beam Pattern: 8 degree conical, maximum.
   6. Transmitter Outputs: Provide each of the following:
      a. 4 to 20 mADC, direct acting and isolated, signal proportional to level, into 0 to 750 ohms.
      b. Minimum of six (6) independently adjustable alarm setpoint, relays outputs rated at five amps, 250 VAC non-inductive.
      c. Loss of echo relay, which energizes when measured level falls beyond signal range or signal, is interrupted for any other reason. Relay output shall be rated five amps 250 VAC non-inductive.
   7. Environmental Conditions: Suitable for use under the environmental conditions specified in Section 17001, Process Control System General Requirements for Process Instrumentation.
   8. Power Consumption: 25 watts, maximum.
   9. Temperature Compensation: Range – 58 to 302ºF, integral temperature sensor in transducer.

C. Required Features:
   1. Transducer:
      a. Encapsulated by a corrosion resistant and submergence resistant material: PVDF.
      b. Class 1 Div 2.
      c. Designed for suspended PVC coated galvanized rigid steel conduit mounting or equipped with ANSI 150 pound flanges for flange mounting.
      d. 1-inch external NPT PVC coated galvanized rigid steel conduit connection.
   2. Transmitter:
      a. Solid state construction.

b. Built-in digital filtering for EMI protection and external acoustical noise rejection.
c. Built-in automatic compensation for variations in temperature, pressure and density of the sonic signal medium.
d. LCD indicator scaled in engineering units for the range required.
e. Software adjustable zero and span adjustment over 0 to 100 percent of the calibrated range.
f. Lost Echo and Power On Lights.
g. Housed in weatherproof, splash proof and corrosion resistant NEMA 4X enclosure and suitable wall or pipe stand mounting. Provide with a transparent window to permit viewing indicating meter and lights.
h. Internally mounted diagnostic LED's to allow isolation of faults in terms of major components.
i. Designed for operation on 120 VAC ±10 percent, 60 Hz power supply.

3. Accessories:
   a. Transducer cables 2-3 copper conductors, twisted with shield and drain wire, the actual length required, for connection between the transducer and transmitter
   b. One Hand held calibrator

D. Product and Manufacturer: Provide the following:
   1. HydroRanger and EchoMax Transducer Model XRS-5, as manufactured by Siemens.

INSTRUMENT TYPE P1 – DIFFERENTIAL PRESSURE TRANSMITTER

A. Type: Two-wire, differential capacitance or resonant type transmitter.

B. Required Features and Accessories:
   1. Accuracy (includes combined effects of linearity, hysteresis and repeatability): ±0.075 percent of calibrated span..
   2. Stability (drift over a six month period): Not more than ±0.25 percent of transmitter upper range limit.
   3. Ambient Temperature Effect: Total Error per 100°F change between the limits of -20°F and +180°F: Not more than ±1.0 percent of the transmitter upper range limit (maximum span).
   4. Supply Voltage Effect: Output change not greater than 0.005 percent of span for each one-volt change in supply voltage.
   5. Output:
      a. Isolated direct acting 4 to 20 mADC.
      b. Digital process variable signal superimposed on 4 to 20 mADC signal without compromising loop integrity.
   6. Solid state electronic components.
   7. Positive overrange protection of at least 1.25 times the maximum span

limit.

8. Calibration Adjustments:
   a. Zero: Adjustable in electronics compartment.
   b. Span: Course and fine span adjustments in electronics compartment.
9. Zero elevation and suppression capability to the extent that the amount of suppression plus calibrated span does not exceed the upper range limits of the sensor.
10. Adjustable internal damping.
11. Measuring elements protected by sealing diaphragm.
12. Built-in electrical surge and RFI protection.
13. Integral square root extraction providing linear 4 to 20 mADC output proportional to flow when required.
14. Electric Conduit Connection: 1/2-inch NPT.
15. Process Connections: 1/2-inch NPT with 5 valve-manifold.
16. Designated to operate on power from receiver or remote power supply, nominal 24 VDC.
17. Type 316 stainless steel mounting bracket and hardware suitable for mounting transmitter on flat vertical surface or 2-inch diameter pipe.
18. Non-Wetted Parts:
   a. Body and Process Connection Bolting: Type 316 stainless steel.
   b. Housing and Cover: Die cast low copper aluminum alloy finished with epoxy paint system; covers shall be threaded and seated on Buna-N O-rings; NEMA 4 rating.
   c. Capsule Fill Liquid: Silicone oil except for Chlorine and Fluoride Systems. For Chlorine and Fluoride Systems use Flurolube Oil.
19. Material: All wetted parts to be metal selected from table in Article 1.6, above, based on process fluid being measured.
20. Assembly: Where specified equipment is shown to be mounted to annular or diaphragm seals, equipment and seal shall be factory assembled, calibrated and furnished as a single unit.
21. Remote Pressure Diaphragm Seals:
   a. Size and Type: 3-inch ANSI Class 150 flanged with flush diaphragm.
   b. Quantity: One or two as required by application.
   c. Diaphragm Seal Housing, Flanges and Bolting (non-process wetted) Materials: Type 316 stainless steel.
   d. Capillary Tubing:
      1) Material: Armored Type 316 stainless steel.
      2) Length: As required to extend from remote seal to transmitter (five feet minimum; 25 feet maximum).
   e. Fill Fluids:
      1) Remote Seal and Capillary: DC 200 silicone oil.
22. Indicator: Provide integral indicator in engineering units.
23. Hazardous Area Requirements: Where so required, provide transmitters rated for use in Class I, Group D, Division 1 hazardous areas.

24. Hand held interface with keyboard and LED display capable of easily configuring and testing the transmitter.

C. Product and Manufacturers: Provide one of the following:
1. DPharp EJX series as manufactured by Yokogawa.
2. 3051CD Series, as manufactured by Rosemount, Incorporated.
3. Smartline STD 700, as manufactured by Honeywell

INSTRUMENT TYPE P3 - PRESSURE GAUGE

A. Bourdon Tube Pressure Element Type, Liquid Filled Gage (for pressure ranges of 15 psi and greater and vacuum ranges to 30-inches Hg):
1. Performance Requirements:
a. Accuracy: ±0.5 percent of span (ANSI B40.1 Grade 2A).
2. Construction Features:
a. Case:
1) Solid front design constructed of glass filled polyester.
2) Color: Black.
b. Ring: Threaded, glass filled polyester.
c. Full blowout back.
d. Window: Glass.
e. Dial: White with black marking; 270-degree scale.
f. Material: All wetted parts to be metal selected from table in Article 1.6, above, based on process fluid being measured.
g. Movement: Cam and roller movement, 300 Series stainless steel.
h. Size: 4-1/2-inch.
i. Connection: 1/4-inch male NPT back or bottom, as required.
j. Mounting: Stem, flush panel or wall mounting, as required.
k. Adjustable pointer.
l. Built-in overload and underload movement stops.
m. Pressure Snubber: Sintered Type 316 stainless steel snubber threaded into gage socket or in external stainless steel housing with 1/4-inch NPT male and female connections.
n. Manifold : 3 valve-manifold
3. Assembly: Where specified equipment is shown to be mounted to annular or diaphragm seals, equipment and seal shall be factory assembled, calibrated and furnished as a single unit.
4. Gauge Filling Liquid: Silicone Oil
B. Product and Manufacturer: Provide one of the following:
1. 1379 Duragauge Series with Performance Plus and diagphram seal, as manufactured by Ashcroft.
2. Or Equal

INSTRUMENT TYPE P4 - PRESSURE INDICATING TRANSMITTER

A. Type: Two-wire, capacitance type, direct mount gage pressure indicating

transmitter with single seal or closed coupled diaphragm seal.

B. Required Features and Accessories:
1. Accuracy (includes combined effects of linearity, hysteresis and repeatability): ±0.075 percent of calibrated span.
2. Stability (drift over a six month period): Not more than ±0.25 percent of transmitter's upper range limit.
3. Ambient Temperature Effect: Total Error per 100°F change between the limits of -20°F and +180°F: Not more than ±1.0 percent of the transmitter upper range limit (maximum span).
4. Supply Voltage Effect: Output change not greater than 0.005 percent of span for each one-volt change in supply voltage.
5. Output:
   a. Isolated direct acting 4 to 20 mADC, Plus Hart digital signal
   b. Digital process variable signal superimposed on 4 to 20 mADC signal without compromising loop integrity.
   c. Zero and span adjustments
   d. Damping adjustable 0 to 10 seconds.
6. Solid state electronic components.
7. Positive over range protection of at least 1.25 times the maximum span limit.
8. Calibration Adjustments:
   a. Zero: Adjustable in electronics compartment.
   b. Span: Course and fine span adjustments in electronics compartment.
   c. Rangeability - Turndown ratio to provide a variable programmable range span.
   d. User selected linear or integral square root extraction providing linear 4 to 20 mADC output proportional to flow when required.
9. Zero elevation and suppression capability to the extent that the amount of suppression plus calibrated span does not exceed the upper range limits of the sensor.
12. Built-in electrical surge and RFI protection.
13. Electrical Connection ½" – NPT
14. When instrument is installed below grade in a valve vault use a submersible type transmitter only. Provide 24VDC pressure indicator readout above grade
15. Power Requirements: 24 VDC (Operates on 10.5 to 55 Volts DC)
16. Process Connection: 1/2-inch NPT with 3 valve manifold.
18. Non-Wetted Parts:
   a. Body and Process Connection Bolting: Type 316 stainless steel.
   b. Housing and Cover: Die cast low copper aluminum alloy finished with epoxy paint system; covers shall be threaded and seated on Buna-N O-rings; NEMA 4 / 6P rating.
   c. Capsule Fill Liquid: Silicone oil except for Chlorine and Fluoride Systems.

19. Material: All wetted parts to be 316 stainless steel or hastiloy C based on process fluid being measured.
20. Software Functionality
    a. Transmitter shall be capable of digital communications over the 4 to 20mA output loop without interruption using the Hart Protocol.
    b. Transmitter shall perform continuous diagnostics, be capable of self-test functions, and be able to give specific diagnostic information.
    c. Configuration capabilities shall allow the user the ability to input and store information including range, engineering units, damping, spare root or linear output, date, message descriptor, and tag number.
21. Indicator: Provide integral indicator in engineering units when the transmitter is readily accessible.
22. Area Requirements: Provide transmitters rated for use in Class I, Division 2 hazardous areas.
23. Assembly: Where specified equipment is shown to be mounted to annular or diaphragm seals, equipment and seal shall be factory assembled, calibrated and furnished as a single unit.
24. Provide one hand held interface with keyboard and LED display capable of easily configuring and testing the transmitter.

C. Product and Manufacturers: Provide one of the following:
    1. Cerabar S PMC71as manufactured by Endress Hauser
    2. Model EJX530A as manufactured by Yokogawa
    2. Model 2051TG as manufactured by Rosemount
    3. Model YSTR14G as manufactured by Honeywell

INSTRUMENT TYPE T4 - TEMPERATURE GAUGE

A. Temperature gage shall be furnished with a thermowell of material compatible with the fluid into which it shall be immersed. Temperature gage shall accurately measure and display the temperature of the process fluid.

B. Required Features:
    1. Molecular sieve type.
    2. Silicone encapsulated helical bourdon tube.
    3. Stainless steel construction.
    4. Adjustable pointer.
    5. Weatherproof.
    6. Accuracy: ± One percent full span.
    7. 4-1/2-inch nominal dial size.
    8. 1/2-inch male NPT connection to thermowell.
    9. Fully adjustable stem where direct mounted; stainless steel capillary tubing protected with stainless steel armor where remote mounting is required.

C. Product and Manufacturer: Provide one of the following:
   1. Duratemp, as manufactured by Ashcroft.
   2. Or Equal

INSTRUMENT TYPE – PANEL DIGITAL INDICATORS

1. Type: Electronic, 3-1/2 Digit LED, 0.60-inch high display

2. Input Impedance: no greater than 250 ohms.

3. Power Source: 110 VAC, 60 hertz

4. Input Signal: 4-20 mA DC

5. Input Dampening: Adjustable

6. Enclosure: 1/8 DIN, general purpose for indoor flush panel mount. Provide indicators for outdoor panels having a NEMA 4X bezel rating or mounted behind a weatherproof gasketed door assembly.

7. Accuracy: +/- 0.05 percent of span +/- 1 count

8. Decimal Point: Selectable via DIP switches or keypad.

9. Input Connections: Compression type screw terminals

10. Range Selection: DIP switches, multi-turn potentiometers, or keypad.

11. Manufacturers:

    a. Precision Digital

    b. Red Lion

    c. Or approved equal

2.3 SPARE PARTS AND TEST EQUIPMENT

A. Furnish and deliver the spare parts and test equipment as outlined below, all of which shall be identical and interchangeable with similar parts furnished under this Section. Comply with the requirements of Section 01783, Spare Parts and Maintenance Materials.

B. Spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

C. The following shall constitute the minimum spare parts:

Primary Sensors and Field Instrument Description	Instrument Type	Required Spares
Magnetic Flowmeter	Flowmeter	1
Differential Pressure Transmitter	Pressure	1
Pressure Transmitter	Pressure	1
Pressure Gauge	Pressure	1

D. The following shall constitute the minimum test and calibration equipment.
1. All tooling required to insert, extract and connect any internal or external connector, including edge connectors.
2. All special calibration equipment required for system calibration.

E. All spare parts shall have been operated and tested in the factory as part of factory testing prior to shipment of the control system.

PART 3 - EXECUTION

3.1. INSTALLATION

A. Provide the services of qualified factory-trained servicemen to assist in the installation of the instrumentation and control system equipment.

B. Install each item in accordance with manufacturer's recommendations and in accordance with the CONTRACT DOCUMENTS. Transmitters and instruments require access for periodic calibration or maintenance. Transmitters and instruments shall be mounted so they are accessible while standing on the floor.

C. All items shall be mounted and anchored using Type 316 stainless steel hardware, unless otherwise noted.

D. All field instruments shall be rigidly secured to walls, stands or brackets, as required, by the manufacturer and as shown on the Drawings. Mounting instruments on handrails will not be allowed.

E. Conform to all applicable provisions of the NEMA and NFPA standards, local, state and federal codes when installing the equipment and interconnecting wiring.

3.2 START-UP, CALIBRATION, AND TESTING AND TRAINING

A. Comply with the requirements of Section 17001, Process Control System General Requirements for Process Instrumentation.

B. Calibration of Instruments:
   a. All instruments are to be field calibrated and witnessed by the ENGINEER through their entire range or with the required setpoints based on the requirements stated in Specification 17053 – Process Control System Instrument Index prior to start-up. Factory calibrated instruments are required to be recalibrated in the field prior to start-up and witnessed by the ENGINEER. Utilized form 17001-B - Calibration Test Data Form as provided in Specification 01331 – Reference Forms to document the field calibration.

C. Primary Sensors/Transducers and Field Instruments:
   a. Provide on-site operation and maintenance training by EQUIPMENT SUPPLIERS and/or the EQUIPMENT MANUFACTURER REPRESENTATIVES prior to placing the equipment in continuous operation, conforming to the requirements of Section 01821, Instruction of Operations and Maintenance Personnel. The services of equipment manufacturer's representatives shall be provided for a minimum of 8 hours for each type of the following instruments.
      1) Magnetic Flowmeter

   b. Training shall accomplish the following:
      1) Provide instruction covering procedures for routine, preventive and troubleshooting maintenance and equipment calibration.

+ + END OF SECTION + +

INSTRUMENT INDEX

Tag Number	P&ID	Serial Key #	Service Description	Spec. Inst. Type	Device	Size / Rating	Range	Setpoints	COMMENTS
LE/LIT-100	I-04		New Wetwell Level Transmitter #1	L1	Ultrasonic		0- 33 ft	4 ft, 7 ft	Lead Lag Pump Off, Lead Pump On
LE/LIT-200	I-04		New Wetwell Level Transmitter #2	L1	Ultrasonic		0- 33 ft	3.5 ft, 8.5 ft	Low Level, High level
PIT-100	I-04		New Wetwell Pump #100 Discharge Pressure	P4	Pressure	14"	0- 100 psi	40.7 psi	Pump rated for 94.1ft TDH
PI-100	I-04		New Wetwell Pump #100 Discharge Pressure Gauge	P3	Pressure	14"	0- 100 psi	N/A	
PIT-200	I-04		New Wetwell Pump #200 Discharge Pressure	P4	Pressure	14"	0- 100 psi	40.7 psi	Pump rated for 94.1ft TDH
PI-200	I-04		New Wetwell Pump #200 Discharge Pressure Gauge	P3	Pressure	14"	0- 100 psi	N/A	
FE/FIT-100	I-04		New Wetwell Pump #100 Discharge Flow	F1	Magnetic Flowmeter	14"	0 - 2500 GPM	1702 GPM	
FE/FIT-200	I-04		New Wetwell Pump #200 Discharge Flow	F1	Magnetic Flowmeter	14"	0 - 2500 GPM	1702 GPM	
DPI-502	I-06		Biofilter Blower Inlet Differential Pressure	P1	Pressure	8"	TBD	TBD	Provided by Biofilter Vendor
PI-504	I-06		Biofilter Blower Inlet Pressure Gauge	P3	Pressure	8"	TBD	TBD	
PI-505	I-06		Biofilter Blower Discharge Pressure Gauge	P3	Pressure	8"	TBD	TBD	
PDIT-506	I-06		Biofilter Blower Differential Pressure	P1	Pressure	8"	TBD	TBD	
PIT-507	I-06		Biofilter Blower Discharge Pressure	P4	Pressure	8"	TBD	TBD	

+ + END OF SECTION + +

SECTION 17226

PROCESS CONTROL SYSTEM I/O LIST

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. I/O lists are compiled as shown on the P&ID DRAWINGS. The I/O list is only the new I/O added under this Contract or requires loop testing due to modifications to the systems.

B. The form provided in this section, identifies the person(s) who witnessed all loop testing. The loop testing shall include the field device through to the computer control system. Once the loop is fully tested and complete, each witness will initial the appropriate space on the form.

C. Completed form to be transmitted to the OWNER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

A. Refer to 17226 Process Control IO list Appendix A.

+ + END OF SECTION + +

SECTION 17260

CONTROL PANELS

PART 1 GENERAL

1.1 SCOPE

A. Contract Documents illustrate and specify functional and general construction requirements of the panel components and do not necessarily show or specify all components, wiring, and accessories required for a completely integrated system.

B. Provide all labor, materials, equipment, documentation including drawings and incidentals as shown on the Drawings, specified and required to design, furnish, install, calibrate, test, start-up, program, configure, commission and place into satisfactory operation all panels, intermediate termination panels and/or enclosures including panel components and instruments.

C. Conform the design and construction of panels to the specifications herein.

1.2 COORDINATION

A. Coordinate the installation of all items specified herein and required to ensure the complete and proper interfacing of all the components and systems.

B. All control loops to function as described in Section 17051, Computer Control System Process Control Descriptions and depicted on the CONTRACT DRAWINGS.

1.3 DEFINITIONS

A. **Intermediate Termination Panel (ITP)**: An Intermediate Termination Panel is any junction box that has terminals to terminate wires and no electrical or electronic powered devices. Exceptions are to be approved by the City of Phoenix (COP). These panels act as interim termination points for field wiring to be connected to the control systems equipment. Please note that junction boxes and pull boxes are different. ITP's are sometimes referred to as junction boxes. However, pull boxes are not allowed to have any wire splicing devices, including terminal blocks.

B. **Local Control Panel (LCP)**: A Local Control Panel is an industrial piece of equipment that contains electrical or electronic devices, in addition to wire terminals. Typically, it is a local panel connected to a specific piece of equipment to provide control and/or monitoring of that equipment. A local control panel contains voltages

of 120VAC or below. Exceptions are to be approved by COP.

C. **Motor Control Panel (MCP)**: An Motor Control Panel is an industrial piece of equipment that houses components for the power distribution and starting of motors. The components may include motor starters and variable frequency drives.

1.4 QUALITY ASSURANCE

A. Reference Standards: Construction of panels and the installation and interconnection of all equipment and devices mounted within also comply with applicable provisions of the following, except where otherwise shown or specified.

1. National Fire Protection Association 79
2. National Electrical Code (NEC) current adoption.
3. National Electrical Manufacturer's Association Standards (NEMA)
4. American Society for Testing and Materials (ASTM)
5. Operational Safety and Health Administration (OSHA) Regulations
6. State and local code requirements
7. Where any conflict arises between codes or standards, the more stringent requirement applies.
8. All panel devices shall bear the label of the Underwriters' Laboratory (UL), Inc. or be UL Recognized. Some products certified by UL are components that are intended to be used in the manufacture of a complete listed product. These components cannot bear the UL symbol, but may use a special Recognized Component Mark.
    a. The UL/UR listed number shall be documented on the Bill of Materials on the drawings.
9. The assembled LCP's and MCP's are to be conformed to meet UL 508A requirements and labeling.

B. Panel to be designed, schematics drawn and assembled by the manufacturer. Utilize one of the following Panel Manufacturers:

1. Wunderlich-Malec Engineering – Systems – Services

   1525 North Hayden Road

   Scottsdale, AZ 85257

   Office: (480) 874-1175

   FAX: (480) 874-1185

2. RDC Electrical

   3411 South 44th Street

   Phoenix, AZ 85040

   Office: (602) 437-0760

3. Custom Controls of Arizona

   42928 North 30th Street

   Phoenix, AZ 85016

   Tel: (602) 954-3949

   Fax: (602) 954-4668

1.5 SUBMITTALS

A. General:

1. Reference Section 01330 Submittals.
2. Panels shall be furnished in accordance with the requirements as shown on the Drawings, and as specified in Division 16, Section 16050 and Division 17000, Sections 17001, 17051, 17052, 17053, 17226 and 17260.
3. Generate drawing package utilizing AutoCAD versions 2004 through 2008. If utilizing a newer AutoCAD version, submit files saved at version 2008.
4. Submit legible hard copies of the panel drawing package printed on 11” x 17” sheets and soft copies in both .dwg and .pdf format.
5. Submit manufacturer’s technical data sheets and product literature for the panel and all components utilized. Cleary identify exact equipment and material that is being supplied on the manufacturer’s data sheets.
6. Submit a sample nameplate with the submittal.

7. Identify general location of all conduit entry points on the Front Elevation drawing of the documentation package.

8. Submit calculations and recommended cooling and heating load requirements. Utilize the nVent Hoffman Cooling Selection tool at: https://coolingtool.nvent.com/index.html

9. Submit location and tube routing details for air conditioner drain line. Coordinate drain location with ENGINEER.

1.6 O&M Manuals

A. Comply with the requirements of Section 01781, Operations and Maintenance Data.

B. Provide an electronic copy of the panel drawing package on a separate CD. Panel Drawings are to be provided electronically in AutoCAD version 2004 through 2008. If utilizing a newer AutoCAD version, submit files saved at version 2008.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements of Section 01651, Transportation and Handling of Materials and Equipment.

B. Comply with the requirements of 01661, Storage of Materials and Equipment.

C. Provide a laminated hard copy of the panel drawings, size 11" x 17", inside the panel upon delivery or project completion. If redline drawings are utilized, replace with approved laminated copies.

PART 2 - PRODUCTS

2.1 PANEL ENCLOSURES

A. General:

1. Conform panels and enclosures to the NEMA requirements as stated in Specification 16050 – General Requirements.

2. All outdoor panels shall be provided with sunshade structures or solar shields. Sunshade structures or solar shields shall be constructed as shown on CONTRACT DRAWINGS.

3. Sizes shown on contract drawings are estimates. Furnish panels and enclosures

sized to house all equipment, instruments, front panel mounted devices, power supplies, power distribution panels, wiring and other components installed within.

4. Size the panel to provide (list the required percentage for spare space. This percentage shall not be less than 5% or a maximum of 20%) spare free space capacity.
5. Use stainless steel fasteners throughout.
6. Provide interior mounting panels and shelves constructed of minimum 12 gage steel.
7. Provide 12”x12” print pocket in panels with a 24” or larger door. Mount on inside door where no door mounted devices are located. If there is not enough room for a 12”x12” print pocket, provide a sized pocket to fit available room.
8. Provide enclosure mounting supports as required for floor, frame, or wall mounting. Indoor wall mount panels utilizing stainless steel unistrut. Outdoor wall mount panels utilizing PVC coated unistrut. PVC coated exceptions may be approved by COP for non-corrosive outdoor installs.

B. Construction Features:

1. General Construction Features - Provide the following convenience accessories inside of each panel.
    a. One or more 120 VAC light fixtures with a minimum 40 watt lamp or LEDs with a snap switch for on/off control.
    b. Provide grounding studs or lugs for metal panels and doors.
    c. Provide all electrical components and devices, support hardware, fasteners, and interconnecting wiring required to make the panels and/or enclosures complete and operational.
    d. Provide oil resistant gasket completely around each door or opening.
    e. For panels located in the field or outdoors that have door mounted devices which do not meet the NEMA rating for the area, provide a window kit that includes a hinged door with a clear plastic window and an oil resistant gasket to encompass all non-NEMA rated panel instruments for this area.
    f. Provide full height doors.

g. Provide panels with no extra holes or knockouts unless shown on CONTRACT DRAWINGS.

C. Environment

1. General:

a. Provide the following panel(s) with an air conditioner, heat exchanger or ventilation fan based on the submitted calculations for cooling and/or heating load requirements.

Coordinate utilization of air conditioners, heat exchangers, ventilations fans and heaters. Include a separate power feed from a lighting panel and drain line location. No air conditioners are allowed at remote facilities of lift stations. Exceptions to be approved by cop.

b. Provide a heater for all panels located outdoors to maintain a minimum temperature of 68°F.

c. Provide a separate supplementary protector for the cooling or heating equipment.

d. Provide thermostats to automatically control heating and cooling requirements.

e. Provide a high temperature switch, for alarm purposes, in all panels that require air conditioners, heat exchangers or ventilation fans. The contact shall be wired to alarm to the Computer Control System.

1) Products and Manufacturers:

a) Hoffman ATEMNC

b) Or approved equal

2. Air Conditioner:

a. Coordinate utilization of air conditioners with the ENGINEER.

b. Provide an automatically controlled closed loop air conditioner with filtered and adjustable air louvers to maintain temperature inside each enclosure below the maximum operating temperature rating of the lowest rated component.

c. Condensate Coltrols:

1) For outdoor installations, provide a condensation drain line for each air conditioner.

2) For indoor installations, provide an active condensate evaporation system.

d. Coordinate space requirements for maintenance.

e. Provide NEMA 4X for outdoor locations.

f. Coat heating and cooling elements on ambient and enclosure sides including coils that are in contact with Plant's ambient environment with Heresite, or equal, for protection from hydrogen sulfide corrosion with hydrogen sulfide levels up to seven ppm.

1) Coordinate application of coating with the ENGINEER.

g. Provide integral heater to maintain internal temperatures above 40°F.

h. Product and Manufacturer:

1) Hoffman (McClean) G or N Series, Model Spectra Cool

3. Heat Exchanger:

a. Coordinate utilization of heat exchangers with the ENGINEER.

b. Provide an automatically controlled heat exchanger to maintain temperature inside each enclosure below the maximum operating temperature rating of the lowest rated component.

c. Coordinate space requirements for maintenance.

d. Products and Manufacturers:

1) Hoffman

4. Ventilation Fan:

a. Coordinate utilization of ventilation fans with the ENGINEER.

b. Provide automatically controlled ventilation fans with filter to maintain temperature of indoor enclosures below the maximum operating temperature of the lowest rated component.

c. Products and Manufacturers:

1) Hoffman

2) Or approved equal

5. Heater:

a. If panel is not equipped with an air conditioner, provide adequately sized

automatically controlled 120 VAC heater to maintain temperature inside each enclosure above 40°F to a maximum of 80°F when the outside temperature is 0°F through 40°F.

b. Maintain a minimum four-inch clearance or minimum clearance recommendations from the manufacturers from any device.

c. Product and Manufacturer:

1) Hoffman

2) Or approved equal

D. Identification:

1. Provide laminated plastic nameplates with a white background and black lettering for identification of panels and components.

2. Construct nameplates with 1/16” plastic and with beveled edges.

3. Nameplate Mounting

a. Indoor panels: Mount nameplates to the panel utilizing glue.

b. Outdoor panels: Mount nameplates to the panel utilizing glue and with two self-sealing #4-40, round head, stainless steel screws.

c. Glue Product and Manufacturer

1) 3M – Nitrile High Performance Rubber & Gasket Adhesive – Part # EC-847

2) Or approved equal

4. Provide nameplates according to Table 2.1.C.5 and Section 3.1.B:

Nameplate Specifications			
Type	Size	Font	Font Size
Manufacturer Nameplate	*1½” x 6”	Arial	1/8“
Panel Nameplate	*2” x 7”	Arial	1/2“
Device Nameplate	*1½”x 2½”	Arial	3/16“

Table 2.1.C.5 Nameplate Specifications

*** This is a minimum height size requirement. Size nameplates large enough to display the information required to clearly identify the panel.**

2.2 PANEL DEVICES:

A. General:

1. Provide DIN rail mounted devices where practical.
2. All devices mounted on the exterior of the panel shall match the NEMA rating of the panel.

B. Internal Component Labeling:

1. Provide a device label for devices mounted inside the panel that conforms to the criteria below:
   a. Instruments: Provide label with the instrument loop number as shown on the CONTRACT DRAWINGS. Place label below the instrument on the backplane.
   b. Supplementary Protector: Label each supplementary protector with CB and the number assigned in the supplementary protector schedule. Place label on the backplane.
   c. Fuses: Label each fuse with FU and the number assigned in the fuse schedule. Place a label on the backplane that includes the fuse number and the fuse size.
   d. Control Relays: Label each relay with CR and the number assigned in the panel drawings. Place label below the relay on the backplane.
   e. Terminal Strips: Label each terminal strip with the terminal strip type. (ex. TB1, TB2, ATB). Place label above the terminal block or at first terminal on the backplane.
   f. Door Mounted Devices: Provide a label on the interior of the front panel door for every panel device. The label should contain the same information as shown on the front panel nameplate. Place the label below the device.

g. Wireway Covers: Label wireways with the voltage that is being routed through it. For example; “24 VDC” for DC voltage or “120VAC” for AC voltage. Place label on wireway cover. Coordinate label size to fit on wireway cover.

h. Identify internal components with permanent adhesive plastic labels.

1) Product and Manufacturer:

a) Brady USA Inc.

b) Or approved equal

2) Provide device label size and fonts per Table 2.2.B.1:

Device	Label Size	Font Size	# Points	Brady Part #
(Wireways) 24VDC	1”x 4”	Arial	48 Points	PTL-42-422
(Wireways) 120VAC	1”x 4”	Arial	48 Points	PTL-42-422
Misc. Device Labels	1”x 1”	Arial	16 Points	PTL-19-423
Panel Door Devices	1” x 1.5”	Arial	8 Points	PTL-31-423

Table 2.2.B.1 Panel Interior Device Label

C. DIN Rail

1. General: DIN rail is the metal rail used to mount various electrical components in a panel

2. Mount all internal components on DIN Rail

3. DIN Rail for terminal blocks shall be raised DIN rail to match the height of the wireways.

4. Product and Manufacturer, Provide one of the following:

a. Phoenix Contact

b. Or approved equal

D. Control Circuit – Supplementary Protectors:

1. Provide single pole supplementary circuit protectors with the following features, 120 Volt AC, DIN rail mounted and UL 1077 listed with auxiliary contacts.

2. Provide end caps, marking strips, insulated side jumpers and other accessories.

3. Product and Manufacturer, Provide one of the following models where "xx" is the appropriate rating.
    a. Phoenix Contact, TMC 1-M1-xxA
    b. Allen-Bradley, 1492-SP1Bxxx
    c. Idec, NC1V-XXXXX-XXAA

E. Air Conditioner or Heater Supplementary Protectors:

1. Provide supplementary protectors with the following features, 120 Volt AC, DIN rail mounted and UL 489 listed with auxiliary contacts.
2. Product and Manufacturer, Provide one of the following:
    a. Allen-Bradley, Bulletin 1489
    b. Or approved equal

F. Control Relays:

1. Type: General purpose, plug-in type rated for continuous duty.
2. Construction Features:
    a. Coil Voltages: 120 VAC
    b. Contacts:
        1) Silver cadmium oxide rated not less than ten amperes resistive at 120 VAC or 28 VDC continuous.
        2) For switching low energy circuits (less than 200 ma) fine silver, gold flashed contacts rated not less than three amperes resistive at 120 VAC or 28 VDC continuous shall be provided.
        3) Number of contacts:
            a) Minimum: Two double pole/double throw contact sets
            b) Maximum: Four double pole/double throw contact sets.
    c. Relays shall have a clear plastic dust cover.
    d. Socket type to be blade.
    e. Remotes and Lift Stations shall have LED indicator; all other relays are not required to have LED indicators.

3. Product and Manufacturer: Provide one of the following:
    a. Square D Company, Type R and/or Type K.
    b. IDEC, Type RH and/or Type RY.
    c. Potter & Brumfield.
    d. Or approved equal.

G. Time Delay Relay:
1. Type: Dial adjustable, plug-in type time delay relay providing delay-on-make, delay-on-break one shots or interval operation.
2. Construction Features:
    a. MOS digital circuit with transformer coupled power.
    b. Switch selectable ranges
    c. Minimum Setting: Three percent of range; except 50 ms for one second range.
    d. Contacts:
        1) Type: DPDT.
        2) Rating: Seven amps resistive at 120 VAC, seven amps at 24 VDC.
    e. Housing:
        1) Plug-in design with dust and moisture resistant molded plastic case.
    f. Power Input: 120 VAC
3. Product and Manufacturer: Provide one of the following:
    a. Automatic Timing and Controls Company.
    b. IDEC.
    c. Or approved equal

H. Selector Switches, Pushbuttons and Indicating Lights:
1. General:
    a. Selector switches, pushbuttons and indicating lights shall be supplied by one manufacturer and be of the same series or model type.

b. Type: Heavy duty, oil tight

c. Mounting: Flush mounted on panel front, unless otherwise noted.

d. NEMA rated to match panel in which mounted.

2. Selector Switches:

a. Type: Provide selector switches with number of positions as required to perform intended functions as shown on the Drawings and specified.

b. Contacts:

1) Provide number and arrangement of contacts as required to perform intended functions specified, but not less than one single pole, double throw contact.

2) Type: Double break, silver contacts with movable contact blade providing scrubbing action.

3) Rating: Compatible with AC or DC current with devices simultaneously operated by the switch contacts, but not less than ten amperes resistive at 120 volts AC or DC continuous.

c. Switch Operator: Standard black knob.

3. Pushbuttons (Standard or Illuminated):

a. Momentary Type: Provide momentary, booted type pushbuttons as required to perform intended functions specified and shown on the Drawings. Boot color to be red for stop buttons and black for other functions.

b. Maintained Type: Provide maintained, push/pull, “Mushroom” type, red in color, to perform intended functions as specified, and as shown on the drawings.

1). Emergency Stop button shall be red and the base of the button shall be yellow.

c. Contacts: Comply with the requirements specified for selector switches.

4. Indicating Lights:

a. Type: Compact, integral non-transformer type.

b. Lamps: 120 VAC, long life (20,000 hours minimum).

c. Common, push-to-test circuitry shall be provided for each panel to simultaneously test all indicating lights on the panel using a single pushbutton.

d. Button and Lens Colors:

1) Red for indication of open, on, or running.

2) Green for indication of closed, off (ready), or stopped.

3) Amber for indication of equipment malfunction, process trouble or alarms.

4) White for indication of electrical control power on.

5. Rotary Cam Switches:

a. Provide rotary cam switches with number of positions and poles as required performing the signal switching function specified and shown on the Drawings.

b. Contacts:

1) Gold-flashed contacts housed in mechanical contact blocks with number and arrangement of contacts as required performing intended function.

2) Contact Rating: Compatible with AC or DC through-put current of signals and devices simultaneously operated by the switch contacts, but not less than 20 amperes at 600 VAC or 250 VDC continuous.

c. Switch Operator: Standard black knob.

6. Product and Manufacturer: Provide one of the following:

a. Square D.

b. General Electric.

c. Allen-Bradley Co.

d. Or approved equal

I. Potentiometer:

1. Type: Industrial potentiometer operator, direct acting, 3/4 to full turn; and standard 3-wire potentiometer.

2. Required Features:

a. NEMA rated to match panel in which mounted.

b. Resistance Range: 0 to 10,000 Ohms.

c. Resistance Element: Wire wound or conductive plastic.

d. Power Rating: Two watts.

e. Mounting: Flush mounted on panel front, unless otherwise noted.

f. Provide legend plate for indication of position (0 to 100 percent).

3. Product and Manufacturer: Provide one of the following:

a. Square D.

b. General Electric.

c. Allen-Bradley Co.

J. Power Supplies:

1. General

a. Panel power supply source, type, voltage, number of circuits and circuit ratings shall be as shown on the Contract Drawings.

b. Panels shall be provided with an internal 120 VAC with number of circuits and separate supplementary protectors sized as required to distribute power to the panel components.

2. Provide one of the Power Supplies based on the size and site location:

3. Power Supplies:

a. General:
1) Single unit and multiple unit power supplies, located in panels, as required.
2) Single Unit Required Features:
a) Solid state circuitry
b) Surface mounting
c) Input Power: 120 VAC, ± 10 percent, 60 Hz.
d) Output Power: 24 VDC or as required.
e) Line/Load Regulation: 0.05 percent.
f) Ripple: 0.25 mv RMS.
g) Overload Protection: Internal preset or fused.
3) Product and Manufacturer: Provide one of the following:

a) Acopian Corporation.
b) Power One.
c) Lambda
d) Puls

4) If redundant power supplies are required: Provide one of the following:
a) Lambda DPL-PU/E
b) Phoenix Contact Quint-Diode/40
c) Puls
d) Or approved Equal

4. For use on WSD Remote and Collection Facilities: Power Supplies/Switches

a. General:
1) Din Rail Mountable
2) Input Voltage 12VDC, 24VDC, 120 VAC
3) Setting Range of Output Voltage 5 VDC…15VDC, 24VDC
4) Products and Manufacturer: Provide the following by Phoenix Contact:
a) DC/DC Converters Mini-PS-12-24DC/5-15DC/2 - Part # 2320018 (only if needed).
b) Power Supply Unit – Quint-PS/1AC/24DC/5 – Part #2866750
c) Uninterruptible Power Supply – Quint-UPS/24DC/24DC/10 – Part # 2320225
d) Industrial Ethernet Switch – Cisco router with SEC bundle w/SEC license - CISCO ISR4321-SEC/K9

K. Wire:

1. General

a. Provide internal wiring of Type MTW stranded copper wire with thermo-plastic insulation with no nylon jacket rated for 600 V at 90°C for single conductors.

b. No utilization of Type THHN for panel wiring.

c. For DC panel signal wiring, use #16 AWG shielded minimum.

d. For AC power wiring, use #14 AWG minimum. For AC signal and control wiring, use #16 AWG minimum. For wiring carrying more than 15 amps, use sizes required by NEC and NFPA 79 Standards.

e. Identify wires at each end using heat shrink labels with permanent number codes using a Brady LS2000 Labeling System, or approved equal.

f. Panels conform to the wire color code as shown in Table 2.2.K.1.f Wire Color Code and NFPD 79 Standards.

2. Product and Manufacturer: Provide one of the following:

   a. Carol

   b. Belden

   c. Anixter

WIRE COLOR CODE TABLE (Inside Panels)			
TYPE	FUNCTION	INSULATION COLOR	WIRE SIZE
AC POWER - HOT	120VAC	**BLACK	#14
AC POWER - NEUTRAL	120VAC	WHITE	#14
AC GROUND	120VAC	GREEN	#14
AC CONTROL	120VAC	**RED	#16
ISOLATED DC GROUND	GROUND	GREEN W/YELLOW	#16
DC POWER	SOURCE	BLUE	#16
DC POWER	COMMON	WHITE /BLUE	#16
CONTROL	FOREIGN VOLTAGES	ORANGE	#16
LOW VOLTAGE AC	24 VAC SOURCE	BROWN	#16
LOW VOLTAGE AC	24 VAC COMMON	BROWN W/WHITE	#16
*AC POWER	480 VAC PHASE A	BROWN	Size to FLA
*AC POWER	480 VAC PHASE B	ORANGE	Size to FLA
*AC POWER	480 VAC PHASE C	YELLOW	Size to FLA
TEMPORARY	TEMPORARY	PURPLE	Size to FLA

Table 2.2.K.1.f Wire Color Code

*** - For Motor Control Panels (MCP's) that are permitted to contain 480 VAC**

**** - Black 120 VAC wires are hot unless powered down via supplementary circuit protector. Red 120 VAC wires are hot based on the control logic state.**

L. Single Shielded Pair Cable:

1. Tinned copper, nineteen strand, PVC insulated conductors, No. 16 AWG minimum, twisted with aluminum-polyester shield, stranded tinned 16 AWG copper drain wire and PVC black or gray outer jacket. Wire conductor colors shall be black (-neg) and red (+pos). 600 Volt Tray Cable (TC) rated.

2. Product and Manufacturer: Provide one of the following:

   a. Belden Company (No. 9342).

   b. Okonite Company.

   c. Dekoron Wire and Cable Company.

   d. Or approved equal.

M. Wire Terminations:

1. Terminate all field and internal component wiring using insulated ferruled connectors attached with manufacturer's recommended tool.

2. Excessive stripping of the wire so as to allow bare wire outside the insulated ferrule is not permitted.

3. Utilize insulated double ferruled connectors wherever two wires terminate on the same terminal block connection.

4. Product and Manufacturer: Provide one of the following:

   a. Phoenix Contact – Clipline

   b. Thomas & Betts

   c. Weidmuller

N. Terminal Blocks:

1. General

   a. Numerically code terminals utilizing terminal block manufacturer's marking system. Information must be printed directly on the terminal label. Sticky back labels are not permitted.

   b. Terminal blocks must be DIN rail mountable with screw clamp connections. Spring cage connections are not permitted.

   c. Double level terminal blocks are permitted for use with signals on ATB only.

d. Terminals used for analog signals on ATB shall be colored blue.

e. Terminal block jumpers must be connected via screw clamp. Screw clamped comb jumpers are permitted. Plug in jumpers are not permitted.

2. Product and Manufacturer: For each terminal strip type provide one of the following:

a. Power Terminal Block (PTB)

1) Phoenix Contact, Type UK 5 N, Color Gray, Model # 30 04 36 2

2) Allen Bradley, Type 1492-J4, Color Gray, Model # 1492-J4

3) Weidmuller, Type WSU 4, Color Dark Beige, Model # 1020100000

b. Field Wiring Discrete Signal Terminal Blocks (TB1 and TB2)

1) Phoenix Contact, Type UDK 3, Double Connection, Color Gray,

Model # 27 75 37 5

2) Weidmuller, Type WDU 4/ZZ, Double Connection, Double Level, Internal Connection, Color Dark Beige, Model # 1905060000

c. Field Wiring Analog or Internal Wiring DC Power (ATB) - Single Level Terminal Blocks:

1) Phoenix Contact, Type UK 3N BU, Color Blue, Model # 30 01 51 4

2) Allen Bradley, Type 1492-J3-B, Color Blue, Model # 1492-J3-B

3) Weidmuller, Type WDU 2.5 BL, Color Blue, Model # 1020080000

d. Field Wiring Analog or Internal Wiring DC Power (ATB) - Double Level Terminal Blocks. Alternating double and single level ATB terminal blocks are permitted.

1) Phoenix Contact, Type MBKKB 2,5 BU, Double Level, Color Blue, Model # 27 71 09 4

2) Allen Bradley, Type 1492-JD3-B, Double Level, Color Blue,

Model # 1492-JD3-B

3) Weidmuller, Type WDK 2.5 BL, Double Level, Color Blue,

Model # 1021580000

O. Surge Protection:

1. Provide DC surge protection with integrated varistor for all analog signal loops that are terminated to Programmable Logic Controllers provided in accordance with Specification Section 17262 – Programmable Logic Controller, Software and Programming.

2. Provide maintenance free, self-restoring surge protection to protect the electronic instrumentation system from surges propagating along the signal and power supply lines. Device shall be removable without interrupting the circuit

3. Provide a separate surge protector for the positive and a separate surge protector for the negative polarity of each loop.

4. Mount the surge protectors on the ATB.

5. Ground the surge protectors to the panel DC ground bus.

6. Label the surge protectors in sequential order starting with the ATB signals.

7. Required Features:

   a. Amp Rating: Compatible with working voltage and current of device being protected.

   b. Voltage Rating: Compatible with the working voltage of protected device.

   c. Reaction Time: nanosecond range

8. Product and Manufacturer: Provide one of the following:

   a. Phoenix Contact

   b. Advanced protection Technologies

   c. EDCO

   d. Or approved equal

P. Wireways:

1. General:

   a. Mount wireways using stainless steel bolts. Drill and tap the sub-panel to accommodate the bolts.

   b. Color to be Gray or White throughout the entire panel. Provide only one color.

c. All wireways to include cover.

d. Wireway covers to be labeled as per section 2.2.B

2. Product and Manufacturer: Provide one of the following:

a. Panduit

b. Thomas & Betts

c. Or approved equal

Q. Motor Starters and Overload Relays:

1. Refer to Specification Section 16423 – Motor Control Centers or 16422 – Combination Motor Starters

PART 3 - EXECUTION:

3.1 EXTERIOR PANEL:

A. Component Layout:

1. Arrange associated control and indication devices for a particular part of the process in close proximity to each other.

2. Mount indicating lights above control switches and push buttons.

3. Standard component spacing is 3 ½" center to center and 3 ½" above and below. It is acceptable to use more space if required, but spatial consistency must be maintained.

4. Maximum height for panel exterior-mounted devices is 6'-0" from the floor. Minimum height for panel exterior-mounted devices is 3'-0" from the floor.

5. Locate alarm horn at the top of the panel. The alarm horn may be located above 6'-0" device height limitation.

6. Unless otherwise noted; route field wiring through the bottom of the enclosure. Provide watertight conduit openings.

B. Exterior Panel Nameplates

1. General

a. Refer to Section 2.1.D for material and size requirements.

b. Provide specific panel identification on nameplates derived from the CONTRACT SPECIFICATIONS and DRAWINGS.

c. Obtain ENGINEER approval for panel identification for panels that are not identified in the CONTRACT SPECIFICATIONS and DRAWINGS.

2. Panel Manufacturer Identifier and Power Requirements Nameplate (NP-1)

   a. Mount nameplate in the upper left corner of the panel front.

   b. Provide the following information for each circuit feeding the panel.

      1) The first line indicates the name of the manufacturer, location and phone number of who assembled the panel.

      2) The following lines:

         a) Include panel voltage, current, phase, frequency, short circuit current rating for each panel feed.

         b) Provide switchboard name and circuit number for each circuit feeding the panel.

         c) Refer to figure 3.1.B.2

MITCHELL & SONS, TOLLESON, AZ - (602) 555-1212

120 VAC, 0.5 AMPS, 1Ø, 60HZ, SCCR 5KA, FED FROM LP-34, CIRCUIT 6

120 VAC, 7.5 AMPS, 1Ø, 60HZ, SCCR 8KA, FED FROM LP-34, CIRCUIT 8

Figure 3.1.B.2

Panel Manufacturer Identifier and Power Requirements Nameplate (NP-1)

3. Panel Identification Nameplate (NP-2)

   a. Mount panel identification nameplate in the top, center of the panel.

   b. Provide the following information:

      1) The first line of text is an abbreviation of the panel as shown on the CONTRACT DRAWINGS.

2) The second line of text on the nameplate is used to spell out the process abbreviation.

3) Refer to figure 3.1.B.3.

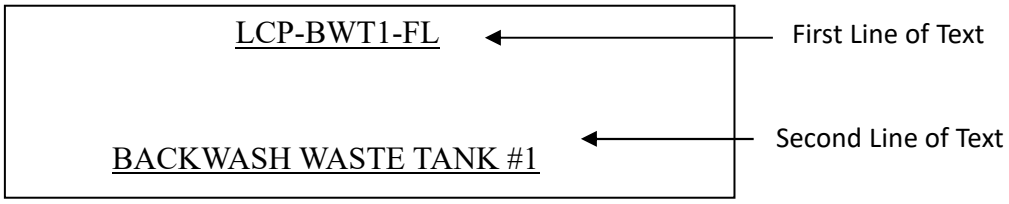

Figure 3.1.B.3

Panel Identification Nameplate (NP-2)

LCP: Stands For Type Of Panel: Local Control Panel

BWT1: Stands For Process Equipment: Backwash Waste Tank #1

FL: Stands For The Area Where The Equipment Is Located: Filter Line

4. Panel Component Nameplates

   a. Mount nameplates above all control and indicating devices.

   b. Provide the following information:

      1) The first line indicates the instrument device loop identifier and number as shown on the DRAWINGS.

      2) The second line identifies the system equipment that the component is associated with.

      3) The third line identifies the control position, condition of the equipment or the alarm state being monitored.

      4) Refer to figure 3.1.B.4

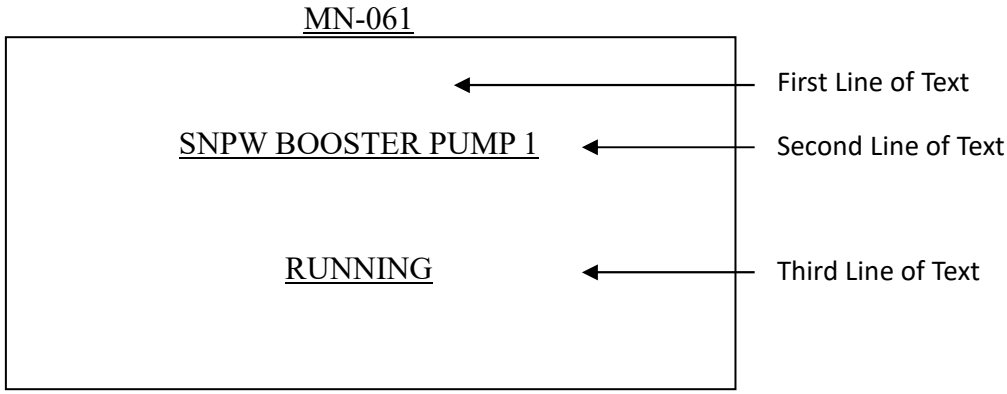

Figure 3.1.B.4

Panel Component Nameplates

3.2 INTERIOR PANEL

A. General:

1. All Wall Mounted Panels - Where conduit enters the panel, maintain a minimum of 4" clearance from any device or wireway to allow room for routing of field wiring.

2. Concrete Pad or Floor Mounted LCP's and MCP's – Where conduits enter the panel through the concrete pad, maintain a minimum of 6" clearance from any device or wireway to allow room for routing of field wiring. Where conduit enters the panel sides or top, maintain a minimum of 4" clearance from any device or wireway to allow room for routing of field wiring.

3. Elevated Floor Mounted LCP's and MCP's - Where conduit enters the panel, maintain a minimum of 4" clearance from any device or wireway to allow room for routing of field wiring.

4. Concrete Pad, Floor Mounted or Elevated Floor Mounted ITP's - Where conduits enter the panel through the top or bottom, maintain a minimum of 6" clearance from any device or wireway to allow room for routing of field wiring.

5. Locate and install all devices and components so that connections can be easily made and that there is ample room for servicing each item.

6. Maintain a minimum 2'0" clearance between components mounted on side panels and components mounted on the opposing side panel.

7. Components mounted on the back panel are to be unobstructed by any components mounted on side panels.

8. Adequately support and restrain all devices and components mounted on or within the panel to prevent any movement.

B. Panel Incoming Power:

1. Panel power fed from lighting panels, or other sources with fused or circuit breaker protection, shall be wired to the Power Terminal Blocks (PTBs). Power sources entering the panel are to be provided with a separate neutral and ground. The PTBs shall have a separate terminal for the hot and neutral for each circuit. The ground to be terminated to the AC ground bar.

2. Mount the PTBs near the top left corner of the panel.

3. Multiple power sources may be required for each panel. Power requirements are identified on the CONTRACT DRAWINGS. The following additional power sources may be required for the panel.

   a. Control Logic Power and Light Fixture

   b. Air Conditioning

4. Arrange the terminal strip in an orderly manner with circuit conductors grouped together. For instance, terminate the hot and neutral conductors on consecutive terminals. Label terminals and internal wiring as H1 and N1 (Control Logic), H2 and N2 (Air Conditioning). Identify each additional source in sequential order beginning with H3 and N3.

5. Terminate all incoming power on one side of the terminal strip.

C. AC Power Distribution:

1. Identify the wire extending from the PTB to the supplementary protector as H1 and H2, etc. Using H1 as an example; the wire terminated to the line side of the supplementary protector is labeled H1, the wire terminated to the load side of the supplementary protector is labeled as L1-1.

2. If L1-1 passes through an additional supplementary protector to feed panel components, this supplementary protector can be shown on the drawings in a horizontal or vertical position on a schematic rung and the wire terminated to the line side of the supplementary protector is labeled L1-1. The wire terminated to

the load side of the supplementary protector is labeled L1 – (the Supplementary Protector #) and the wire color is black.

3. If the panel controls multiple pieces of equipment, such as two pumps with separate control circuits, provide a supplementary protector for each control circuit.

4. Powering 120 VAC field 4-wire instruments from the panel is not permitted.

D. DC Power Distribution:

1. Mount DC power supplies near the top right of the panel. Mount fuses associated with the power supply in close proximity to the power supplies.

2. Identify terminals used for DC power distribution as PTB-DC.

3. Provide a fuse for each analog loop that loop power is provided by a power supply located in the panel.

E. Grounding:

1. AC Ground:

a. Provide the AC ground bus bar with cage type or screw terminals installed near the bottom of the back panel with extended mounting bolts.

b. Provide adequate metal to metal contact between the AC ground bus bar and the back plane.

c. Connect all AC power sources and devices to ground at this ground bus.

d. Connect all panel enclosure doors to the AC ground bus.

e. Connect all side panels to the AC ground bus.

f. Provide a connection point on the ground bus for connection to the ground grid system. Coordinate connection from the ac ground bus to the earth ground system. Provide wire type and size on the contract drawings.

2. DC Ground:

a. Install the isolated DC grounding bus bar with cage type or screw terminals installed near the bottom of the back panel at a minimum distance of 6” from the AC ground bus.

b. The isolated grounding bus bar consists of two non-conductive mounting blocks with a single copper grounding bar attached between them.

c. Connect all shields (SH) requiring loop grounding in the panel from the analog signal terminals to the DC grounding bus bar.

d. To avoid ground loops, connect analog cable signal shields to ground at one location only, preferably in the LCP, MCP or ITP; not in the field. Maintain consistency for the termination point of signal shield for all analog signals.

e. Provide a connection point on the ground bus for connection to the ground grid system. Coordinate connection from the dc ground bus to the earth ground system. Provide wire type and size on the contract drawings.

f. Figure 3.2 illustrates a typical ground system within a panel. The illustration depicts the physical terminations of the ground wires in the panel**.** Ground Conductor AWG size to ground grid system shall be as stated in Specification 16061 – Grounding Systems.

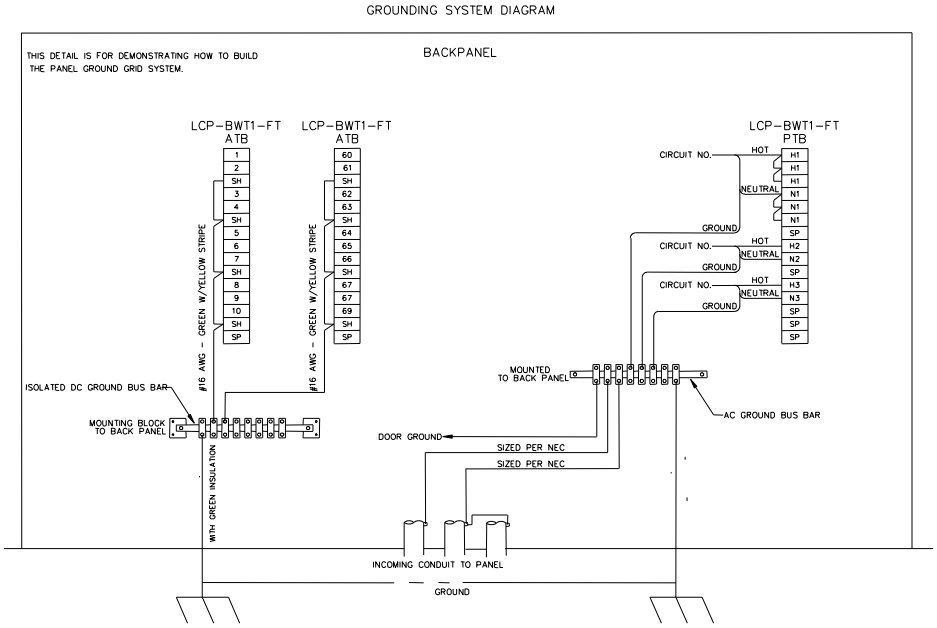

Figure 3.2

Typical Grounding Systems

F. Circuit Protection:

1. Provide an isolating supplementary protector for each group of control logic. For example: the start, stop and reset control circuit for Pump #1 has a dedicated

supplementary protector supplying power to the control logic. Pump #2 requires a separate isolating supplementary protector for the control logic.

2. Provide an isolating supplementary protector for each component requiring 120 VAC power.

3. A supplementary protector is not required for control circuits powered from a fused control power transformer in an MCP.

4. Size supplementary protector to handle the connected load.

5. Mount supplementary protector next to the PTBs near the top left corner of the panel.

6. Provide an auxiliary contact for each supplementary protector. Wire each auxiliary contact from the supplementary protector in series to one "Power fail' relay. Send one Power Fail status to the Computer Control System.

G. Internal Panel Wiring:

1. Route all internal wiring using wireways. Terminate all internal wires on one side of the terminal blocks. The opposite side of the terminal block shall remain available for field wires.

2. Where wires pass through panel walls, provide suitable bushings to prevent cutting or abrading of insulation.

3. Adequately support and restrain all wiring runs to prevent sagging or other movement. Wires extended from the control logic to the panel door devices are to be wrapped in plastic protective wire wrap designed for this purpose.

4. Wire splicing is not allowed at any time.

5. Utilize two wires (hot and return leg) with field wiring for each field input. It is not acceptable to utilize one common Hot for multiple field inputs.

6. Terminate wires with an insulated ferrule type crimp connector. Excessive stripping of the insulation to allow bare wire strands between the insulation and the ferrule is not permitted.

7. Orientate wire labels on the individual conductor or cable so that wire labels are legible without having to twist or move the connectors. Securely heat shrink the labels around the conductor. Label wires or cables with the number assigned in the panel documentation. Refer to Section 2.2.K.1.e for wire label materials.

8. DC wiring for analog and discrete field or Computer Control System signals that enter or leave the panel are to be terminated on the Analog Terminal Block (ATB).

9. AC wiring for discrete field signals that enter or leave the panel are to be terminated on the Terminal Block 1 (TB1).

10. AC wiring for discrete Computer Control System signals that enter or leave the panel are to be terminated on Terminal Block 2 (TB2).

11. The terminal blocks (TB1, TB2 or ATB) can be mounted on the left or right side panels.

12. Provide a minimum of 10% spare terminal DIN rail space per terminal strip.

13. Signals from the field that enter the panel and only pass through the panel from the field to the Computer Control System require internal wiring from TB1 to TB2.

14. Arrange all control wiring associated with a particular piece of process equipment together on adjacent terminal blocks.

15. Identify wire number by the schematic rung numbers. Label TB1 and TB2 terminals with the rung number associated with the internal wire number connected to the terminal. Label ATB terminals in sequential order starting with the number 1. Identify analog shield terminations with an "SH" on the terminal block.

16. Multi-conductor cables of two pair or more shall have the outer cable insulation removed before entering the wireway.

17. Route all DC power and analog signals at a minimum of six inches from AC power and controls. When the six inch minimum distance is not available, provide a metallic barrier that extends 3" beyond the tallest wireway between the analog and discrete wireways.

H. Wireways:

1. Mount wireways from the internal panel components and terminal blocks with a minimum 2" spacing.

2. Arrange wireways to maintain a six inch minimum distance between analog and discrete circuit wiring.

3. Provide wireways for all field wiring. Arrange wireways to allow field wiring to enter from the top or bottom of the panel.
4. Align wireways between back and side panels.
5. Install a wireway on both sides of each terminal strip.
6. Size wireways to prevent conductor fill from exceeding 50% of the interior cross-sectional area of the wireway.
7. In addition to the above requirements, for ITP's, wireways are not to be common for two terminal strips. Each terminal strip shall have a dedicated wireway on each side of the strip.

I. Control Logic:

1. The Start commands are to be designed utilizing normally open contacts from pushbuttons and/or the Computer Control System and shall be of a momentary signal that will require a seal circuit to maintain operation. Constant signals from positions switches are not allowed unless noted on the CONTRACT DRAWINGS.
2. All system failure, safety logic control devices or normal operations that are intended to cause the equipment to stop are to be wired in series with the start seal circuit. The unsealing of the start command on any fault or normal operation that causes the equipment to stop will require another start command to reseal.
3. Provide interlocks for the control functions of Local and Computer Modes in series with the Start and Stop logic. Provide a closed switch or relay contact to the Computer Control System to identify when the equipment is in Computer Mode.
4. Provide control logic of voltage 120 VAC. Exceptions must be approved by OWNER
5. Use power relays when control relay contacts are insufficient for the designated load.
6. Terminate the "Hot" conductor on the common of the switch or relay contact.
7. Control alarm logic shall be wired in a fail-safe mode from the field device to the panel circuitry to alarm when a field wire has failed.

3.3 PANEL DRAWING DOCUMENTATION

A. General:

1. Files of the title block, panel symbols for front and internal sub-panel elevations, terminal strips, control schematics, analog loops, etc. are available in hard copy and AutoCAD .dwg format from the OWNER upon request through the ENGINEER via Example Panel Drawing Packages and Drawing Templates.

2. Provide drawing copies in the following format:

   a. Hard Copy - B Size - 11” X 17”

   b. Hard Copy - D Size - 22” X 34”

   c. Soft Copy in .DWG

3. The panel drawing documentation package consists of the following drawings types arranged in the following order.

   a. Cover Sheet

   b. Symbols and Legends 1 – Exterior and Interior Panel Symbols

   c. Symbols and Legends 2 – Schematic Symbols

   d. Front Panel Elevation

   e. Interior/Sub Panel Layout

   f. Terminal Strip Drawings

   g. Control Schematics

   h. Analog Loop Diagrams

4. Drawing Scale:

   a. Provide Front Elevation and Interior/Sub Panel Layout Drawings proportionately correct and to scale. Create all drawings on a D Size layout.

5. Border and Title Block:

   a. Provide each drawing with a border and title block information.

   b. Utilize the border and title block as provided in the Drawing Templates referenced in Section 3.3.A.1.

B. Panel Drawing Types:

1. General:

a. Provide a complete documentation package for each panel consisting of the drawings in the order listed in Section 3.3.A.3.

2. Cover:

a. Cover sheet for the panel documentation shall include the following information.

1) Located on the left half of the sheet to include the Manufacturers Name, Address, Phone Number, Web Address, Project Reference Number and UL508A Certification Number.

2) Located on the right half of the sheet include the title “City of Phoenix” “Water Service Department” and the project title, City of Phoenix project number, the panel full title, the panel abbreviation, the facility area in which the panel exists, submittal date, volume number and sheet count.

3. Symbols & Legends

a. Utilize the Symbols and Legend sheets as provided by the OWNER upon request from the ENGINEER.

b. Additional symbols may be added if an existing symbol on the Symbol and Legend sheets does not exist.

4. Front Elevation Drawing

a. The Front Elevation drawing illustrates the arrangement of the panel and position of the devices on the front face of the panel.

b. Provide panel dimensions in inches. Provide dimensions for height, width, and depth. If the panel is small in size, the Front Elevation Drawing and Internal layout Drawing can be combined on one drawing.

c. Provide the nameplate schedule on the Front Elevation drawing.

d. Device Callouts

1) Device callout hexagons are utilized to reference a device to the bill of materials. Place the bill of material item number inside the hexagon.

2) Provide a leader from the hexagon that will point to the device.

3) For a typical of multiple devices of the same type, only one device callout is necessary.

5. Interior Sub Panel Layout:

a. General:

1) The Interior Sub Panel Layout drawing identifies the individual interior components and their physical location.

2) Draw all components within the panel to scale.

3) Include all interior sub panels if the panel has sub panels on the side walls.

b. Provide the following information on the Interior Sub Panel Layout Drawing. Utilize the formats provided on the Drawing Templates. The information can be shown on a second sheet if needed due to drawing clutter.

1) Bill of Materials

a) Include all devices on the Front Panel Elevation and the Interior Sub Panel(s) Elevation.

b) Include items that are not specifically shown on the Front Panel Elevation or the Interior Sub Panel Layout drawing, such as wire size, color and type, on the bill of materials.

c) The utilization or insertion of Microsoft Excel files for the Bill of Materials is not allowed.

2) Fuse Schedule

3) Supplementary Protector Schedule

c. Label and identify all devices, including terminal strips, relays, fuses, timers, power supplies and other special components on the drawing.

d. For unique devices not shown on the Symbols and Legend Sheets, use rectangles and squares with the appropriate dimensions of the device.

e. Device Callouts

1) Device callout hexagons are utilized to reference a device to the bill of materials. Place the bill of material item number inside the hexagon.

2) Provide a leader from the hexagon that will point to the device.

3) For a typical of multiple devices of the same type, only one device callout is necessary indicated by (typ) near callout hexagon.

6. Terminal Strip Drawing:

a. General:

1) Terminal Strip Drawings provides locations for wiring terminations from field devices and other equipment external to the panel.

2) Display the wiring connections exactly as they are physically installed. For example, if field wiring is terminated to the left side of the terminal strip, the terminal strip drawing displays the wiring connections to the left side of the terminal block.

3) There are 6 different types of terminal strips and each has a specific function. The following is a brief description of each:

a) For LCP's and MCP's:

i. Power Terminal Block (PTB) – Power supply/supplies to the panel (120 VAC or higher). Identify terminal block number with the wire number assigned in the control logic drawings. Identify power sources with the originating panel, voltage and circuit number.

ii. Field Wiring Discrete Signal Terminal Blocks (TB1) – Discrete field inputs and outputs to/from the panel. Identify terminal block number with the rung number assigned in the control logic drawings.

iii. Field Wiring Discrete Signal Terminal Blocks (TB2) – Discrete inputs and outputs to/from the Computer Control System. Identify terminal block number with the rung number assigned in the control logic drawings.

iv. Field Wiring Analog (ATB) or Internal Wiring DC Power Terminal Blocks - Field or Computer Control System Analog inputs and outputs to/from the panel, including 4-20 mA, 1-5 VDC, thermocouple or Resistance Temperature Detectors (RTD's). Identify terminal block number with consecutive numbers starting with number 1. The shield wire terminal block is to be label "SH".

b) For ITP's:

i. TB-A thru Z – Discrete field inputs and outputs to/from the panel.

ii. ATB-A thru Z – Analog inputs and outputs to/from the panel.

4) It is acceptable, if space available, to combine TB1, TB2, ATB and PTB on a single terminal strip drawing.

5) Identify spare terminals with an "SP" inside the rectangle.

6) Display terminals in the order they appear in the panel.

7) Place field wire labels on each line extending toward the terminal. Obtain this information from the cable and conduit schedules. If wire labels are unavailable, place seven "X's" where wire tag normally resides. Provide this information prior to final deliverable of the Operations & Maintenance Manuals.

8) Signal description consists of 3 lines of text. Center the text next to the terminals.

a) The 1st line of text lists the Equipment Name.

b) The 2nd line of text is for the Signal Function.

c) The 3rd line of text is the Signal Loop Number, if applicable.

7. Control Schematic:

a. General:

1) Control Schematics show the controls associated with pieces of process equipment and provide a visual depiction of the majority of control wiring.

b. Control Schematic Components:

1) Power Rail:

a) Represent the power rail with two parallel vertical lines that extend vertically down the schematic.

b) Each drawing includes two sets of power rails separated by 2.5".

c) Identify each power rail with the wire number such as L1 at the top and bottom of each power rail.

d) The left power rail represents the "Hot" side of the power source. The right power rail represents the "Neutral" side of the power source.

2) Power Source:

a) Identify power source(s) with the originating panel, voltage and circuit number between the "Hot" terminal and "Neutral" terminal on the first rung of the portion of the schematic for each source.

b) Indicate the terminals from the PTB providing the source and neutral powering the rail.

c) A supplementary protector or fuse is displayed in the power rail directly below the power source (Hot) terminal. Label the supplementary protector or fuse with the supplementary protector or fuse number and current rating.

d) Power layout for LCP's:

i. In the first portion of the schematic, display power to the general purpose receptacle and panel light.

ii. In the second portion of the schematic, display power to the air conditioner and/or heater.

iii. In the third portion of the schematic, display the power to the control logic.

iv. See Sections 3.2.B Panel Incoming Power and 3.2.C AC Power Distribution.

e) Power layout for MCP's:

i. The first portion is for the typical 480 VAC motor control circuit with starter and disconnect, the next sections are the same as for the LCP's.

3) Rung Number:

a) Rung numbers are used to identify the location and cross referencing of devices within the schematic and provide a practical means of labeling conductors and terminals within the panel.

b) Rung numbers are a sequential series of numbers starting with number 1. Locate the numbers vertically along the left side of the "Hot" power rail.

c) Rungs are to be spaced on 0.5" centers based on a D Sized drawing.

4) Wire Numbering:

a) On the downstream side of the first device on a rung, the wire number takes the rung number appearing to the left of the power rail. If a second device is located in the circuit, the wire number to the right of the second device takes the rung number, but is appended with an "A". The wire number to the right of the third device is appended with a "B", and so on.

b) When the electrical connection originated on the previous rung, the wire numbers continue to use the previous rung number as the base.

c) Connections to the power neutral rail take on the power neutral rail's wire number N#.

5) Electrical Connections:

a) Represent electrical connections as a solid small circle where two or more wires interconnect.

b) Represent electrical connections as a hollow small circle where wires terminate to a device.

6) Electrical Wiring:

a) Electrical wires or circuits are represented by horizontal rungs that connect terminal blocks, relays, contacts and all other components used in the electrical schematic.

b) Space the schematic electrical wiring every other rung at a minimum.

c) Identify each wire with the rung number as the wire number.

d) Label each wire with the conductor insulation color below each electrical wire. Refer to Table 2.2.K.1.f.

e) Indicate electrical wiring that is external to the panel with dashed lines.

7) Device Labeling:

a) Device symbols in the schematic for field devices, pilot lights, switches, push buttons etc. requires two lines of text above the device and one line of text below the device to describe the usage of the device.

   i. The first line of text above the device is the name of the equipment the device is associated with.

   ii. The second line of text above the device is the control function of the device.

   iii. The line of text under the device is the loop number.

b) Relay and timer symbol labels are to be identified with consecutive number starting with the number 1 or the rung number. For relay coils and contacts, identify the relay base terminal connection. Normally open or normally closed contacts refer to the de-energized or "off the shelf" state.

c) Symbols in the schematic for contacts of relays, timers, etc. require two lines of text above the contact and two lines of text below the contact to describe the usage and coil reference of the contact.

   i. The first line of text above the contact is the name of the equipment the device is associated with.

   ii. The second line of text above the device is the control function of the device.

   iii. The first line of text under the device is the relay or timer number to reference the relay or timer in the schematic.

   iv. The second line of text under the device is the rung number of the relay or timer to reference where the relay or timer is located in the schematic. If using the rung number for the relay or timer coil, the rung number under the contact is not required.

   v. For relays and timer contact references, at the right of the neutral power rail, the schematic rung number location of all associated contacts is shown. If the contact is normally closed, underline the reference number. If a contact is unused, "SP" is shown.

8) Field Contacts:

a) Show Field Contacts connected to their respective TB1 or TB2 Terminals.

b) The connection lines from the contact to the terminal are dashed to designate they originate from outside the panel.

9) Selector Switches:

a) Always show the switch in the far-left position, the switch contacts are shown as either opened or closed in this state. If they're in the closed state, the contact is shown closed, indicated by a line shown below and touching the two side small circles. If the contact is open in this position, a line is drawn above the two side small circles, but not touching them.

b) Show each position of the switch directly above its respective location on the switch. This indicates whether it is a two, three, four, or more position (pole) switch, and shows what the nameplate on each position will read.

c) To indicate which positions the contact is closed, show a contact legend in parenthesis below and to the right of the contact. If the contact is closed in a position, an "X" is shown in the order of the contact position in which it is closed. If the contact is open in a position, an "O" is shown.

d) When a selector switch is continued onto another sheet or further down on the same sheet, the continuation note is shown below the selector switch. Where the switch is continued, the same note appears, but on the top of the contact.

10) Push Buttons:

a) Represent the push button contact in its "off the shelf" state.

11) Terminals:

a) Terminal numbers are dependent upon the specific rung number that they appear in the schematic logic. As a horizontal electrical connection is followed from left to right, the first terminal number takes on the number of the rung. The second terminal number also takes the rung number but is appended by the letter A, the third by the letter B, and so on.

12) Programmable Logic Controller:

a) Panels that contain a Programmable Logic Controller (PLC) require connection information for the PLC I/O modules.

i. Utilize the PLC drawings as provided in the Drawing Templates referenced in Section 3.3.A.1.a.

b) Module Layout:

i. Represent the module with a 1 1/2" wide vertical rectangle with a length suitable to encompass a maximum of 16 channels or 8 analog per section based on type of module. Two cards can be shown per sheet.

ii. Display field wiring (inputs) including TB1 and field device connections with a description on the left side of the module symbol.

iii. Label the module with model number, input voltage, rack number and slot number above the module symbol.

iv. Number each screw terminal per manufacturer's data.

v. Display the associated PLC register address with each signal.

vi. Identify the positive and negative legs of the analog cable.

vii. Include all required jumpers for signal type and all 120VAC and 24VDC power requirements.

13) 480 Volt Equipment:

a) Provide the motor horsepower, full load amps and motor identification.

14) Contact Development:

a) The last sheet of the control schematic displays contacts for internal panel relay contacts that connect with external field equipment or the Computer Control System (CCS).

b) Organizes into two sections. The first section lists all contacts extending to the CCS. Title this section "Contacts to CCS". The second section lists all contacts extending into the field equipment

external to the panel. Title this section "Contacts to Field". Group multiple contacts related to a single piece of equipment together.

c) Each contact includes a signal description and its associated relay number and relay rung number location. Device signals require the appropriate symbol from the Schematic Legend Sheet.

8. Analog Loop Diagrams:

a. General:

1) The analog loop diagram only displays the portion of the instrument loop that passes through a particular panel.

2) The analog loop diagram displays the connections between field instruments, panels and the CCS.

3) Analog loop diagrams are reserved for analog signals and control loops, but may be used to show complex connections for a particular instrument or device.

4) Divide each loop into three different segments.

a) The left segment is "FIELD" connections. This segment provides information on terminations external to the panel (i.e., connected panels, instrument transmitters). If the first segment is another panel, the panel name replaces the "FIELD" label.

b) The center segment is the internal panel wiring and controls.

c) The right segment information represents output or input signals to downstream panels or the CCS.

5) Identify shield grounding location.

6) Identify surge protection devices for each signal. Include surge protection for positive and negative leads. Utilize the surge protection block symbol from the legends and symbols sheet.

7) Identify the cable number, wire color and polarity for each cable in the loop.

3.4 INSTALLATION

A. Install equipment in conformance with NEC. Mounting panels on handrails is not allowed. Mounting panels below grade or in pits will require exception from the OWNER.

B. Unless otherwise noted, install indoor free-standing panels on 4-inch concrete pad. Extend pad 4-inches beyond outside dimensions of base, all sides. Lay grout after panel sills have been securely fastened down.

C. Unless otherwise noted, install outdoor free-standing panels on a reinforced concrete pedestal:

1. Minimum Thickness: 8-inches with No. 4 steel reinforcing bars at 12-inches on centers, each way.
2. Minimum Size: 4-inches larger than outer dimensions of base, all sides.
3. Provide excavation and backfill work in conformance with Section 02315, Structural Excavation and Backfill.
4. Provide concrete work in conformance with Section 03300, Cast-In-Place Concrete.
5. Seal the contact surface between the panel base and concrete surface with a gasket, gasket sealant and along the outside perimeter of the panel using RTV sealant.
6. Install anchor bolts and anchor in accordance with Section 05051, Anchor Bolts, Toggle Bolts and Concrete Inserts.

D. Elevated Panels with floor stands:

1. When installing conduits through bottom, utilize bushings to retain the NEMA rating of the panel.

E. Install each item in accordance with manufacturer’s recommendations and in accordance with the Contract Documents.

3.5 RECORD DRAWINGS:

A. Maintain a set of red-line panel drawings to reflect changes or deviations that occur during installation, start-up and commissioning and incorporate these deviations into the final Operation & Maintenance Manual.

B. Provide record drawings in accordance with Section 01782 – Record Documents

3.6 SPARE PARTS AND TEST EQUIPMENT

A. Furnish and deliver the spare parts and test equipment as outlined below, identical and interchangeable with similar parts furnished under this Specification. Comply with the requirements of Section 01783, Spare Parts and Maintenance Materials.

B. Pack spare parts in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

C. The following constitutes the minimum spare parts:

1. Five of each type of control relay for each 40 or less furnished for this Contract.
2. One replacement power supply for each type and size furnished for this Contract.
3. One per ten (two, if fewer than twenty) of each type of panel mounted instrument including lights and pushbuttons.
4. One dozen of each type and size of fuse used in panels and instruments.

D. The following constitutes the minimum test and calibration equipment:

1. All tooling required to insert, extract and connect any internal or external connector, including edge connectors. Identify specialized tooling and calibration equipment required.
2. All special calibration equipment required for system calibration.

3.7 TESTING AND ADJUSTMENTS:

A. Perform system testing and make any adjustments necessary in accordance with this Section and Section 17001, Process Control System General Requirements.

B. Perform power supply, voltage adjustments to tolerances required by the appurtenant equipment.

C. A Factory Acceptance Test shall be conducted before the panel is shipped to the site. The Factory Acceptance test shall be witnessed by the ENGINEER and OWNER. The Factory Acceptance Test Report listed in Specification Section 01331 – Reference Forms – Form 17260-A shall be utilized to document the test.

1. The following is a list of panels that require the Factory Acceptance Test to be witnessed by ENGINEER and OWNER:

   a. LCP-BIO-LS76

   b. LCP-OXD-LS76 (Provided by Bioxide Manufacturer)

2. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to perform factory testing, before shipment, at the manufacturer's facility to verify that system components are functioning properly and that they meet the functional and performance requirements of the Contract Documents.

3. Submit information on factory testing procedures to verify that testing shall fulfill the requirements as specified herein. Submittal shall be made at least two months in advance of any scheduled testing and shall include dates of scheduled tests.

4. Notify ENGINEER, in writing, at least four weeks before expected initiation of tests. OWNER and ENGINEER may elect to be present at CONTRACTOR'S facilities during operational test of system equipment, either for individual units or as an integrated system. Presence of OWNER and ENGINEER during testing does not relieve CONTRACTOR from conforming to the requirements of the Contract Documents and shall in no way imply acceptance of the equipment.

D. System Hardware Operational Testing

1. All input/output devices and components shall be tested to verify operability and basic calibration.
2. All system hardware components equipment shall be tested to verify proper operation of the equipment as stand-alone units. Test shall include, but not be limited to, the following:
    a. AC/DC power checks.
    b. Power fail/restart tests.
    c. Diagnostics checks.
    d. Test demonstrating that all specified equipment functional capabilities are working properly.
    e. All system components shall be tested to verify that communication between units is working properly.

3.8 MANUFACTURER'S SERVICE

A. Provide the services of qualified factory-trained service representative to check and approve the installation of the panel(s).

B. The factory trained service representative shall be provided for installation supervision, start-up and testing services. The representative shall make a minimum of (2) visits to the site to approve the completed installation and to perform start-up testing of the equipment. The representative shall coordinate each visit with the ENGINEER prior to arrival on the site. The representative shall test operate the system in the presence of the ENGINEER and verify that the equipment conforms to requirements. The representative shall revisit the job site as often as necessary until the installation and testing is entirely satisfactory.

C. The factory trained service representative shall be provided for operation and maintenance personnel training services. The representative shall make a minimum of (2) visits to the site to perform the services as described under Section 01821, Instruction of Operations and Maintenance Personnel. The representative shall coordinate each visit with the ENGINEER prior to arrival on the site.

D. For the factory trained service representative, all costs, including travel, lodging, meals and incidentals, shall be considered as included in the bid price.

E. Warranty: Minimum 1 year from final startup date or as specified in N.T.S. or in the contract specifications, whichever is longer.

++ END OF SECTION ++