

**Navajo Nation  
Western Navajo Pipeline Phase 1  
Boday-Gap Well, Tank and Pipeline**

**PROJECT MANUAL**

**CONTRACT NO. 2: WELL HOUSE, STORAGE TANK, ALTITUDE  
VALVE, AND PIPELINES**

**VOLUME 2 OF 2**

**DIVISION 1 THRU 17 – TECHNICAL SPECIFICATIONS**

**BID ISSUE**

**NAVAJO NATION**

October 2021

Brown and Caldwell  
6975 Union Park Center, Suite 490  
Midvale, UT 84047



Cover  
00010



PROJECT MANUAL  
FOR CONSTRUCTION OF

Navajo Nation  
*WESTERN NAVAJO PIPELINE PHASE 1  
BODAWAY-GAP WELL, TANK AND PIPELINE*

*CONTRACT NO. 2: WELL HOUSE, STORAGE TANK, ALTITUDE VALVE, AND PIPELINES*

Volume 2 of 2  
Division 1 thru 17– Technical Specifications

Navajo Nation

Prepared by:

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Project No. 150360



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Navajo Nation  
WESTERN NAVAJO PIPELINE PHASE 1

BC PROJECT NO.: 150360

BODAWAY-GAP WELL, STORAGE TANK AND PIPELINE

DIVISION 1

GENERAL REQUIREMENTS

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## SECTION 01010

### SUMMARY OF WORK

#### 1.0 GENERAL

The work covered under this contract will be performed at multiple sites of the Bodaway-Gap Community Water Systems operated by the Navajo Tribal Utility Authority.

#### 2.0 DESCRIPTION OF OWNER'S PROJECT

The overall project will provide additional water supply to the Bodaway-Gap Water System by adding a new supply well and storage tank north of Bodaway-Gap. The well and storage tank will be connected to the Bodaway-Gap Water System with a 10-inch pipeline.

#### 3.0 WORK OF THIS CONTRACT

The work to be performed under this contract (Contract No. 2) includes:

- Construction of a Well House No. 3 for a new water supply well with an anticipated capacity of 160 gpm. Well house includes site work, fencing, precast pump house, yard piping, well house piping, gas chlorination system, electrical and telemetry components to operate the new well.
- Construction of approximately 42,184 feet of 10-inch PVC pipeline and a 6-inch altitude/rate of flow control valve station.
- Construction of an 80,000-gallon potable water welded steel storage Tank No. 2. Storage tank includes site work, fencing, yard piping, tank foundation, discharge piping and outlet, and telemetry components to operate the tank.

#### 4.0 WORK OF OTHER CONTRACTS

- Contract No. 1 – Bodaway - Gap Well 3: Construction of the new drinking water supply well (approximately 1,000 ft deep, 160 gpm) at the well site.

#### 5.0 CLARIFICATIONS REGARDING THE WORK

- The Contractor is advised that the Work includes everything in the Project Manual and on the Drawings and is further advised to clarify any questions regarding references to other contracts that may have been missed during repackaging.

**\*\*END OF SECTION\*\***

Summary of Work  
01010-1

Bodaway-Gap Contract 2  
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## SECTION 01014

### WORK SEQUENCE

#### PART 1--GENERAL

##### 1.01 CONTINUITY OF SYSTEM OPERATIONS

###### A. GENERAL:

The existing Bodaway-Gap water system is currently and continuously providing potable water, and that function shall not be interrupted except as specified herein. The Contractor shall coordinate the work to avoid any interference with normal operation of water production, disinfection, and storage processes.

##### 1.02 SEQUENCE AND SCHEDULE OF CONSTRUCTION

###### A. General:

1. To permit continuous production and disinfection of water and compliance with water quality requirements, the construction schedule shall provide for the following specific conditions:
  - a. Installation and modification of various control systems within this project will not impact system and not require temporary partial shutdown of these systems. Works shall be planned and scheduled in advance to minimize downtime.
2. To facilitate the required temporary modifications to allow production and treatment operations to continue during construction of the work of this project, the Contractor shall coordinate with the Owner and Engineer

B. To permit potable water system operation and disinfection, the construction schedule required in in the General Conditions or Section 01310 of the Contract Documents shall provide for the following specific conditions.

###### C. Existing Bodaway-Gap System.

1. Potable water is produced by the existing Well 1 and Well 2, and delivered to the Gap Tank No. 1.
2. Well 1 and 2 are chlorinated at Well 2 pumphouse.
3. The Gap Tank's No. 1 existing Telemetry PLC provides tank level

information for start/stop and chlorinator control to Well 1 and Well 2.

4. The existing system shall maintain operation with at least one well to provide additional water until the new water system is ready for service.
5. The Contractor shall propose and submit all required well, tank, piping, telemetry, or other process outage plans as required.

D. New Bodaway-Gap Well No. 3.

1. The well and piping modifications shall be tested, disinfected and made operational prior to modification of the system disinfection means and Telemetry operations for well operation. An approval for disinfection shall be obtained prior to the disinfection process.
2. Chlorination shall be provided at the Well No. 3.
3. The Well No. 3 Telemetry PLC shall obtain tank level information from the new Bodaway-Gap Tank and provide start/stop control of Well No. 3.
4. The system with treatment and two existing wells in operation shall be maintained throughout the remainder of the work.

### 1.03 SUBMITTALS

The following submittals shall be provided in accordance with Section 01300:

A. OUTAGE PLAN:

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 section. 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 enough cause for rejection of the entire submittal with no further

consideration.

2. Submit a detailed outage plan and time schedule for operations which will make it necessary to remove any facility, piping, well, electrical or control circuit, or equipment from service. The schedule shall be coordinated with the construction schedule specified in the General Conditions of the Contract Documents and shall meet the restrictions and conditions specified in this section. The detailed plan shall describe the means and methods to maintain the potable water system as operational and disinfected, the length of time required to complete the operation, and the necessary personnel and equipment the Contractor will provide to prevent extended duration loss of available potable water.

PART 2—PRODUCTS – NOT USED

PART 3—EXECUTION – NOT USED

**\*\*END OF SECTION\*\***

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Work Sequence  
01014-4

Bodaway-Gap Contract 2  
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## SECTION 01050

### SURVEY INFORMATION

Reference benchmarks and baselines are as specified in the Survey Drawings. From the information provided, the Contractor shall develop and make such additional surveys as are needed for construction, such as control lines, slope stakes, batter boards, stakes for pipe locations and facility site layouts and other working points, lines, and elevations. Survey work shall be performed under the supervision of a licensed land surveyor or registered civil engineer. Contractor shall reestablish reference benchmarks and survey control monuments destroyed by his operations at no cost to the Owner.

**\*\*END OF SECTION\*\***

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01050-2

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SECTION 01071

STANDARD REFERENCES

Wherever used in the project manual, the following abbreviations will have the meanings listed:

AA	Aluminum Association Incorporated P.O. Box 753 Waldorf, MD 20604
AABC	Associated Air Balance Council 1518 K Street N.W. Washington, DC 20005
AAMA	American Architectural Manufacturers Association 1540 East Dundee Road, Suite 310 Palatine, IL 60067
AASHTO	American Association of State Highway and Transportation Officials 444 North Capitol Street, N.W., Suite 249 Washington, DC 20001
ABMA	American Bearing Manufacturers Association 1200 19th Street N.W., Suite 300 Washington, DC 20036
ACI	American Concrete Institute 22400 West Seven Mile Road P.O. Box 19150, Redford Station Detroit, MI 48219
AEIC	Association of Edison Illuminating Companies 600 North 18th Street P.O. Box 2641 Birmingham, AL 35291
AGA	American Gas Association ATTN: Records 1515 Wilson Boulevard Arlington, VA 22209
AGMA	American Gear Manufacturer's Association, Inc. 1500 King Street, Suite 201 Alexandria, VA 22314
AHA	American Hardboard Association 1210 West Northwest Highway Palatine, IL 60067
AISC	American Institute of Steel Construction One East Wacker Drive, Suite 3100 Chicago, IL 60601

AISI	American Iron and Steel Institute 1101 Seventeenth Street, NW, Suite 1300 Washington, DC 20036
AITC	American Institute of Timber Construction 7012 South Revere Parkway, Suite 140 Englewood, CO 80112
ALSC	American Lumber Standard Committee P.O. Box 210 Germantown, MD 20875
AMCA	Air Movement and Control Association, Inc. 30 West University Drive Arlington Heights, IL 60004
ANSI	American National Standards Institute 11 West 42nd Street, 13th Floor New York, NY 10036
APA	American Plywood Association 7011 South 19th Street Tacoma, WA 98466
API	American Petroleum Institute 1220 "L" Street N.W. Washington, DC 20005
ARI	Air-Conditioning and Refrigeration Institute 4301 North Fairfax Drive, Suite 425 Arlington, VA 22203
ASCE	American Society of Civil Engineers United Engineering Center 345 East 47th Street New York, NY 10017
ASCII	American Standard Code for Information Interchange United States of America Standards Institute 10 East 40th Street New York, NY 10016
ASE Code	American Standard Safety Code for Elevators, Dumbwaiter and Escalators American National Standards Institute 1430 Broadway New York, NY 10018
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc. 1791 Tullie Circle, NE Atlanta, GA 30329
ASME	American Society of Mechanical Engineers 345 East 47th Street New York, NY 10017
ASTM	American Society for Testing and Materials 100 Barr Harbor Drive Standard References 01071-2

West Conshohocken, PA 19428  
 AWWPA American Wood-Preservers' Association  
 9549 Old Fredrick Road  
 Ellicott City, MD 21042  
 or  
 P.O. Box 286  
 Woodstock, MD 21163-0286  
 AWS American Welding Society  
 550 NW LeJeune Road  
 P.O. Box 351040  
 Miami, FL 33135  
 AWWA American Water Works Association  
 6666 West Quincy Avenue  
 Denver, CO 80235  
 BOCA Building Officials and Code Administrators, International, Inc.  
 4051 West Flossmoor Road  
 Country Club Hills, IL 60478  
 CALTEST Materials Manual, State of California, Business and Transportation Agency  
 Department of Public Works  
 State of California, Department of Transportation  
 6002 Folsom Boulevard  
 Sacramento, CA 95819  
 CALTRANS Standard Specifications, State of California, Department of Transportation  
 State of California, Business and Transportation Agency  
 P.O. Box 1499  
 Sacramento, CA 95807  
 CBM Certified Ballast Manufacturers  
 2120 Keith Building  
 Cleveland, OH 44115  
 CMAA Crane Manufacturers Association of America, Inc.  
 (Formerly called: Overhead Electrical Crane Institute) (OECI)  
 8720 Red Oak Boulevard, Suite 201  
 Charlotte, NC 28217  
 CRSI Concrete Reinforcing Steel Institute  
 933 N Plum Grove Road  
 Schaumburg, IL 60173  
 CSA Canadian Standards Association  
 178 Rexdale Boulevard  
 Rexdale, Ontario, M9W IR3, Canada  
 DEMA Diesel Engine Manufacturer's Association  
 30200 Detroit Road  
 Cleveland, OH 44145  
 DHI Door and Hardware Institute  
 14170 Newbrook Drive  
 Chantilly, VA 22021  
 Standard References  
 01071-3

DIS Division of Industrial Safety  
California Department of Industrial Relations  
2422 Arden Way  
Sacramento, CA 95825

EI Edison Electric Institute  
90 Park Avenue  
New York, NY 10016

EIA Electronic Industries Association  
Order from:  
Global Engineering Documents  
18201 McDermott West  
Irvine, CA 92714

EJMA Expansion Joint Manufacturers Association  
25 North Broadway  
Tarrytown, NY 10591

ESO Electrical Safety Orders  
California Administrative Code, Title 8, Chap. 4, Subarticle 5  
Office of Procurement, Publications Section  
P.O. Box 20191  
8141 Elder Creek Road  
Sacramento, CA 95820

FEDSPEC Federal Specifications  
General Services Administration  
Specification and Consumer Information  
Distribution Branch  
Washington Navy Yard, Bldg. 197  
Washington, DC 20407

FEDSTDS Federal Standards  
(see FEDSPECS)

FM Factory Mutual Engineering and Research Corporation  
1151 Boston-Providence Turnpike  
P.O. Box 9102  
Norwood, MA 02062

HEI Heat Exchange Institute  
1300 Sumner Avenue  
Cleveland, OH 44115

HI Hydraulic Institute  
9 Sylvan Way, Suite 180  
Parsippany, NJ 07054

HPVA Hardwood Plywood & Veneer Association  
1825 Michael Faraday Drive  
P.O. Box 2789  
Reston, VA 22090-2789

IAPMO International Association of Plumbing and Mechanical Officials  
20001 Walnut Drive S  
Standard References  
01071-4

	Walnut, CA 91789
ICBO	International Conference of Building Officials 5360 Workman Mill Road Whittier, CA 90601
ICEA	Insulated Cable Engineers Association P.O. Box 440 South Yarmouth, MA 02664
IEEE	Institute of Electrical and Electronics Engineers 445 Hoes Lane P.O. Box 1331 Piscataway, NJ 08855
IES	Illuminating Engineering Society of North America 120 Wall Street New York, NY 10017
ISA	Instrument Society of America 67 Alexander Drive P.O. Box 12277 Research Triangle Park, NC 27709
JIC	Joint Industrial Council 7901 West Park Drive McLean, VA 22101
MFMA	Metal Framing Manufacturers Association 401 N. Michigan Avenue Chicago, IL 60611
MILSPEC	Military Specifications Naval Publications and Forms Center 5801 Tabor Avenue Philadelphia, PA 19120
MSS	Manufacturers Standardization Society of the Valve & Fittings Industry, Inc. 127 Park Street, N.E. Vienna, VA 22180
NAAMM	National Association of Architectural Metal Manufacturers 11 South La Salle Street, Suite 1400 Chicago, IL 60603
NACE	National Association of Corrosion Engineers 1440 South Creek Drive Houston, TX 77084
NBC	National Building Code Published by BOCA
NEC	National Electric Code National Fire Protection Association One Batterymarch Park P.O. Box 9101 Quincy, MA 02269
NELMA	Northeastern Lumber Manufacturers Association, Inc.

Standard References  
01071-5

P.O. Box 87A  
 Cumberland Center, ME 04021  
 NEMA National Electrical Manufacturer's Association  
 2101 L Street, NW, Suite 300  
 Washington, DC 20037  
 NESC National Electric Safety Code  
 American National Standards Institute  
 1430 Broadway  
 New York, NY 10018  
 NFOR National Forest Products Association  
 (Formerly National Lumber Manufacturer's Association)  
 1111 19 Street NW, Suite 700  
 Washington, DC 20036  
 NFPA National Fire Protection Association  
 One Batterymarch Park  
 P.O. Box 9101  
 Quincy, MA 02269  
 NHLA National Hardwood Lumber Association  
 6830 Raleigh LaGrange  
 P.O. Box 34518  
 Memphis, TN 38184-0518  
 NSF National Sanitation Foundation  
 3475 Plymouth Road  
 P.O. Box 130140  
 Ann Arbor, MI 48113  
 OSHA Occupational Safety and Health Act  
 U.S. Department of Labor  
 Occupational and Health Administration  
 San Francisco Regional Office  
 450 Golden Gate Avenue, Box 36017  
 San Francisco, CA 94102  
 PCI Precast/Prestressed Concrete Institute  
 175 West Jackson Blvd., Suite 1859  
 Chicago, IL 60604  
 PPIC The Plumbing & Piping Industry Council, Inc.  
 510 Shatto Place, Suite 402  
 Los Angeles, CA 90020  
 RIS Redwood Inspection Service  
 California Redwood Association  
 405 Enfrente Dr., Suite 200  
 Novato, CA 94949  
 RMA Rubber Manufacturers Association  
 1400 K Street NW, Suite 900  
 Washington, DC 20005  
 SAE Society of Automotive Engineers, Inc.  
 Standard References  
 01071-6



	400 Commonwealth Drive Warrendale, PA 15096
SAMA	Scientific Apparatus Makers Association One Thomas Circle Washington, DC 20005
SBC	Standard Building Code Published by SBCCI
SBCCI	Southern Building Code Congress International Inc. 900 Montclair Road Birmingham, AL 35213
SCMA	Southern Cypress Manufacturers Association 400 Penn Center Boulevard, Suite 530 Pittsburg, PA 15235
SDI	Steel Door Institute 30200 Detroit Road Cleveland, OH 44145
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc. P.O. Box 221230 Chantilly, VA 22021
SPI	Society of the Plastics Industry, Inc. 1275 K Street NW, Suite 400 Washington, DC 20005
SPIB	Southern Pine Inspection Bureau 4709 Scenic Highway Pensacola, FL 32504
SSPC	Society for Protective Coatings 40 24 <sup>th</sup> Street, 6 <sup>th</sup> Floor Pittsburgh, PA 15222
SSPWC	Standard Specifications for Public Works Construction Building News, Inc. 3055 Overland Avenue Los Angeles, CA 90034
TEMA	Tubular Exchanger Manufacturer's Association 25 North Broadway Tarrytown, NY 10591
TPI	Truss Plate Institute 583 D'Onofrio Drive, Suite 200 Madison, WI 53719
UBC	Uniform Building Code Published by ICBO
UL	Underwriters Laboratories Inc. 333 Pfingsten Road Northbrook, IL 60062
UMC	Uniform Mechanical Code Published by ICBO

Standard References  
01071-7

UPC Uniform Plumbing Code  
Published by IAPMO

USBR Bureau of Reclamation  
U.S. Department of Interior  
Engineering and Research Center  
Denver Federal Center, Building 67  
Denver, CO 80225

WCLIB West Coast Lumber Inspection Bureau  
6980 SW Varns St.  
P.O. Box 23145  
Portland, OR 97223

WWPA Western Wood Products Association  
(Formerly called: West Coast Lumbermen's Association (WCLA))  
Yeon Building  
522 SW 5th Avenue  
Portland, OR 97204

**\*\*END OF SECTION\*\***

## SECTION 01150

### METHOD OF MEASUREMENT AND BASIS OF PAYMENT

#### PART 1 GENERAL

##### 1.01 SCOPE

The method of measurement and basis of payment is described in Article 1.04 of this section.

##### 1.02 GENERAL

The total bid price for each item of the contract shall cover all Work, shown on the Drawings and required by the Specifications and other Contract Documents. All costs in connection with the Work, including furnishing all materials, equipment, supplies and appurtenances; providing all construction plant, equipment, and tools; performing all necessary labor and supervision to fully complete the Work; and state sales tax and excise tax shall be included in the unit and lump sum bid prices. No item required by the Contract Documents for the proper and successful completion of the Work will be paid for outside of or in addition to the prices submitted in the bid. All work not specifically set forth as a pay item in the Bid Form shall be considered a subsidiary obligation of the CONTRACTOR and all costs in connection therewith shall be included in the prices bid.

##### 1.03 ESTIMATED QUANTITIES

All estimated quantities stipulated in the Bid Form or other Contract Documents are approximate and are to be used only (a) as a basis for estimating the probable cost of the Work and (b) for the purpose of comparing the bids submitted for the Work. The actual amounts of work done and materials furnished under unit price items may differ from the estimated quantities. The basis of payment for work and materials will be the actual amount of work done and materials furnished. The CONTRACTOR agrees that he will make no claim for damages, anticipated profits, or otherwise on account of any difference between the amounts of work actually performed and materials actually furnished and the estimated amounts herein accept as follows. Either the OWNER or the CONTRACTOR may demand in writing that a supplemental agreement or change order be prepared to authorize an adjustment in the unit price of any major contract item if the quantity of said major contract item increases or decreases by more than 25 percent from that shown in the Contract Documents. A major contract item is defined as any item having an original contract value in excess of 10 percent of the total original contract.

##### 1.04 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

Trench Excavation, Bedding, Compaction, Backfilling and Surface Restoration, Clearing and Grubbing. There will not be any separate measurement and payment for structural excavation,

Measurement and Payment

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compaction and backfilling, bedding, gravel or asphalt surface restoration, traffic control, dewatering, sheeting, or shoring, clearly and grubbing, but they shall be considered subsidiary to associated bid items. The pipe installation; trench excavation, haul, compaction, water, backfilling, surface restoration, sheeting, or shoring will not be measured and paid separately and shall be included in the unit price of PVC and HDPE pipe unless otherwise noted herein. Likewise, all locating, crossing, protecting and coordination relating to privately owned buried utilities shall be included in the appropriate bid prices. Additional greater bury depth of up to 8 feet to the top of the pipe, in order to avoid creating a high point in the pipe is also subsidiary.

**A. MOBILIZATION/DEMobilIZATION: ITEM A1:**

Measurement for this item will be lump sum with payment made for mobilization to cover the costs of preparatory work and operations, including but not limited to those necessary for the movement of personnel, equipment, supplies, materials and incidentals to the project site; for the establishment of all offices, supervision and compliance with safety regulations, staging areas and revegetation of these areas, utilities buildings and other facilities necessary for the Work on the project and for all other work and operations which must be performed or cost incurred including final cleanup and moving off of project site upon completion of Work.

Mobilization costs for subcontracted work shall be considered included. Also included are the costs for any permits and fees.

**B. CONTRACT BOND AND INSURANCE: ITEM A2:**

Contract Bond is defined as an approved form of security, executed by the Contractor and their surety or sureties, which guarantees performance of the work in accordance with the contract and all supplemental agreements, pertaining thereto, and the payment of all legal debts pertaining to the construction of the project. The Contract Bond shall be in effect during the full term of CONTRACTOR'S warranty period which is one (1) year from the date of substantial completion. This item shall also include the CONTRACTOR'S liability and property insurance as required in the modifications to the General Conditions.

At the time of the execution of the contract, the successful Bidder shall furnish a surety for a performance bond and for a labor and materials bond, in an amount equal to the full amount of the contract. The liability and property insurance shall also be submitted at the time of contract execution. To receive payment for the contract bond and insurance, the successful Bidder shall comply with the following requirements:

Subsequent to award of the contract and satisfactory compliance with the above, the successful Bidder shall submit a written request to the OWNER requesting payment of the Contract Bond Bid and Insurance bid item. The successful Bidder shall include with this written request, a statement from the insuring firm, indicating the cost of the contract bonds based on the preliminary estimate of the cost of the contract and how that cost will be adjusted based on the final cost.

Measurement shall be lump sum with payment for the Contract Bonds and Insurance bid item to be the actual cost with no CONTRACTOR'S markup (overhead and profit).

**C. GENERAL REQUIREMENTS: ITEM A3:**

Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for the requirements specified in the Division 1 General Requirements to include: attending and coordinating project meetings; coordination of submittals with the work; developing and maintaining and current project schedule; arranging and contracting with a third party testing laboratory for testing in accordance with technical specifications; providing contractors utilities; implementing environmental controls; preparing and implementing of all Stormwater Pollution Prevention Plans and Permits; project identification signs; shipment protection and storage of equipment and materials; equipment and system performance and operational testing; commissioning of the project; training of NTUA operators on specific equipment and appurtenances; final cleanup and post construction repairs; maintaining and submitting record drawings; and providing operation and maintenance instructions.

**D. GAP WELL HOUSE NO. 3 SITE/CIVIL: ITEM B1**

Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:

- Includes clearing & grubbing, topsoil stripping, cut, engineered fill, excavation, shoring and bracing, haul, dewatering, backfill, compaction, drainage basin, surface restoration, topsoil replacement and seeding, erosion control blanket, geo fabric, locating and crossing all adjacent utilities as well as final grading and reclamation.
- Access/parking area – grading, subgrade preparation, compaction, riprap, exterior concrete, furnishing and placing the crushed base surfacing, bluetopping (if necessary).
- Also included are any other work, materials, tools, equipment, erosion protection, labor or other incidentals necessary to complete this item.

**E. GAP WELL HOUSE NO. 3 PREFABRICATED WELL HOUSE: ITEM B2**

Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:

- The complete precast building setting; all of its components including the walls, roof, doors, door hardware, HVAC components and all other accessories, fasteners, and appurtenances required for the satisfactory installation;
- Also included are any other work, materials, tools, equipment, erosion protection, labor or other incidentals necessary to complete this item.

**F. GAP WELL HOUSE NO. 3 WELL HOUSE MECHANICAL: ITEM B3**

Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:

- The piping to the transition couplings outside of the building, including these couplings; tees, bends and valves between the couplings; restrained joint fittings and concrete encasement.
- Floor drain; all associated piping and pipe spools; pressure gauges, pressure transducers, pressure switches, ball valves, hose bibs, flange adaptors, pipe stands and supports; the air/vac valve with isolation valve, and the magnetic flow meter.
- Furnishing and installing chlorine gas treatment system including gas chlorination cylinders, chlorination system piping with fittings, chlorine scale, chlorinator ejector unit, chemical feed pump, rotameter control unit, booster pump, ball valve, pressure cock valve, pressure regulator, gate valve, and appurtenances required for satisfactory installation.
- Testing, flushing and disinfection of well house piping and appurtenances.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

**G. GAP WELL HOUSE NO. 3 WELL HOUSE ELECTRICAL AND INSTRUMENTATION: ITEM B4**

Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:

- Connection to the well pump and motor to include: the pumping system with motors, pumps, check valves, isolation valves, temperature switches, and pump mounting structure; as well as the check out, startup and training on the pumps and controls, and providing O&M manuals and factory certifications;
- Furnishing and installing all electrical and controls components associated with this building including SCADA panels and antennas; and coordination with and connection to the local electrical utility;

- Furnishing and installing all chlorine monitoring equipment and SCADA controls, training on monitoring equipment, and providing O&M manuals and factory certifications.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

H. GAP WELL HOUSE NO. 3 - 8-FOOT CHAIN LINK FENCE AND GATE:  
ITEM B5

Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:

- 8-foot chain link fencing, with serpentine razor wire, gate, signs, etc.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

I. GAP WELL HOUSE NO. 3 – YARD PIPING: ITEM B6

Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:

- Piping, valves, fittings, flush valve assembly, and appurtenances within the well house fenced site to connect to the 10” pipeline and the well head pitless adapter. Also includes the drain line and overflow line with wingwall;
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

J. STORAGE TANK NO. 2 SITE/CIVIL: ITEM C1

Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:

- All topsoil stripping, excavation, shoring and bracing, haul, dewatering, backfill, compaction, surface restoration, riprap, exterior concrete, topsoil replacement and seeding, erosion control blanket, locating and crossing all adjacent utilities as well as final grading and reclamation.
- Access/parking area – grading, subgrade preparation, compaction, furnishing and placing the crushed base surfacing, bluetopping (if necessary).

- Also included are any other work, materials, tools, equipment, erosion protection, labor or other incidentals necessary to complete this item.

K. STORAGE TANK NO. 2 WELDED-STEEL TANK: ITEM C2

Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:

- The welded steel tank as shown in IHS Standard Detail W-20 including the self-supported dome roof, vent pipe, support strap, overflow/weir box, hatch door, exterior caged ladder, roof handrail, dollar plate w/formed rise, eave angle, liquid level indicator, overflow schedule 40 steel pipe, roof gore, target locator plate, stainless steel glass filled float, counterweight, varec cable connector, steel cable, tank internal and external coating, etc.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

L. STORAGE TANK NO. 2 CONCRETE FOUNDATION: ITEM C3

Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:

- The tank foundation including forming and placing concrete, concrete reinforcing steel; all associated inlet, outlet and drain piping and pipe manifold with duck bill check valves and appurtenances required for the satisfactory installation.
- Also included are any other work, materials, tools, equipment, and labor or other incidentals necessary to complete this item.

M. STORAGE TANK NO. 2 YARD PIPING: ITEM C4

Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:

- All pipe necessary for the completion of the steel tank, the inlet and outlet piping to the transition couplings outside of the tank foundation, including these couplings; tees, bends and valves between the couplings on the suction and discharge piping; anodes; restrained joint fittings and concrete encasement.
- Drain piping, drain outlet structure, and culverts.
- Testing, flushing, and disinfection of storage tank, valve vault, and yard piping.

Measurement and Payment

01150-6



- Also included are any other work, materials, tools, equipment, and labor or other incidentals necessary to complete this item.

N. STORAGE TANK NO. 2 PRESSURE TRANSMITTER VAULT:  
ITEM C5

Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:

- Furnishing pressure transmitter vault including electronic pressure transmitter system with wire and PVC conduit, air release valve, gate valve, pressure gauge, pressure cock valve, double strap saddle or banded, transmitter piping with fittings, gravel, and appurtenances for complete installation.
- Also included are any other work, materials, tools, equipment, erosion control, and labor or other incidentals necessary to complete this item.

O. STORAGE TANK NO. 2 INSTRUMENTATION: ITEM C6

Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:

- Furnishing and installing all electrical and controls components associated with this tank including SCADA panels and antennas; and coordination with and connection to the local electrical utility;
- Also included are any other work, materials, tools, equipment, erosion protection, labor or other incidentals necessary to complete this item.

P. STORAGE TANK NO. 2 8-FOOT CHAIN LINK FENCE AND GATE:  
ITEM C7

Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:

- 8-foot chain link fencing, with serpentine razor wire, gate, signs, etc.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

Q. ALTITUDE VALVE STATION SITE/CIVIL: ITEM D1

Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:

- Includes all trench excavation to depths indicated, bedding/backfill; traffic control; shoring, dewatering, all surface restoration, and compaction.
- 8'x6' concrete vault
- Included are any other work, materials, tools, equipment, erosion protection, labor or other incidentals necessary to complete this item.

R. ALTITUDE VALVE STATION ALTITUDE VALVE: ITEM D2

Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:

- Thrust blocking, restrained joints if necessary, testing and disinfection; furnishing and installing the materials; marker posts (marked accordingly) and all materials including altitude valve with rate of flow control, piping with fittings, air release valves, gate valves, valve boxes, check valve, pressure gauges, saddle, curb stop and corporation stop valves, precast concrete vault, hatch, and appurtenances for complete installation.
- Included are any other work, material, tools, fittings, equipment, labor or other incidentals necessary for completion of these items.

Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:

S. ALTITUDE VALVE STATION INSTRUMENTATION: ITEM D3

Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:

- Furnishing and installing all electrical and controls components associated with this altitude valve vault including SCADA panels and antennas; conduit from altitude

valve to the Gap Tank No. 1; and coordination with and connection to the local electrical utility;

- Also included are any other work, materials, tools, equipment, erosion protection, labor or other incidentals necessary to complete this item.

T. 10-INCH PIPELINE PVC PIPE: ITEM E1

This item shall be measured in the field with quantity for payment based on actual lineal footage of PVC piping installed, which price shall include all trench excavation up to an 8.0' depth as measured from the top of pipe (minimum bury for all areas shall be 3'-6" to top of pipe), stabilization, pipe, bends, bedding/backfill, compaction, surface restoration (Topsoil stripping and replacement); traffic control; removal and replacement of all gravel on driveways and road surfaces, fences, and other features; shoring, dewatering, trench backfill, clearing and grubbing, tree removal, buried warning tape; tracer wire; crossing privately owned utilities, repair or replacement of damaged utility lines; testing, flushing and disinfection; furnishing and installing the pipe; erosion protection to include fertilizing, seeding, and mulching of all disturbed areas; and all materials, tools, equipment, labor and performance of all work necessary or incidental for completion of these items.

Pipe length shall be as measured through valves and fittings, unless otherwise stated.

U. 10-INCH PIPELINE IMPORTED BACKFILL: ITEM E2

Where imported backfill is required for the pipeline embedment zone and initial backfill to meet the requirements specified in the drawings and Section 02200 (Earthwork), it shall be as measured by delivery tickets and paid based on the tonnage of material delivered.

V. 10-INCH PIPELINE RESIDENTIAL ROAD CROSSINGS: ITEMS E3 THROUGH E8

This item shall be measured in the field with quantity for payment based on actual lineal footage of PVC piping installed, actual lineal footage of steel casing, which price shall include all trench excavation up to an 8.0' depth as measured from the top of pipe (minimum bury for all areas shall be 3'-6" to top of pipe), stabilization, pipe, bends, bedding/backfill, compaction, surface restoration (Topsoil stripping and replacement); traffic control; removal and replacement of all gravel on driveways and road surfaces, fences, and other features; shoring, dewatering, trench backfill, clearing and grubbing, tree removal, buried warning tape; tracer wire; crossing privately owned utilities, repair or replacement of damaged utility lines; testing, flushing and disinfection; furnishing and installing the pipe; erosion protection to include fertilizing, seeding, and mulching of all disturbed areas; and all materials, tools, equipment, labor and performance of all work necessary or incidental for completion of these items.

Pipe length shall be as measured through valves and fittings, unless otherwise stated.

W. GATE VALVES: ITEMS E9

These items shall be measured in the field with quantity for payment based on actual number of valves and fittings installed. Price shall include all trench excavation to depths indicated, bedding/backfill; traffic control; shoring, dewatering, all surface restoration, compaction, surface restoration, thrust blocking, cad-welds, anodes, restrained joints if necessary, testing and disinfection; furnishing and installing the materials; valve boxes and covers, marker posts (marked accordingly) and all materials, tools, fittings, equipment, labor and performance of all work necessary or incidental for completion of these items.

X. COMBINATION AIR VALVE ASSEMBLY: ITEM E11:

Measurement for this item will be made in the field with the quantity for payment determined by the actual number of air/vacuum assemblies installed. Payment for this item will be made at the contract unit price per each. Price shall include furnishing and installing the combination air/vacuum valve, the curb stop valve, saddle, pipe, valves, marker post (marked accordingly), and fittings. Payment will also include the 36" meter box, lid, washed gravel floor, and all labor, equipment, tools, all excavation, backfill compaction, dewatering, final grading, sheeting, shoring, and incidentals required to complete this item in accordance with the Contract Documents.

Y. FLUSH VALVE ASSEMBLY: ITEM E12:

Measurement for this item shall be made in the field with the quantity for payment determined by the actual number of flush valve assemblies installed. For the purpose of measurement and payment, a flush valve assembly shall be defined to include all 2-inch piping from the connection to the water main, the 2-inch gate valve with box, and tee on the main. Payment for a flush valve assembly shall be made at the contract price per each. Price shall include furnishing and installing the tee, 2-inch pipe, 2-inch gate valve w/box, all trench excavation, shoring, dewatering, backfill, compaction, thrust blocking, washed gravel, filter fabric, tie rods, marker post, testing and disinfection, surface restoration, furnishing and installing each flush valve assembly, and all materials, tools, equipment, labor and performance of all work necessary or incidental for the completion of this item in accordance with the Contract Documents.

Z. CONNECT NEW WATER LINES TO EXISTING WATER LINE:  
ITEM E13:

Measurement for this item will be made in the field for a connection from the new waterline to the existing 12-inch waterline near the Gap Tank No. 1. Payment will be made at the contract unit price for the connection and shall include exposing the existing line, furnishing and installing couplings, thrust restraint, anodes and other corrosion protection requirements, dewatering, backfill, compaction, miscellaneous fittings not paid under another item,

reclamation, testing, disinfection, and all labor, equipment, bedding, and other materials required to complete the connection.

**AA. GREATER BURY DEPTH: ITEM E14:**

This item shall be measured in the field with the quantity for payment determined by the actual lineal footage of pipe placed at a depth greater than 8.0' deep to 11'8" feet to the top of the pipe. Payment will be made under these items only if greater bury depth applies. The cost for greater bury depth will cover all additional costs for excavation, shoring, dewatering, backfill, compaction, and related efforts needed due to the greater depth.

**BB. UNDERGROUND UTILITY (TELEPHONE LINE) LOCATIONS:  
ITEM E15:**

Measurement for this item will be made in the field for each eligible underground utility located that may be in conflict with the installation of pipe on this project. Utilities covered under this item are those owned by a power, telephone or fiber optic utility company. Locating the utility shall include determining the buried utility's horizontal location, its elevation, its type, and providing this information to the ENGINEER. No payment will be made for locating abandoned utilities, or for utilities or structures whose location, elevation and type can be determined without excavation. No payment will be made for locating utilities that were installed under this project. No payment will be made for locating privately owned utilities.

Each utility line or pipe will be counted for payment each time it enters the trench. Multiple lines that are combined in a single pipe or other encasement will have each pipe or encasement counted as one. A utility which parallels the pipeline, will be counted as one each time it enters the excavation from the ditch bank, regardless of the length in the excavation. Utilities shall not be counted under this bid item if they are not marked in the field by the utility owner, not known to exist by the CONTRACTOR, and cut during the excavation for the pipeline.

Payment for the item shall constitute full compensation for contacting of utility owners and their field marking of buried utilities, preserving these markings, locating of the utility including all excavation, shoring, dewatering, backfill, compaction and surface restoration, maintaining an open trench until the ENGINEER has had an opportunity to survey the buried utility that has been exposed, providing safe access to the work site to inspect the buried utility, repair of utilities damaged during the location process, and providing all labor, equipment, tools, materials and other incidentals necessary to complete this work.

**CC. UNDERGROUND UTILITY (TELEPHONE LINE) CROSSINGS:  
ITEM E16:**

The same bid amount will be used for crossing eligible utilities under this item. Therefore, if an eligible utility is both located and crossed, it will be counted as two.

Measurement for this item will be made in the field when each eligible underground utility is crossed, as described below. This includes only utilities owned by a power, telephone or fiber optic line company that are actually crossed. Payment for this item at Contract unit price shall constitute full compensation for production slowdown, costs to repair any utility damaged by the Contractor including materials, utility relocation costs to the utility company if relocation is requested by the Contractor, and other costs associated with the utility crossing, including excavation, backfill, and associated work necessary to complete the item. No payment will be made for utility crossings which are abandoned, or for crossing waterlines installed under this project. When multiple utility conduits lie in the same trench crossing, payment will be made for each of the conduits if they are not physically combined in a single encasement or pipe.

There shall be no measurement of surface or overhead facility crossings, crossing over the top of buried utilities, nor for crossing of private utilities or water, sewer or drainage lines, if encountered. No payment will be made for paralleling adjacent utilities, regardless of the space horizontally or vertically between the existing utility and the improvement. No payment will be made for restraint or support of utility poles during excavation. This work shall be considered subsidiary to the work.

DD. TRAFFIC CONTROL: ITEM E17:

The project traffic control will be paid for on a lump sum basis which is to be full compensation for furnishing a traffic control maintainer person, traffic control devices, such as signs barricades, barrels, cones, escort vehicle(s), two-way radios, and any other tools and equipment needed.

**\*\*END OF SECTION\*\***

## SECTION 01200

### PROJECT MEETINGS

#### 1.0 PRECONSTRUCTION CONFERENCE

The Construction Manager will schedule and conduct one preconstruction conference prior to the commencement of any work at the site, to which all interested agencies and utility companies will be invited to discuss their interests and requirements relating to the project. Contractor and all subcontractor representatives shall attend.

#### 2.0 CONSTRUCTION PERIOD MEETINGS

Construction period meetings will be conducted at weekly intervals or at some other frequency if approved by the Contractor and Construction Manager. These meetings shall be attended by the Construction Manager and the Contractor's Project Manager and any others that are invited by these people.

The Contractor will host a monthly construction meeting on site at their construction trailer. This meeting will be attended by the Engineer, Contractor, Construction Manager, Owner, and others as required.

The agenda of these project meetings will include reports on construction progress, the status of submittal reviews, the status of information requests, and any general business. The meetings will be conducted by the Construction Manager. Construction Manager shall keep minutes of the proceedings. The minutes shall be typed and distributed to all attendees within 48 hours of each meeting.

**\*\*END OF SECTION\*\***

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## SECTION 01300

### SUBMITTALS

#### 1.0 GENERAL

Submittals covered by these requirements include manufacturers' information, shop drawings, test procedures, test results, samples, requests for substitutions, and miscellaneous work-related submittals. Submittals shall also include, but not be limited to, all mechanical, electrical and electronic equipment and systems, materials, reinforcing steel, fabricated items, and piping and conduit details. The Contractor shall furnish all drawings, specifications, descriptive data, certificates, samples, tests, methods, schedules, and manufacturer's installation and other instructions as specifically required in the contract documents to demonstrate fully that the materials and equipment to be furnished and the methods of work comply with the provisions and intent of the contract documents.

#### 2.0 CONTRACTOR'S RESPONSIBILITIES

##### A. GENERAL

The Contractor shall be responsible for the accuracy and completeness of the information contained in each submittal and shall assure that the material, equipment or method of work shall be as described in the submittal. The Contractor shall verify that all features of all products conform to the specified requirements. Submittal documents shall be clearly edited to indicate only those items, models, or series of equipment, which are being submitted for review. All extraneous materials shall be crossed out or otherwise obliterated. The Contractor shall ensure that there is no conflict with other submittals and notify the Construction Manager in each case where his submittal may affect the work of another contractor or the Owner. The Contractor shall coordinate submittals among his subcontractors and suppliers including those submittals complying with unit responsibility requirements specified in paragraph 11000-1.02 C and applicable technical sections.

The Contractor shall coordinate submittals with the work so that work will not be delayed. He shall coordinate and schedule different categories of submittals, so that one will not be delayed for lack of coordination with another. No extension of time will be allowed because of failure to properly schedule submittals. The Contractor shall not proceed with work related to a submittal until the submittal process is complete. This requires that submittals for review and comment shall be returned to the Contractor stamped "No Exceptions Taken" or "Make Corrections Noted."

The Contractor shall certify on each submittal document that he has reviewed the submittal, verified field conditions, and complied with the contract documents.

The Contractor may authorize in writing a material or equipment supplier to deal directly with the Construction Manager or with the Owner with regard to a submittal. These dealings shall be limited to contract interpretations to clarify and expedite the work.

Submittals  
01300-1

### 3.0 CATEGORIES OF SUBMITTALS

#### A. GENERAL:

Submittals fall into two general categories; submittals for review and comment, and submittals which are primarily for information only. Submittals which are for information only are generally specified as PRODUCT DATA in Part 2 of applicable specification sections.

At the beginning of work, the Construction Manager will furnish the Contractor lists of those submittals specified in the project manual. Two separate lists will be provided: submittals for review and comment and product data (submittals) for information only.

#### B. SUBMITTALS FOR REVIEW AND COMMENT:

All submittals except where specified to be submitted as product data for information only shall be submitted by the Contractor to the Construction Manager for review and comment.

#### C. SUBMITTALS (PRODUCT DATA) FOR INFORMATION ONLY:

Where specified, the Contractor shall furnish submittals (product data) to the Construction Manager for Information only. Submittal requirements for operation and maintenance manuals, which are included in this category, are specified in Section 01730.

### 4.0 TRANSMITTAL PROCEDURE

#### A. GENERAL:

Unless otherwise specified, submittals regarding material and equipment shall be accompanied by Transmittal Form 01300-A specified in Section 01999. Submittals for operation and maintenance manuals, information and data shall be accompanied by Transmittal Form 01730-A specified in Section 01999. A separate form shall be used for each specific item, class of material, equipment, and items specified in separate, discrete sections, for which the submittal is required. Submittal documents common to more than one piece of equipment shall be identified with all the appropriate equipment numbers. Submittals for various items shall be made with a single form when the items taken together constitute a manufacturer's package or are so functionally related that expediency indicates checking or review of the group or package as a whole.

A unique number, sequentially assigned, shall be noted on the transmittal form accompanying each item submitted. Original submittal numbers shall have the following format: "XXX"; where "XXX" is the sequential number assigned by the Contractor. Resubmittals shall have the following format: "XXX-Y"; where "XXX" is the originally assigned submittal number and "Y" is a sequential letter assigned for resubmittals, i.e., A, B, or C being the 1st, 2nd, and 3rd resubmittals, respectively. Submittal 25B, for example, is the second resubmittal of submittal 25.

Submittals  
01300-2

B. DEVIATION FROM CONTRACT:

If the Contractor proposes to provide material, equipment, or method of work which deviates from the project manual, he shall indicate so under "deviations" on the transmittal form accompanying the submittal copies.

C. SUBMITTAL COMPLETENESS:

Submittals which do not have all the information required to be submitted, including deviations, are not acceptable and will be returned without review.

5.0 REVIEW PROCEDURE

A. GENERAL:

Submittals are specified for those features and characteristics of materials, equipment, and methods of operation which can be selected based on the Contractor's judgment of their conformance to the specified requirements. Other features and characteristics are specified in a manner which enables the Contractor to determine acceptable options without submittals. The review procedure is based on the Contractor's guarantee that all features and characteristics not requiring submittals conform as specified. Review shall not extend to means, methods, techniques, sequences or procedures of construction, or to verifying quantities, dimensions, weights or gages, or fabrication processes (except where specifically indicated or required by the project manual) or to safety precautions or programs incident thereto. Review of a separate item, as such, will not indicate approval of the assembly in which the item functions.

When the contract documents require a submittal, the Contractor shall submit the specified information as follows:

1. Unless otherwise specified, (4) hard copies and one (1) electronic copy in Adobe “.pdf” format of all submitted information. Consolidate electronic format submittals with multiple pages into a single file. Include an electronic submittal transmittal form 01300-A as the first page in the electronic file.
2. ~~2.~~ Unless otherwise specified, one (1) electronic copy in Adobe “.pdf” format of all submitted information shall be transmitted for submittals (Product Data) for information only.
3. Organize submittals in ~~exactly the same~~ the same order as the items are referenced, listed, and/or organized in the specification section.
4. For submittals that cover multiple devices used in different areas under the same specification section, the submittal for the individual devices must list the area where the device is used.

Submittals  
01300-3

5. Where required, three (3) samples of submitted information shall be provided to the Construction Manager. Samples will not be returned. Provide samples from manufacturer's standard colors, materials, products, or equipment lines. Clearly label samples to indicate any that represent ~~non~~ standard/non-standard colors, materials, products, or equipment lines and that if selected, will require an increase in Contract Time or Contract Price.
6. If requested by Engineer, Contractor shall provide hardcopies of any submittals or shop drawings.

**B. SUBMITTALS FOR REVIEW AND COMMENT:**

Unless otherwise specified, within 10 working days after receipt of a submittal for review and comment, the Construction Manager shall review the submittal and return 1 electronic copy of the marked-up reproducible original noted in 1 above. Thirty (30) calendar days shall be allowed for review and response to shop drawings pertaining to the Well, Storage Tank and Pipeline. The reproducible original will be retained by the Construction Manager. The returned submittal shall indicate one of the following actions:

1. If the review indicates that the material, equipment or work method complies with the project manual, submittal copies will be marked "NO EXCEPTIONS TAKEN." In this event, the Contractor may begin to implement the work method or incorporate the material or equipment covered by the submittal.
2. If the review indicates limited corrections are required, copies will be marked "MAKE CORRECTIONS NOTED." The Contractor may begin implementing the work method or incorporating the material and equipment covered by the submittal in accordance with the noted corrections. Where submittal information will be incorporated in O&M data, a corrected copy shall be provided.
3. If the review reveals that the submittal is insufficient or contains incorrect data, copies will be marked "AMEND AND RESUBMIT." Except at his own risk, the Contractor shall not undertake work covered by this submittal until it has been revised, resubmitted and returned marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED."
4. If the review indicates that the material, equipment, or work method does not comply with the project manual, copies of the submittal will be marked "REJECTED - SEE REMARKS." Submittals with deviations which have not been identified clearly may be rejected. Except at his own risk, the Contractor shall not undertake the work covered by such submittals until a new submittal is made and returned marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED."

Submittals  
01300-4

C. SUBMITTALS (PRODUCT DATA) FOR INFORMATION ONLY:

Such information is not subject to submittal review procedures and shall be provided as part of the work under this contract and its acceptability determined under normal inspection procedures.

6.0 EFFECT OF REVIEW OF CONTRACTOR'S SUBMITTALS

Review of contract drawings, methods of work, or information regarding materials or equipment the Contractor proposes to provide, shall not relieve the Contractor of his responsibility for errors therein and shall not be regarded as an assumption of risks or liability by the Construction Manager or the Owner, or by any officer or employee thereof, and the Contractor shall have no claim under the contract on account of the failure, or partial failure, of the method of work, material, or equipment so reviewed. A mark of "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED" shall mean that the Owner has no objection to the Contractor, upon his own responsibility, using the plan or method of work proposed, or providing the materials or equipment proposed.

**\*\*END OF SECTION\*\***

Submittals  
01300-5

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Submittals  
01300-6

Bodaway – Gap Contract 2  
~~Draft~~ ~~Bid Issue~~ Agency Review Bid Issue

## SECTION 01310

### CONSTRUCTION SCHEDULE

#### 1.0 SCOPE

This section specifies reports and schedules for planning and monitoring the progress of the work.

#### 2.0 DESCRIPTION

The Contractor shall provide a graphic construction schedule indicating the various subdivisions of the work and the dates of commencing and finishing each. The schedule shall show the time allowed for testing and for other procedures which must be completed prior to the work being put into operation. The schedule will include the time of completion and the specific dates given in Section 00520.

#### 3.0 SUBMITTAL PROCEDURES

Within 20 days after the date of the Notice to Proceed, the Contractor shall submit in accordance with Section 01300, a construction schedule conforming to paragraph 01310-2.0. The submittal shall consist of a reproducible original and two copies.

Within 7 calendar days after receipt of the submittal, the Construction Manager shall review the submitted schedule and return one copy of the marked up original to the Contractor. If the Construction Manager finds that the submitted schedule does not comply with specified requirements, the corrective revisions will be noted on the submittal copy returned to the Contractor.

#### 4.0 SCHEDULE REVISIONS

Revisions to the accepted construction schedule may be made only with the written approval of the Contractor and Owner. A change affecting the contract value of any activity, the completion time, and specific dates and sequencing may be made only in accordance with applicable provisions of Sections 00700 and 00800.

#### 5.0 PROJECT STATUS UPDATE

Project status review and update shall be provided each month.

**\*\*END OF SECTION\*\***

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## SECTION 01400

### QUALITY ASSURANCE, INSPECTION, AND TESTING

#### PART 1 GENERAL

##### 1.01 SUMMARY

This section specifies administrative and procedural requirements for quality assurance and control services, special inspections, field testing and structural observations required for this project. This Section is supplementary to the applicable testing and inspection program in the Contract, and describes the responsibilities of all parties pertaining to testing and inspections.

This section covers requirements for quality assurance and inspection required in accordance with the latest version of the International Building Code and is in addition to and supplements the quality assurance requirements contained on the Contract Drawings.

The Contractor is responsible for providing quality workmanship and materials for the construction of this project in accordance with the Contract Documents.

The Contractor will engage and pay for the services of an Owner-approved Special Inspector and Laboratory Service. The Special Inspector shall be qualified to the satisfaction of the Building Official in accordance with Chapter 17 of the International Building Code. The Special Inspector shall be acceptable to the Owner in its sole discretion.

##### 1.02 DEFINITIONS

- A. Approved Agency: An agency approved by the Building Official to engage in furnishing testing or inspection services.
- B. Certificate of Compliance: A certificate stating that materials and products meet specified standards or that work was performed in compliance with approved construction documents.
- C. Registered Design Professional in Responsible Charge: An architect or engineer, licensed to practice in the State of Arizona, acting as the Owner's agent.
- D. Resident Project Representative: The authorized representative of Engineer assigned to assist Engineer at the Site. As used herein, the term Resident Project Representative or "RPR" includes any assistants or field staff of Resident Project Representative. The term "Construction Manager," as used in this and other technical specifications, refers to the Resident Project Representative.

- D. Special Inspection: Inspection of materials, installation, fabrication, erection or placement of components and connections requiring special expertise to ensure compliance with approved construction documents and referenced standards.
- E. Special Inspection, Continuous: The full-time observation of work requiring special inspection by an approved Special Inspector who is present in the area where the work is being performed.
- F. Special Inspection, Periodic: The part-time or intermittent observation of work requiring special inspection by an approved Special Inspector who is present in the area where the work is being performed and at the completion of the work.
- G. Special Inspector: A qualified person who has demonstrated competence, to the satisfaction of the Building Official, to perform inspection of the construction or operation requiring special inspection.
- H. Statement of Special Inspections: The quality assurance plan contained in the contract drawings establishing the systems and components subject to special inspection and testing, as well as the frequency of testing and extent and duration of the special inspection.
- I. Structural Observation: The visual observation of the structural system by a registered design professional for general conformance to the approved construction documents at significant construction stages and at completion of the structural system.

### 1.03 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

References to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). 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, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
ASCE 7-5	Minimum Design Loads for Buildings and Other Structures
ASTM C1093	Practice for Accreditation of Testing Agencies for Unit Masonry
ASTM E329	Practice for Use in Evaluation of Inspection and Testing Agencies as Used in Construction
AWS D1.1	Structural Welding Code – Steel
AWS D1.2	Structural Welding Code – Aluminum
AWS D1.3	Structural Welding Code – Sheet Steel
AWS D1.4	Structural Welding Code – Reinforcing Steel
AWS D1.6	Structural Welding Code – Stainless Steel
AWS QC 1	Standard for AWS Certification of Welding Inspectors
IBC	International Building Code with local amendments
ICC-ES	International Code Council – Evaluation Service Reports and Legacy Reports

#### 1.04 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

1. Fabricator Approval: Certification showing that fabricator is registered and approved to perform shop fabrication without special inspection.
2. Certificates of Compliance: Certificates of compliance shall be submitted stating that materials and products meet specified standards.
3. Contractor Statement: Prior to start of construction, Contractor shall submit statement of responsibility containing the following:
  - a. Acknowledgement of awareness of special inspection requirements.
  - b. Acknowledgement that control will be exercised to obtain conformance with documents approved by the Building Official.
  - c. Procedures for exercising control within the Contractor's organization.
  - d. Identification and qualifications of persons exercising control.
4. Testing Laboratory Qualifications: Prior to start of construction, submit latest inspection report of testing laboratory facilities indicating current accreditation by the accreditation authority.

## 1.05 STRUCTURAL OBSERVATION

A licensed engineer acting as the Owner's agent shall make visual inspections of the work to assess general conformance with the Contract Documents at significant construction stages and at completion of the structural system.

The following structural milestones shall be considered significant construction stages:

1. Structural fill.
2. Foundations prepared for concrete placement.
3. Rebar forming and installation.
4. Concrete pouring/placement.
5. Preparation of masonry walls with reinforcing in place prior to placement of grout.
6. Completion of lateral force resisting elements including diaphragms, shear walls, and other elements.
7. Completion of structural system after all significant architectural, mechanical, plumbing, heating/ventilation equipment, electrical, and finish elements have been installed.

## 1.06 INSPECTION AND TESTING

The Construction Manager/Resident Project Representative may throughout the duration of construction, inspect construction and require the Contractor to test materials to assure Contractor conformance with these specifications. Special inspections and associated testing, as shown on the drawings, will also be performed by approved Special Inspectors for compliance with IBC. This testing will be in addition to that otherwise required of the Contractor in this and other specification sections.

## 1.07 COSTS

- A. Paid by the Owner: None
- B. Paid by the Contractor:
  1. Testing to demonstrate and document conformance with the Contract Documents and applicable permits and codes, except for Special Inspections and associated testing for compliance with IBC, Chapter 17 as identified in paragraph 1.07A above.
  2. Retesting and re-inspections required due to defective work.  
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3. Testing performed for the convenience of the Contractor.
4. Mechanical and electrical component testing and certification.
5. Required inspections of fabricator(s) not registered and approved to perform shop fabrication without special inspection.
6. Special inspections and testing, as specified in this Section, will be paid by the Contractor. A cash allowance in the bid form has been included to cover these costs. Retests and re-inspections required due to defective work are also included.

#### 1.08 CONTRACTOR'S RESPONSIBILITIES

Contractor shall cooperate with testing personnel. Contractor shall provide access to the work and supplier's operations.

Contractor shall deliver adequate samples of materials proposed to be used and which require testing to the Testing Laboratory or as otherwise directed by the Construction Manager/Resident Project Representative.

Contractor shall furnish casual labor and facilities, including but not limited to obtaining and handling samples, repairing of test areas to match original conditions, storage and curing of samples, etc.

Contractor shall provide all testing required to demonstrate compliance with the Contract Documents as well as all special inspections. Additional testing requirements are specified in the technical specification sections.

For all Contractor-required testing, the Contractor shall provide the services of an independent testing laboratory which complies with the requirements of ASTM E329.

#### 1.09 SPECIAL INSPECTOR'S RESPONSIBILITIES

Special Inspector shall keep records of inspections.

Special Inspector shall provide inspection reports to the Resident Project Representative/Construction Manager and Building Official.

Special Inspector shall provide a final report documenting special inspections and correction of any discrepancies noted in the inspections to the Resident Project Representative/Construction Manager and Building Official.

Special Inspector shall attend pre-construction conferences and construction progress meetings if requested by the Resident Project Representative/Construction Manager.

## 1.10 APPROVED AGENCY'S RESPONSIBILITIES

The Approved Agency shall employ personnel experienced and trained to perform the types of tests or inspections required for this project.

The Approved Agency personnel performing testing of welds shall be certified in accordance with AWS QC 1.

## 1.11 SPECIAL INSPECTION AND TESTING REPORTS

### A. REPORT CONTENTS:

At a minimum, Special Inspection and Testing Reports shall include the following:

1. Project name and date of report.
2. Testing laboratory name, address, telephone number, name of laboratory field sampling personnel, and name of lab testing personnel, as applicable.
3. Date, time, and location of sampling, testing, and inspecting.
4. Ambient temperature and weather conditions at the site or shop and curing conditions of samples.
5. Product identification and referenced specification section number.
6. Type of sample, test, and inspection and industry standard for sampling and testing.
7. Results of sample, test, and inspection.
8. Evaluation of compliance with requirements in Contract Documents.

### B. DISTRIBUTION OF REPORTS:

Test and Inspection reports shall be submitted to the Resident Project Representative/Construction Manager and distributed by the Testing Laboratory as directed by the Resident Project Representative/Construction Manager. Draft field test and inspection reports shall be submitted to the Resident Project Representative/Construction Manager prior to the Special Inspector departing the project site. Final test and inspection reports shall be submitted not more than three days after completion of required tests and inspections. Inspection reports shall be submitted immediately to the Resident Project Representative/Construction Manager if deficiencies or significant irregularities are noted. Provide two legible reproducible copies of all draft field reports and one copy of all final reports.

## PART 2 PRODUCTS

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NOT USED.

### PART 3 EXECUTION

#### 3.01 GENERAL:

The Contractor shall furnish access to the Work as required for special inspections, testing and structural observations.

The Contractor shall notify the Resident Project Representative/Construction Manager in advance of required special inspections and structural observation no later than 3 days prior to the date of the inspection.

Contractor shall correct defective work at no additional cost to the Owner.

Structural observation will be performed by a registered professional engineer.

#### 3.02 TESTING

Component and attachment testing shall be required of component manufacturers for mechanical and electrical components subject to special inspections for seismic resistance. The Contractor shall submit a certificate of compliance prepared by the component manufacturer.

Certificates of Compliance shall include the manufacturer's name and address; applicable Drawing and Detail number, products, units and assemblies, and system equipment identification.

**\*\*END OF SECTION\*\***

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SECTION 01410

TESTING LABORATORY SERVICES

PART 1--GENERAL

1.01 DESCRIPTION:

This Section specifies Quality Control testing and reporting performed by the Testing Laboratory. Construction Manager shall select a qualified Testing Laboratory and contract for the services specified herein, except as specifically noted where Contractor may elect to utilize Testing Laboratory to fulfill submittal requirements. Such an arrangement does not relieve the Contractor from their responsibility to provide the completed project as specified, and to perform Quality Assurance according to the QCS as reviewed and accepted.

1.02 REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). 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, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM A880	Criteria for Use in Evaluation of Testing Laboratories and Organizations for Examination and Inspection of Steel, Stainless Steel, and Related Alloys
ASTM C802	Conducting an Inter-laboratory Test Program to Determine the Precision of Test Methods for Construction Materials
ASTM C1021	Laboratories Engaged in the Testing of Building Sealants
ASTM C1077	Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C1093	Accreditation of Testing Agencies for Unit Masonry

ASTM D3666	Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D3740	Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D4561	Quality Control Systems for Organizations Producing and Applying Bituminous Paving Materials
ASTM E4	Force Verification of Testing Machines
ASTM E329	Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction
ASTM E543	Agencies Performing Nondestructive Testing
ASTM E994	Calibration and Testing Laboratory Accreditation Systems General Requirements for Operation and Recognition.
CBC	2001 California Building Code (based on the 1997 Uniform Building Code)

#### 1.03 TESTING LABORATORY QUALIFICATIONS:

Testing Laboratory shall satisfy the following qualifications:

1. Recommended Requirements for Independent Laboratory Qualification, published by American Council of Independent Laboratories.
2. Conform to the requirements of ASTM E329 in particular, and other reference standards as generally pertain to this project.
3. Authorized to operate in the State of Arizona, with personnel and equipment based sufficiently close to the project to allow short-notice site access for sampling and testing.
4. Acceptable to OWNER, Construction Manager, and local building authorities.

#### 1.04 TESTING LABORATORY RESPONSIBILITIES:

Testing Laboratory shall provide qualified personnel at the site and cooperate with Construction Manager and Contractor in performance of the following services:

1. Perform specified independent inspection, sampling, and testing of products in accordance with specified standards, to determine compliance with requirements of Contract Documents.

2. Provide sampling equipment and personnel, deliver samples to the testing laboratory, record field measurements, and cure samples as required by Contract Documents.
3. Perform Building Department required tests and inspections, including Special Inspection as specified in Section 01400.
4. Timely prepare and deliver reports summarizing results of tests and inspections.
5. Attend pre-construction conferences and, if requested, a limited number of progress meetings where Quality Control, testing, and inspection issues require discussion.
6. When directed by the Construction Manager or requested by the Contractor, provide special and additional tests and inspections to verify material compliance with requirements of Contract Documents.
  - a. Construction Manager shall pay for special tests and inspections where work conforms to the Contract Document requirements.
  - b. Contractor shall pay for additional tests and inspections where work fails to comply with Contract Document requirements (re-inspection) and for costs associated with cancelled or short-notice re-scheduling of requested sampling, testing, and inspection. Testing Laboratory work requested by Contractor to fulfill submittal requirements shall also be considered additional tests.

#### 1.05 CONTRACTOR RESPONSIBILITIES:

Contractor shall deliver adequate samples of materials proposed to be used and which require testing to the Testing Laboratory. Contractor shall cooperate with Testing Laboratory personnel, and provide access to the work and to manufacturer's facilities. Contractor shall provide incidental labor and facilities to provide access to work to be tested, to obtain and handle samples at the site or at source of products to be tested, to facilitate tests and inspections, storage and curing of test samples.

Contractor shall notify Testing Laboratory and Construction Manager 24 hours prior to expected time for operations requiring inspection, sampling and testing services.

#### 1.06 TEST AND INSPECTION REPORTS:

##### A. REPORT CONTENTS:

At a minimum, Test and Inspection Reports shall include the following:

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1. Project name and date of report.
2. Testing Laboratory name, address, telephone number, name of laboratory field sampling personnel, lab testing personnel, or QCS Inspector as applicable.
3. Date, time, and location of sampling, testing, and inspecting.
4. Ambient temperature and weather conditions at the site or shop and curing conditions of samples.
5. Product identification and referenced specification Section number.
6. Type of sample, test, and inspection and industry standard for sampling and testing.
7. Results of sample, test, and inspection.
8. Evaluation of compliance with requirements in Contract Documents.
9. Certified Inspection Reports shall specifically indicate the qualification of the inspector to render judgment and certify said inspection.
10. When requested by Construction Manager, interpretation of test results.

**B. DISTRIBUTION OF TEST AND INSPECTION REPORTS:**

Test and Inspection reports shall be submitted to the Construction Manager for distribution as Product Data described in Section 01300. Test reports shall be submitted not more than two days after completion of required tests. Inspection reports shall be submitted immediately if deficiencies or significant irregularities are noted, and in no case less than two working days after said inspection. Provide six (6) copies of all reports.

**1.07 SUBMITTALS:**

The following information shall be provided in accordance with Section 01300:

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,

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referenced to a detailed written explanation of the reasons for requesting the deviation. The ENGINEER 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. Documentation of conformance with Testing Laboratory Qualifications as specified in paragraph 1.03 herein.
3. Form A described in paragraph 3.03 herein, by both Testing Laboratory and Contractor.

#### 1.08 LIMITS ON TESTING LABORATORY AUTHORITY:

Testing Laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents. Testing Laboratory may not approve or accept any portion of the work, nor assume any duties of Contractor. Testing Laboratory has no authority to stop the work

### PART 2--PRODUCTS

#### 2.01 SOURCE QUALITY CONTROL

##### A. GENERAL:

Source quality control is defined in Section 01400. This Section provides general guidelines as to the sampling, tests, and inspections required of products and manufactures prior to delivery to the project site, and should be considered a minimum. Additional information and requirements are provided in each technical specification Section and those requirements shall control over this Section when in conflict. Absence of a test, inspection or requirement listed herein from a subsequent specification Section does not relieve the Testing Laboratory or the Contractor from their respective responsibilities specified in this Section.

##### B. REFERENCE STANDARDS IN OTHER SECTIONS:

Codes, standards, and other references called out below, but which are not listed in paragraph 1.02 are described in other specification Sections and not repeated herein.

##### B. FILL MATERIALS:

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1. **IMPORTED FILL MATERIALS:** Testing Laboratory may conduct additional testing on behalf of Contractor to prepare required submittals specified in Section 02200.
2. **TYPE C FILL MATERIAL:** Testing Laboratory shall conduct required testing to verify on-site materials proposed for fill conforms to specification Section 02200. Contractor shall pay Testing Laboratory for such sampling and testing. Sampling and testing shall determine Liquid Limit, Plasticity Index, optimum moisture content and density relationship, and other data as required for proper use of this material.

**C. PAVING MATERIALS:**

Provide sampling and testing requested by Construction Manager or additional testing as requested by Contractor to verify materials proposed for use conform to specification Sections 02200 and 02500.

**D. CONCRETE REINFORCING:**

Provide sampling and testing requested by Construction Manager or additional testing as requested by Contractor to verify materials proposed for use conform to specification Section 03200.

**E. CAST-IN-PLACE CONCRETE:**

Provide sampling and testing requested by Construction Manager or additional testing as requested by Contractor to verify materials proposed for use conform to specification Section 03300. At Contractor's expense, Testing Laboratory may assist Contractor in formulating concrete mix designs, testing and reporting same, and providing the services of a Professional Engineer to review and seal the mix design.

**F. PRECAST CONCRETE:**

1. **PRECAST YARD INSPECTION:** Source quality inspection is not required for PCI Certified facilities unless otherwise directed by the Building Official.
2. **NON PCI CERTIFIED FACILITIES:** Provide Special Inspection conforming to CBC Chapter 17 and PCI recommendations for all facets of operation including reinforcing, prestressing, concrete placing, finishing, and curing, form release and handling.
3. **VAULTS, MANHOLES, AND NON-STRUCTURAL PRECAST CONCRETE ITEMS:** Precast yard inspection is not required unless so directed by the Construction Manager due to quality concerns or lack of

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experience by the manufacturer. Such inspection and testing shall be paid for by the Contractor, and conform to this Section's requirements, as well as Section 03471.

**G. MASONRY:**

1. **CONFIRMATION OF MASONRY ASSEMBLAGE f'm:** Upon request of Contractor and at their expense, provide additional testing for Standard Compliance of masonry units, grout compressive strength, and mortar type to verify f'm by the tabular method described in the CBC.
2. **CONFIRMATION OF MASONRY ASSEMBLAGE f'm:** Prism testing, if elected rather than tabular method, shall be tested as Field Quality Control.

**H. STRUCTURAL STEEL:**

1. **SHOP WELD INSPECTION FOR STRUCTURAL STEEL, AND STEEL FABRICATIONS:** AWS Certified Welding Inspector shall visually inspect 100 percent of structural welds and will inspect 25 percent of fillet welds greater than 5/16 inch, 100 percent of butt welds, moment connection welds, and full penetration groove welds by ultra-sonic or magnetic particle inspection. Acceptance Criteria: AWS D 1.1. Paragraph 8.15.1 for visual inspection and Paragraphs 8.15.2.1 and 8.15.2.2 for ultra-sonic or magnetic particle inspection.
2. **SHOP INSPECTION OF HIGH-STRENGTH BOLTED CONNECTIONS:** Inspect 100 percent of high-strength bolted connections according to AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts." All such bolts shall be fully tensioned unless otherwise noted on the drawings.
3. **MATERIALS' CONFORMANCE TO SPECIFICATIONS:** Testing Laboratory shall sample and test such items to ensure Standard Compliance for any specified steel materials, connection hardware, and details for which mill certificates or other required certificates have not been submitted. Contractor shall pay for the cost of such sampling, additional testing, and reporting.

**I. STEEL DECK: NOT USED**

Provide sampling and testing requested by Construction Manager or additional testing as requested by Contractor to verify materials proposed for use conform to specification Section 05310.

**J. COLD FORMED STEEL FRAMING AND TRUSSES: NOT USED**

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Provide sampling and testing requested by Construction Manager or additional testing as requested by Contractor to verify materials proposed for use conform to specification Section 05172.

**K. ROUGH CARPENTRY: NOT USED**

Provide sampling and testing requested by Construction Manager or additional testing as requested by Contractor to verify materials proposed for use conform to specification Sections 06100 and 06172.

**L. MISCELLANEOUS METALWORK, GRATING, GUARDRAILING:**

Provide sampling and testing requested by Construction Manager or additional testing as requested by Contractor to verify materials proposed for use conform to specification Sections 05505, 05520, and 05530.

**M. PLASTIC LINING FOR STRUCTURES:**

Provide sampling and testing requested by Construction Manager or additional testing as requested by Contractor to verify materials proposed for use conform to specification Section 09876.

**N. COATING SYSTEMS:**

Provide sampling and testing requested by Construction Manager or additional testing as requested by Contractor to verify materials proposed for use conform to specification Section 09900.

**O. ENGINEERED METAL BUILDINGS: NOT USED**

Provide sampling and testing requested by Construction Manager or additional testing as requested by Contractor to verify materials proposed for use conform to specification Section 13121.

**PART 3--EXECUTION**

**3.01 FIELD QUALITY CONTROL**

**A. GENERAL:**

Field quality control is defined in Section 01400. This Section provides general guidelines as to the sampling, tests, and inspections required of work in progress or completed in the field, and should be considered a minimum. Additional information and

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requirements are provided in each technical specification Section and those requirements shall control over this Section when in conflict. Absence of a test, inspection or requirement listed herein from a subsequent specification Section does not relieve the Testing Laboratory or the Contractor from their respective responsibilities specified in this Section.

**B. REFERENCE STANDARDS IN OTHER SECTIONS:**

Codes, standards, and other references called out below, but which are not listed in paragraph 1.02 are described in other specification Sections and not repeated herein.

**C. FILL:**

1. **SUBGRADE PREPARATION AND COMPACTION:** Verify depth of scarification, moisture content within optimal limits for compaction, and degree of compaction specified in Section 02200. Frequency of testing shall generally conform to 25 foot maximum spacing for strip footings, each isolated pad footing, every 900 square feet for slabs and mat foundations, or as directed by the Construction Manager in light of actual geometry and conditions extent.
2. **STRUCTURE FILL:** Verify material provided, lift thickness, and compaction density. Frequency of sampling and testing shall be the same as for Subgrade Preparation and Compaction.
3. **STRUCTURE BACKFILL:** Verify material provided, lift thickness, and compaction density. Frequency of sampling and testing shall be as directed by the Construction Manager but not less than every 2 feet vertical (lifts) and every 1600 square feet of filled area.
4. **OTHER FILL MATERIALS:** Verify material used, lift thickness, and compaction density. Frequency of sampling and testing shall be as directed by the Construction Manager.

**D. PAVING: NOT USED**

1. **Earthwork and Base Aggregate:** Provide sampling and testing same as Fill described above, and specified in Section 02200. Frequency shall conform to Asphalt Concrete Pavement, below.
2. **Asphalt Concrete Pavement:** Sample and test pavement thickness and installation per CALTRANS Standard Specifications. Thickness verification shall be made at a frequency not to exceed 1600 square feet of roadway or parking zones or as directed by the Construction Manager.

- b. Sitework Concrete at Pavement: Sitework concrete at pavement consists of curbs, gutters, monolithic curb/sidewalk, inlet structures, catch basins, and other concrete construction in contact with paving or necessary for a complete paving job but not associated with buildings, process structures, or structural work controlled by the CBC. Testing Laboratory shall conduct sampling and testing the same as specified for cast-in-place concrete in Section 03300, except strength cylinder testing shall occur at one-half the frequency (placing rate) as for structural concrete.

E. CONCRETE REINFORCING:

Provide Special Inspection for all structural reinforcing in concrete and masonry per CBC Section 1701.5 Item 4.

Provide Special Inspection for mechanical reinforcing connectors and splicing systems as required by that product's ICBO Evaluation Report, or equivalent.

F. CAST-IN-PLACE CONCRETE:

Sample the first daily truck load of ready mixed concrete and every 50 cubic yards thereafter, complying with ASTM C 172.

Perform one slump test for the first daily truck load of ready mixed concrete and every 50 cubic yards thereafter or as requested by Construction Manager if consistency is in question, complying with ASTM C143.

Perform one air content test for each set of compressive strength specimens, complying with ASTM C 31.

Fabricate compressive strength specimens, complying with ASTM C 39.

Make one set of 6 of compressive strength specimens for each day of structural concrete placing or each 100 cubic yards or fraction thereof for each class of concrete.

Test two specimens after curing 7 days, two specimens after curing 28 days, and retain two specimens for later testing if required.

Comply with ACI 350 Section 5.6 (ACI 318 for non-water retaining structures) for evaluation and acceptance of concrete.

G. PRECAST CONCRETE:

- 1. SITE INSPECTION OF PRECAST CONCRETE STRUCTURAL ASSEMBLIES: Visually inspect precast plank, beam, hollowcore, or other precast systems after units are set in place, mechanically anchored, reinforcing and details completed but prior to placing concrete or grout

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which would prevent such inspection. Verify precast pieces conform to expected geometry, bearing conditions and camber.

2. **COMPLETION OF PRECAST CONCRETE STRUCTURAL ASSEMBLIES:** Inspect reinforcing, placement of concrete or grout fill as specified for those materials.

**H. ANCHOR BOLTS AND ANCHORS:**

1. **SPECIAL INSPECTIONS:** Provide Special Inspection for wedge anchors, undercut anchors, adhesive anchors, epoxy anchors, and all other anchoring systems installed in hardened concrete and masonry as required by that product's ICBO Evaluation Report, or equivalent.
2. **SITE INSPECTION OF STRUCTURAL ANCHOR BOLTS:** Visually inspect all structural anchor bolts for grade, diameter, embedment, geometry or type ("J" bolt or hex-head), quantity and general location. Contractor shall assume all responsibility for detailed dimensions locating each individual bolt, each bolt group in total, and locations of bolts within each group (template).

**I. GROUT:**

1. **SITE INSPECTION OF MASONRY GROUTING:** See Masonry section of this specification.
2. **CEMENTITIOUS GROUT FOR STRUCTURAL BEARING:** Visually inspect all column baseplates, and grouted zone between structural struts/beams and their supporting wall elements. Determine complete fill beneath baseplate by tapping with hammer and noting hollow reports. Verify grout conforms to specification by observing empty bags, which Contractor shall leave visible adjacent to area used until inspection complete.
3. **EPOXY GROUT FOR EQUIPMENT BASES:** Provide inspection conforming to specification Section 11002 and its reference standards, details on the Drawings, and the requirements of the epoxy grout manufacturer.

**J. MASONRY:**

1. **CONFIRMATION OF MASONRY ASSEMBLAGE f'm:**  
Demonstrate conformance with specified f'm using prism testing, unless tabular method accepted and completed. Prism preparation and testing shall conform to CBC Section 2105.3, and be at

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Contractor's expense as additional testing except for Testing Laboratory observation, inspection, and reporting defined therein.

2. **INSPECTION OF REINFORCING, MASONRY LAYUP, AND GROUTING:** Testing Laboratory shall provide all inspections and Special Inspections required by the CBC.
3. **GROUT TESTING:** Where grout is required to be sampled and tested, Testing Laboratory shall conduct such work conforming to CBC Section 2105.3.4, Item 4. Cylinders or mortar cubes may be used to confirm grout strength.

**K. STRUCTURAL STEEL:**

1. **SITE WELD INSPECTION FOR STRUCTURAL STEEL, STEEL JOISTS, AND STEEL FABRICATIONS:** Visually inspect 100 percent of structural welds. Inspect 25 percent of fillet welds greater than 5/16 inch, 100 percent of butt welds, moment connection welds, and complete penetration groove welds by ultrasonic or magnetic particle inspection.
2. **ACCEPTANCE CRITERIA:** AWS D 1.1. Paragraph 8.15.1 for visual inspection and paragraphs 8.15.2.1 and 8.15.2.2 for ultrasonic or magnetic particle inspection.
3. **FIELD INSPECTION OF HIGH-STRENGTH BOLTED CONNECTIONS:** Inspect 100 percent of high-strength bolted connections according to AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts." All such bolts shall be fully tensioned unless otherwise noted on the drawings.
4. **BEND TESTS:** Perform bend test on 10 percent of welded shear connectors. Modify test method and frequency if alternate (non-welded) shear connectors utilized by Contractor.

**L. COLD FORMED STEEL FRAMING AND TRUSSES:**

1. **SITE WELD INSPECTIONS FOR STEEL DECK, COLD-FORMED METAL FRAMING, AND STEEL PAN STAIR SYSTEMS:** See structural steel requirements except reference AWS D1.3 for light gage metals.
2. **SCREWED ATTACHMENTS AND CONNECTIONS:** Visually confirm fastener grade, size, quantity and location for each truss to support connection, and 25 percent of other screwed connections.

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3. **BOLTED CONNECTIONS:** Visually inspect all bolted connections for fastener size, grade, and nut in snug tight condition. For high-strength bolts required to be fully tensioned, see structural steel requirements.

**M. STEEL DECK: NOT USED**

1. **STEEL ROOF DECK:** Verify deck depth, gage (thickness), galvanizing, attachment to framing type, size, and frequency, sidelap fastening, and detail connections shown on the Drawings. Provide 100 percent visual inspection of all such decks, or other test method as dictated by supplier of alternate fastening systems, if any.
2. **COMPOSITE STEEL DECK:** Verify deck depth, gage (thickness), galvanizing, attachment to framing type, size, and frequency, sidelap fastening, composite anchors type, size, spacing and attachment to framing, and detail connections shown on the Drawings. Provide 100 percent visual inspection of all such decks, or other test method as dictated by supplier of alternate fastening systems, if any. Inspect composite shear connectors as described in Structural Steel.

**N. ROUGH CARPENTRY: NOT USED**

1. **CONVENTIONAL FRAMING WITH SAWN LUMBER:** Visually inspect for size and grade of sawn lumber bearing wall elements, joists, rafters, and beams. Visually inspect for adequate bearing on supporting elements.
2. **ENGINEERED AND MANUFACTURED WOOD JOISTS, BEAMS AND POSTS:** Visually inspect for size, type, and manufacturer's product grade for all elements using engineered and manufactured wood including glu-laminated members. Verify tension rated lamination of glu-laminated beams is properly oriented. Visually inspect for adequate bearing on supporting elements.
3. **ENGINEERED WOOD TRUSSES:** Visually inspect against reviewed and accepted manufacturer's shop drawings, including general shape, chord and web sizes, bridging and bracing, and adequate bearing.
4. **ROOF AND WALL SHEATHING:** Visually inspect for specified thickness and plies, Index, APA rating, strength axis across supporting members, staggered layout on roofs and floors, blocking or clips, edge nailing and field nailing.

5. CONNECTORS: Verify bolted and nailed connections conform to specifications. In particular, visually inspect “gun nails” for conformance to specified common nail diameters and lengths. Inspect cold-formed steel framing connectors, rafter/truss ties, straps and seismic hold-downs according to ICBO Evaluation Report descriptions, controlling Code or specified standard. Inspect split ring connectors and their bolting.

O. MISCELLANEOUS METALWORK, GRATING, GUARDRAILING:

1. MISCELLANEOUS METALWORK: Provide field inspections and testing if requested by Construction Manager for the work specified in Section 05505. Sampling and testing shall conform to the applicable Reference Standard or Code listed in that section.
2. GRATING AND GUARDRAILING: Provide field inspections and testing if requested by Construction Manager for the work specified in Sections 05520 and 05530. Sampling and testing shall conform to the applicable Reference Standard or Code listed in those sections.

P. PLASTIC LINING FOR STRUCTURES:

1. DIGESTERS COVER PLANKS: Provide field inspections including visual, non-destructive seam testing, and holiday (spark) testing specified for HDPE embedment liner as shown on the Drawings and specified in Section 09876.
2. OTHER PLASTIC LINING SYSTEMS: Provide inspection as specified in Section 09876 for other lined structures, as requested by Construction Manager, and additional inspections as requested by Contractor.

Q. COATING SYSTEMS:

1. FLEXIBLE, WATERTIGHT COATINGS ON CONCRETE: Provide field inspections specified for coating system PM-2 in Section 09900.
2. OTHER COATING SYSTEMS: Provide inspection as requested by Construction Manager, and additional inspections as requested by Contractor.

R. ENGINEERED METAL BUILDINGS:

Provide sampling and testing requested by Construction Manager or additional testing as requested by Contractor to verify work provided conforms to specification Section 13121.

### 3.02 EVALUATION AND CORRECTION :

#### A. EVALUATION:

Satisfactory completion of work will be judged on results of laboratory, shop, and site tests and inspections.

#### B. CORRECTIONS:

If results of tests and inspections indicate work is below requirements of Contract Documents, that portion of work is defective and shall be repaired or replaced by the Contractor at no additional expense to the CITY by methods specified in each material or system's Section. Corrective action shall continue until such work meets the requirements of the Contract Documents.

### 3.03 SCHEDULE OF INSPECTIONS AND TESTS:

Form A below shall be used to coordinate sampling and testing provided by Testing Laboratory, Construction Manager, Contractor, and other parties, if any. Testing Laboratory shall fill out Form A with anticipated inspections, sampling, and testing, submit for review by Construction Manager and for information to Contractor, and revise as directed. After receipt of Testing Laboratory's Form 01410-A submittal, Contractor shall submit Form 01410-A to identify sampling and testing requested for submittal preparation, and with an allowance for additional inspections. Such allowance shall not be less than five percent (5%) of the anticipated Field Quality Control budget for the Testing Laboratory, but shall not contractually commit Contractor to such expenditure, unless additional inspections requested and then only to their extent.

FORM 01410-A  
 ANTICIPATED SAMPLING, TESTING, AND INSPECTIONS BY TESTING  
 LABORATORY AND CONTRACTOR.

Prepared by : \_\_\_\_\_ Testing Laboratory \_\_\_\_\_ Contractor (check one).

*Electronic version available upon request. Expand each cell as necessary to provide a complete scope description.*

Specification Section	Source Quality Control	Field Quality Control
02200 Earthwork		
02500 Paving – NOT USED		
03200 Concrete Reinforcement		
03300 Cast-in-Place Concrete		
03471 Precast Concrete		
03600 Grout		
04200 Masonry – NOT USED		
05100 Structural Steel		
05172 Fabricated Steel Trusses – NOT USED		
05310 Steel Deck – NOT USED		
05405 Cold-Formed Metal Framing – NOT USED		
05501 Anchor Bolts		
05505 Miscellaneous Metalwork		
05520, 05530 Guardrailing, Metal Grating		
06100 Rough Carpentry – NOT USED		
6192 Fabricated Wood Trusses – NOT USED		
09876 Plastic Lining for Structures		
09900 Coating Systems		
13121 Engineered Metal Buildings – NOT USED		

\*\*END OF SECTION\*\*

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## SECTION 01500

### CONTRACTOR'S UTILITIES

#### 1.0 OFFICE

The Contractor shall maintain a suitable office at the site of the work.

#### 2.0 POWER

The Contractor shall provide power for construction at the plant site. He shall make arrangements with the electrical utility and with the Owner for power takeoff points, voltage and phasing requirements, transformers and metering and shall pay the costs and fees arising therefrom. The Contractor shall provide the special connections required for his work.

#### 3.0 TELEPHONE

The Contractor shall provide telephone service at his construction site office.

#### 4.0 SANITARY FACILITIES

The Contractor shall provide toilet and washup facilities for his work force at the site of work. The facilities shall comply with applicable laws, ordinances, and regulations pertaining to the public health and sanitation of dwellings and camps.

**\*\*END OF SECTION\*\***

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## SECTION 01560

### ENVIRONMENTAL CONTROLS

#### 1.0 SITE MAINTENANCE

The Contractor shall keep the work site clean and free from rubbish and debris. Materials and equipment shall be removed from the site when they are no longer necessary. Upon completion of the work and before final acceptance, the work site shall be cleared of equipment, unused materials, and rubbish to present a clean and neat appearance.

#### 2.0 TEMPORARY DAMS

Except in time of emergency, earth dams are not acceptable at catch basin openings, local depressions, or elsewhere. Temporary dams of sand bags, asphaltic concrete, or other acceptable material will be permitted when necessary to protect the work, provided their use does not create a hazard or nuisance to the public. Such dams shall be removed from the site as soon as they are no longer necessary.

Measures to protect and maintain water quality shall be in accordance with Section 01561 STORM WATER POLLUTION PREVENTION PLAN (SWPPP).

#### 3.0 AIR POLLUTION CONTROL

The Contractor shall not discharge smoke, dust, and other contaminants into the atmosphere that violate the regulations of any legally constituted authority. The Contractor shall also abate dust nuisance by cleaning, sweeping, and sprinkling with water, or other means as necessary. The use of water, in amounts which result in mud on public streets, is not acceptable as a substitute for sweeping or other methods.

#### 4.0 NOISE CONTROL

Between 7:30 p.m. and 7:00 a.m., noise from Contractor's operations shall not exceed limits established by applicable laws or regulations and in no event shall exceed 86 dBA at 50 feet from the noise source.

**\*\*END OF SECTION\*\***

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## SECTION 01561

### STORM WATER POLLUTION PREVENTION PLAN (SWPPP)

#### PART 1--GENERAL

##### 1.01 SCOPE

- A. The CONTRACTOR shall provide all labor, equipment, materials, and services to acquire, prepare, implement and maintain best management practices (BMP) under a Construction General Permit (CGP) and Stormwater Pollution Prevention Plan (SWPPP) for construction activities that may adversely impact water quality.
1. The U. S. Environmental Protection Agency (EPA), Pacific Southwest, Region 9 is the permitting authority for all regulated stormwater discharges on Indian Lands. More information on stormwater permitting on Indian Lands within Arizona is available online at U.S. EPA and U.S. EPA Region 9 NPDES Stormwater Program at:  
  
<http://www.epa.gov/region09/water/npdes/stormwater.html>
  2. Definitions shall be in accordance with EPA
  3. For information about the storm water program in EPA's Pacific Southwest Region (AZ, CA, NV, Pacific Islands, and Tribal lands), contact: Eugene Bromley, [bromley.eugene@epa.gov](mailto:bromley.eugene@epa.gov) (415) 972-3510, or Andrew Sallach, [sallach.andrew@epa.gov](mailto:sallach.andrew@epa.gov), (415) 972-3503.

##### 1.02 SUBMITTALS

- A. The CONTRACTOR shall submit record copies of the following documents to the CONSTRUCTION MANAGER:
1. Approved Notice of Intent (NOI)
  2. Approved SWPPP and amendments
  3. Notice of Termination (NOT) following completion of construction and final /permanent stabilization
  4. Inspection and non-compliance reports that at a minimum include name of the inspector, time and date, reason for the inspection, and any findings on the conditions of the SWPPP controls and any location(s) of discharges of sediments or other pollutants from the site, BMP's that require maintenance, additional BMPs required, corrective actions to be taken, and evidence of or potential for pollutant discharge from the site.

### 1.03 CONTRACTOR'S RESPONSIBILITIES

- A. The CONTRACTOR shall complete a Storm Water Pollution Prevention Plan (SWPPP) that complies with all Federal, State and local requirements.
  - 1. The Storm Water Pollution Prevention Plan shall be developed in accordance with the permit requirements and EPA guidebook, "Developing Your Stormwater Pollution Prevention Plan: A Guide for Construction Sites" (EPA publication number 833-R-06-004). The guidebook is a reference for information relating to the different methods of stormwater pollution prevention presented in this SWPPP.
  - 2. The CONTRACTOR shall amend the SWPPP as necessary during completion of the Work if there are changes to the site that significantly affect the discharge of pollutants or if inspection or investigation determine the approved SWPPP is no longer effective at mitigating pollutants in stormwater discharges.
- B. The CONTRACTOR shall provide a "qualified person" to perform inspections according to the inspection schedule provided in the approved SWPPP, before and/or during predicted rain events and "spot" inspections as requested by the CONSTRUCTION MANAGER to ensure Best Management Practices (BMPs) are in place and maintained.
  - 1. A "qualified person" is a person knowledgeable in the principles and practice of erosion and sediment controls and pollution prevention, who possesses the skills to assess conditions at the construction site that could impact stormwater quality, and the skills to assess the effectiveness of any stormwater controls selected and installed to meet the requirements of the SWPPP and CGP.
- C. The CONTRACTOR shall maintain a copy of the approved grading and drainage plan, NOI, up to date SWPPP and inspection reports available on site at all times for review..
- D. Construction Wastes: The CONTRACTOR is responsible for proper disposal of all construction wastes in accordance with all applicable Federal, State, and local codes.
  - 1. Unless otherwise required by code, construction wastes shall be disposed of in a proper manner via use of an on-site dumpster supplied by the CONTRACTOR. The CONTRACTOR shall provide removal services by a licensed solid waste management firm. The dumpster shall be emptied a minimum of once per week or more often if necessary. Burial of construction wastes on-site is not permitted. The CONTRACTOR shall

ensure that the CONTRACTOR on-site work crews and subcontractors are trained in the proper manner of disposal for construction wastes.

- E. Sanitary Wastes: Disposal of sanitary waste from the construction site shall meet all applicable Federal, State, and local codes.
  - 1. The CONTRACTOR shall hire a licensed sanitary waste management firm for the disposal of the sanitary waste from the construction site, including from the CONTRACTOR's trailers.
- F. Hazardous Wastes: All hazardous materials used for the construction shall be stored, handled, and applied per the manufacturer's printed instructions and per all applicable Federal, State, and local codes.
  - 1. The CONTRACTOR shall ensure that the on-site work crews and subcontractors are trained in the proper manner of disposal for hazardous wastes. The disposal of hazardous wastes from the construction site shall be the responsibility of the CONTRACTOR and shall be performed by a licensed hazardous wastes management firm.
- G. Construction access shall be stabilized to prevent the removal of sediment from the construction site onto the adjacent property or paved road. The stabilized access roadway shall be wide enough to handle the anticipated truck traffic to and from the construction site.

## PART 2--PRODUCTS

- A. NOT USED

## PART 3--EXECUTION

### 3.01 MAINTENANCE AND INSPECTION

- A. Perform joint inspections with the CONSTRUCTION MANAGER per the approved SWPPP schedule and after any storm event unless otherwise specified.
- B. All erosion control structures and stabilization practices shall be maintained in good working condition throughout the duration of the construction project.
  - 1. Remove accumulated sediment and debris from silt fences before it loses thirty percent (30%) or its storage capacity. Remove accumulated sediment and debris before other BMP lose fifty percent (50%) of storage capacity.
- C. Repair of the damage to any erosion control structure shall commence within 24 hours of discovery of the damage.

### 3.02 SPILL PREVENTION

- A. Only materials used for completion of Work performed as part of this construction project shall be stored on-site.
- B. The handling and storage of all materials shall follow the Manufacturer's written instructions, the site conditions, project Specifications, or applicable governmental codes; whichever is most stringent. Materials shall be stored in a neat and orderly fashion in their original containers.
- C. When transferring or unloading materials, the CONTRACTOR shall ensure that the area is protected from discharge into protected areas and that the materials transfer operation shall not cause contamination to stormwater due to runoff from the materials transfer location.
- D. During adverse weather, as described in the General Conditions of the Contract Documents, and against the possibility thereof, the CONTRACTOR shall take all necessary precautions to ensure the protection of the construction materials storage area.

### 3.03 HAZARDOUS MATERIALS SPILL PREVENTION AND PRACTICES

- A. The following precautions shall be followed for hazardous materials:
  - 1. The CONTRACTOR shall keep the Material Safety Data Sheets of all hazardous materials at the Site.
  - 2. Products shall remain in their original containers with the original legible product label attached to the container. All products shall be used before disposal of the container.
  - 3. Hazardous materials shall be stored separately from non-hazardous materials on-site.
  - 4. Hazardous materials, including diesel fuel, must be stored in contained areas which are able to contain 150 percent of the volume of the largest container's contents. If the area is not exposed to stormwater, the volume of the containment area shall be 110 percent of the volume of the largest container's contents. Each hazardous material shall be stored in its own containment area. Under no circumstances shall hazardous materials be used or stored within 100-feet of any water supply well, unless specifically permitted by the CONSTRUCTION MANAGER and governing Federal, State, or local codes.

At a minimum, the containment area shall be constructed with dikes and lined with a material resistant to the properties of the hazardous material



being contained. Before removal of any stormwater from the containment area, a representative sample of water shall be tested for contamination by the hazardous material stored in that containment area. If the stormwater is found to be contaminated, the CONTRACTOR shall follow the spill control measures for this hazardous material.

5. Hazardous materials shall be disposed of in accordance with proper disposal procedures and in accordance with all Federal, State, or local codes.

#### B. PRODUCT SPECIFIC PRACTICES

1. **Petroleum-Based Products:** All on-site vehicles shall be properly maintained and checked for any leaks of fluid or petroleum-based products. If a leak is found, the vehicle shall be repaired immediately or removed from the Site. Diesel fuel shall be considered a hazardous material and shall be stored in a containment area as indicated above.
2. **Acid and Base Chemicals:** All acid and base chemicals are considered hazardous materials and shall be stored in containment areas as described above. Disposal of acid or base chemicals shall, under no circumstances, occur via dumping or via the storm drain system.
3. **Paints, Thinners and Solvents:** Paints, thinners, and solvents shall be stored in their original containers. Unused paints, thinners, and solvents shall not be dumped on-site or disposed through the sanitary or storm sewer system. Disposal of unused paints, thinners, and solvents shall be through proper hazardous materials disposal procedures.
4. **Fertilizers and Pesticides:** Fertilizers and pesticides shall be applied at the minimum rate recommended by the manufacturer. Before spraying any pesticide, a certified pesticide applicator shall receive a permit for spraying of the pesticide in a well field. Storage of fertilizers shall be transferred to sealable containers to prevent spillage and exposure to stormwater. Fertilizer shall be worked into the soil upon application in a landscaped area.
5. **Concrete Trucks:** The washdown of concrete trucks or the disposal of unused or unacceptable concrete from a concrete truck will be permitted on-site only if the CONTRACTOR has set aside a specific area, with dikes to prevent contact between excess concrete and washdown water or stormwater. After the solids in the area have hardened, the CONTRACTOR shall dispose of the solids in a proper manner as approved by the CONSTRUCTION MANAGER.

### 3.04 SPILL CONTROL PRACTICES

- A. In addition to the precautionary practices described above, the following practices shall be followed for spill prevention, control, cleanup, and notification:
1. Any spills shall be cleaned up immediately.
  2. The CONTRACTOR shall notify the CONSTRUCTION MANAGER, OWNER, and all applicable agencies if a spill occurs.
  3. Manufacturer's printed instructions for the cleanup of a spill shall always be kept on-site by the CONTRACTOR. The CONTRACTOR's work crews and subcontractors shall be required to be familiar with the requirements and procedures for spill cleanup. Equipment necessary for spill cleanup, such as gloves, metal containers, mops, etc., shall be maintained on-site by the CONTRACTOR. The cleanup equipment shall be kept on-site by the CONTRACTOR during construction activities.
  4. Workers involved in the cleanup of a spill shall be properly protected by protective suits, ventilation masks, goggles, and other necessary equipment, prior to contact with the spilled material.
  5. The CONTRACTOR shall name an employee who will be on-site full-time throughout the duration of the project as the spill cleanup coordinator. The spill cleanup coordinator will be responsible for notifying the proper personnel and agencies of a spill and obtaining the proper equipment and personnel to clean up the spill. The name and phone number where the spill cleanup coordinator can be reached at all times shall be posted on the Site. The spill cleanup coordinator shall be properly trained in spill cleanup procedures.
  6. After a spill is contained and cleaned up, a spill occurrence report shall be completed by the on-site inspector and the SWPPP shall be modified to prevent a reoccurrence of a spill.

**\*\*END OF SECTION\*\***

## SECTION 01580

### PROJECT IDENTIFICATION SIGNS

The Contractor shall provide one 4-foot by 8-foot multicolored signboard with a multi-colored "Navajo Nation" emblem. Signboard shall be provided with 1-1/4-inch by 4-inch edging, shall be constructed of exterior grade high density overlaid plywood, and shall be mounted and located in an acceptable manner which will permit public viewing. Sign shall list the following information:

The final layout of the sign shall comply with the requirements of the sign details shown on Figure 01580-1.

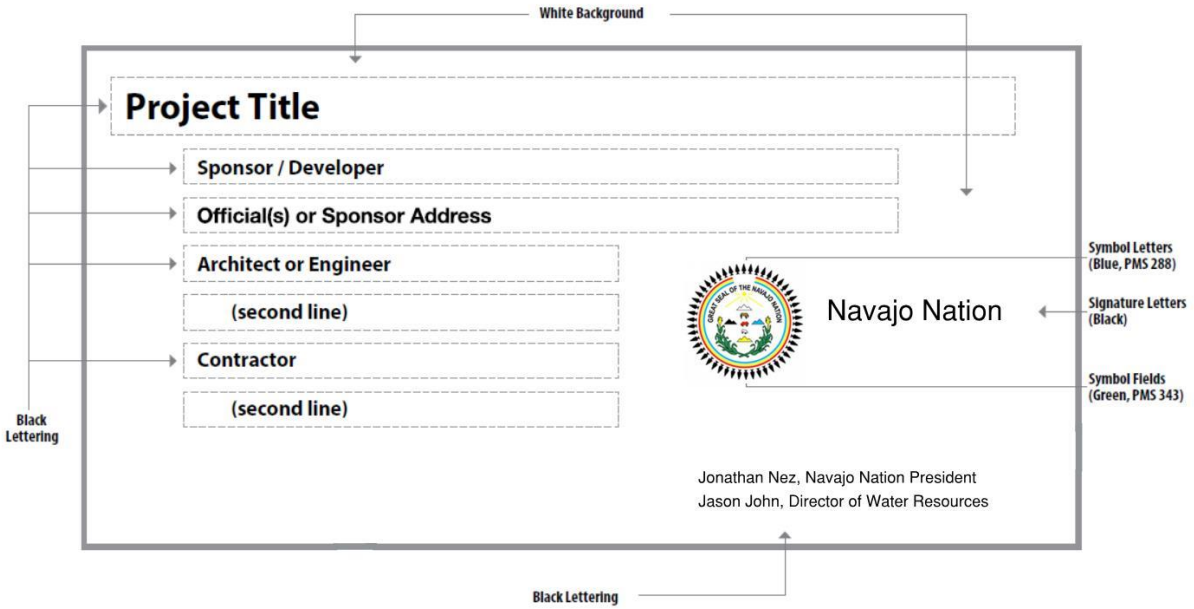
Project Title: Bodaway-Gap and Coppermine Chapters Well, Storage Tank and Pipeline Project.

The Contractor shall erect the sign in accordance with the details shown on Figure 01580-1 and the following specifications. The sign shall be maintained in good condition until completion of the contract, at which time the sign shall become the property of the Owner. The sign is to be painted white with lettering and emblem colors as shown. Sign support shall be 4-inch by 6-inch posts painted black, set a minimum 3 feet 6 inches in the ground. Paint shall be exterior type. The lettering shall be similar in style to that shown.

The Contractor and his subcontractors may erect signs for information and direction. No commercial or advertising signs will be allowed on the site of the work.

# TEMPORARY CONSTRUCTION SIGN FOR PROJECTS

Recommended Fonts: Helvetica, Arial, or Myriad Pro



**SIGN DIMENSIONS** : 1200 mm x 2400 mm x 19 mm (approx. 4' x 8' x ¾")  
**PLYWOOD PANEL (APA RATED A-B GRADE-EXTERIOR)**

Figure 01580-1

**\*\*END OF SECTION\*\***

## SECTION 01605

### SHIPMENT, PROTECTION AND STORAGE

#### 1.0 GENERAL

Equipment, products and materials shall be shipped, handled, stored, and installed in ways which will prevent damage to the items. Damaged items will not be permitted as part of the work except in cases of minor damage that have been satisfactorily repaired and are acceptable to the Construction Manager.

#### 2.0 PIPE

Pipe and appurtenances shall be handled, stored, and installed as recommended by the manufacturer. Pipes with paint, tape coatings, linings or the like shall be stored to protect the coating or lining from physical damage or other deterioration. Pipes shipped with interior bracing shall have the bracing removed only when recommended by the pipe manufacturer.

#### 3.0 EQUIPMENT

##### A. PACKAGE AND MARKING:

All equipment shall be protected against damage from moisture, dust, handling, or other cause during transport from manufacturer's premises to site. Each item or package shall be marked with the number unique to the specification reference covering the item.

Stiffeners shall be used where necessary to maintain shapes and to give rigidity. Parts of equipment shall be delivered in assembled or subassembled units where possible.

##### B. IDENTIFICATION:

Each item of equipment and valve shall have permanently affixed to it a label or tag with its equipment or valve number designated in this contract. Marker shall be of stainless steel. Location of label will be easily visible.

##### C. SHIPPING:

Bearing housings, vents and other types of openings shall be wrapped or otherwise sealed to prevent contamination by grit and dirt.

Damage shall be corrected to conform to the requirements of the contract before the assembly is incorporated into the work. The Contractor shall bear the costs arising out of dismantling, inspection, repair and reassembly.

D. FACTORY APPLIED COATINGS:

Unless otherwise specified, each item of equipment shall be shipped to the site of the work with the manufacturer's shop applied epoxy prime coating as specified in Section 09900. The prime coating shall be applied over clean dry surfaces in accordance with the coating manufacturer's recommendations. The prime coating will serve as a base for field-applied finish coats. Electrical equipment and materials shall be painted by manufacturer as specified in paragraph 09900-3.03 I.

E. STORAGE:

During the interval between the delivery of equipment to the site and installation, all equipment, unless otherwise specified, shall be stored in an enclosed space affording protection from weather, dust and mechanical damage and providing favorable temperature, humidity and ventilation conditions to ensure against equipment deterioration. Manufacturer's recommendations shall be adhered to in addition to these requirements.

Equipment and materials to be located outdoors may be stored outdoors if protected against moisture condensation. Equipment shall be stored at least 6 inches above ground. Temporary power shall be provided to energize space heaters or other heat sources for control of moisture condensation. Space heaters or other heat sources shall be energized without disturbing the sealed enclosure.

F. PROTECTION OF EQUIPMENT AFTER INSTALLATION:

After installation, all equipment shall be protected from damage from, including but not limited to, dust, abrasive particles, debris and dirt generated by the placement, chipping, sandblasting, cutting, finishing and grinding of new or existing concrete, terrazzo and metal; and from the fumes, particulate matter, and splatter from welding, brazing and painting of new or existing piping and equipment. As a minimum, vacuum cleaning, blowers with filters, protective shieldings, and other dust suppression methods will be required at all times to adequately protect all equipment. During concreting, including finishing, all equipment that may be affected by cement dust must be completely covered. During painting operations, all grease fittings and similar openings shall be covered to prevent the entry of paint. Electrical switchgear, unit substation, and motor load centers shall not be installed until after all concrete work and sandblasting in those areas have been completed and accepted and the ventilation systems installed.

**\*\*END OF SECTION\*\***

## SECTION 01660

### EQUIPMENT AND SYSTEM PERFORMANCE AND OPERATIONAL TESTING

#### PART 1--GENERAL

##### 1.01 DESCRIPTION

This section contains requirements for the Contractor's performance in documenting testing work required under this contract. In addition, this section contains requirements for the Contractor's performance during installed performance testing of all mechanical, electrical, instrumentation, and HVAC equipment and systems, including structures for watertight construction, provided under this contract. This section supplements but does not supersede specific testing requirements found elsewhere in this project manual.

##### 1.02 QUALITY ASSURANCE

###### A. CONTRACTOR'S QUALITY ASSURANCE MANAGER:

The Contractor shall appoint an operations engineer or equally qualified operations specialist as Quality Assurance Manager to manage, coordinate, and supervise the Contractor's quality assurance program. The Quality Assurance Manager shall have at least 5 years of total experience, or experience on at least five separate projects, in managing the startup commissioning of mechanical, electrical, instrumentation, HVAC, and piping systems. Operations engineers shall be graduates from a minimum 4-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 this project manual will be implemented.
2. A documentation program to record the results of all equipment and system tests.
3. An installed 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 01660-2.02 C.

For the purposes of this section, a system shall include all 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.

**B. CALIBRATION:**

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 to within plus or minus 2 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.

Liquid flow meters, including all open channel flow meters and all meters installed in pipelines with diameters greater than 2 inches shall be calibrated in situ using either the total count or dye dilution methods. Gas flow meters installed in piping systems with diameters greater than 6 inches shall be calibrated in situ 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 2 percent.

**C. REFERENCES:**

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). 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, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

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
AWWA M6	Water Meters – Selection, Installation Testing and Maintenance

### 1.03 SUBMITTALS

Submittal material, to be submitted in accordance with Section 01300, shall consist of the following:

1. A complete description of the Contractor's plan for documenting the results from the test program in conformance with the requirements of paragraph 01660-2.02 A, including:
  - a. Proposed plan for documenting the calibration of all test instruments.
  - b. Proposed plan for calibration of all instrument systems, including flow meters and all temperature, pressure, weight, and analysis systems.
  - c. Sample forms for documenting the results of field pressure and performance tests.
2. The credentials and certification of the testing laboratory proposed by the Contractor for calibration of all test equipment.
3. Preoperational 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 the Contractor for the systematic testing of all equipment and systems installed under this contract.

5. A schedule and subsequent updates, presenting the Contractor's plan for testing the equipment and systems installed under this contract.
6. A schedule establishing the expected time (calendar dates) when the Contractor plans to commence operational 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, showing conformance to paragraph 01660-1.02 A requirements.

## PART 2--PRODUCTS

### 2.01 GENERAL

The Contractor shall prepare test plans and documentation plans as specified in the following paragraphs. The Construction Manager/Resident Project Representative will not witness any test work for acceptance until all test documentation and calibration plans and the specified system or equipment test plans have been submitted and accepted.

### 2.02 DOCUMENTATION

#### A. DOCUMENTATION PLANS:

The Contractor shall 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.

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 Construction manager's/Resident Project Representative's witness and the 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:

1. Metallurgical tests
2. Factory performance tests
3. Accelerometer recordings made during shipment
4. Field calibration tests<sup>1</sup>
5. Field pressure tests<sup>1</sup>
6. Field performance tests<sup>1</sup>
7. Field operational tests<sup>1</sup>

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<sup>1</sup>Each of these tests is required even though not specifically noted in detailed specification section.

Section 01999 contains samples showing the format and level of detail required for the documentation forms. The Contractor is advised that these are samples only and are not specific to this project nor to any item of equipment or system to be installed under this contract. The Contractor shall 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 produced for review by the Construction Manager/Resident Project Representative as a condition precedent to the Contractor's receipt of progress payments more than 50 percent of the contract amount. Once the Construction Manager/Resident Project Representative has reviewed and taken no exception to the forms proposed by the Contractor, the Contractor shall produce enough forms, at his expense, to provide documentation of all testing work to be conducted as a part of this contract.

**B. TEST PLANS:**

The Contractor shall 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 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:

1. 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.
2. Calibration of all analysis instruments and control sensors.
3. 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 project manual.
4. System tests designed to duplicate, as closely as possible, operating conditions described in the project manual.

Test plans shall contain a complete description of the procedures to be employed to achieve the desired test environment.

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 the Contractor eight weeks in advance of the date the Contractor wishes to begin any testing work (whichever occurs earliest in the project schedule), the Contractor shall 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 Construction Manager/Resident Project Representative has reviewed and taken no exception to the Contractor's test plans, the Contractor shall reproduce the plans in sufficient number for the Contractor's purposes and an additional ten copies for delivery to the Construction Manager/Resident Project Representative. No test work shall begin until the Contractor has delivered the specified number of final test plans to the Construction Manager/Resident Project Representative.

#### C. TESTING SCHEDULE:

The Contractor shall produce a testing schedule setting forth the sequence contemplated for performing the test work. The schedule shall be in bar chart form, plotted against calendar time, shall detail the equipment and systems to be tested, and shall be coordinated with the Contractor's construction schedule specified in Section 01310. 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 4 weeks in advance of the date testing is to begin. The Construction Manager/Resident Project Representative will not witness any testing work for acceptance until the Contractor has submitted a schedule to which the Construction Manager/Resident Project Representative takes no exception. 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 this project manual.

### 2.03 SYSTEM AND EQUIPMENT PERFORMANCE TESTS

Each item of mechanical, electrical, instrumentation, and HVAC equipment installed under this contract shall be tested to demonstrate compliance with the performance requirements of this project manual. Each electrical, instrumentation, mechanical, piping, and HVAC system installed or modified under this contract shall be tested in accordance with the requirements of this project manual.

### 2.04 OPERATIONAL TESTS

Once all equipment and systems have been tested individually, the Contractor shall fill all systems except wastewater, scum sludge and other wastewater derived systems with the intended process fluids. Wastewater-derived process systems shall be filled with water. After filling operations have been completed, the Contractor shall operate all systems for a continuous period of not less than 2 days, simulating actual operating conditions to the greatest extent possible. The Contractor shall install temporary connections, bulkheads and make other provisions to recirculate process fluids or otherwise simulate anticipated operating conditions. During the operational testing period, the Contractor's Quality Assurance Manager and testing team shall monitor the characteristics of each machine and system and report any unusual conditions to the Construction Manager/Resident Project Representative.

## 2.05 PRODUCT DATA

Product data, to be provided in accordance with Section 01300, shall be the original and three copies of all records produced during the testing program.

## PART 3--EXECUTION

### 3.01 GENERAL

The Contractor's quality control manager shall organize teams made up of qualified representatives of equipment suppliers, subcontractors, the 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 Construction Manager's/Resident Project Representative's complete satisfaction, that the structures, systems, and equipment constructed and installed under this contract meet all performance requirements and the facility is 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.

### 3.02 CALIBRATION OF FIXED INSTRUMENTS

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 acceptance tests shall be performed until instruments, gages, and meters to be installed in that system have been calibrated and the calibration work has been witnessed by the Construction Manager/Resident Project Representative.

All analysis instruments, sensors, gages, and meters used for performance testing shall be subject to recalibration to confirm accuracy after completion, but prior to acceptance of each performance test. All analysis instruments, sensors, gages, and meters installed under this contract shall be subject to recalibration as a condition precedent to commissioning under the provisions of Section 01662.

### 3.03 PERFORMANCE TESTS

#### A. GENERAL:

Performance tests shall consist of the following:

1. Pressure and/or leakage tests.
2. Electrical testing as specified in Section 16030.

3. Wiring, individual component, loop, and loop commissioning testing as described in Section 17030.
4. Preoperational checkout for all mechanical and HVAC equipment. Preoperational check-out procedures shall be reviewed and approved by the respective equipment manufacturers.
5. Initial operation tests of all mechanical, electrical, HVAC, and instrumentation equipment and systems to demonstrate compliance with the performance requirements of this project manual.

In general, performance tests 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 Construction Manager/Resident Project Representative after receipt of a written request, complete with justification of the need for the change in sequence.

**B. PRESSURE AND LEAKAGE TESTS:**

Pressure and leakage tests shall be conducted in accordance with applicable portions of Divisions 3 and 15. All acceptance tests shall be witnessed by the Construction Manager/Resident Project Representative. Evidence of successful completion of the pressure and leakage tests shall be the Construction Manager's/Resident Project Representative's signature on the test forms prepared by the Contractor.

**C. FUNCTIONAL 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 procedures required in Section 16030.

**D. 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 in accordance with the procedures required in Section 17030.

**E. ELECTRICAL RESISTANCE:**

Electrical resistance testing shall be in accordance with Section 16030.

**F. PREOPERATIONAL TESTS:**

Preoperational tests shall include the following:

1. Alignment of equipment using reverse dial indicator method.
2. Preoperation lubrication.
3. Tests per the manufacturers' recommendations for prestart preparation and preoperational check-out procedures.

G. FUNCTIONAL TESTS:

1. GENERAL: Once all affected equipment has been subjected to the required preoperational check-out procedures and the Construction Manager/Resident Project Representative 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. If available, plant effluent may be employed for the testing of all liquid systems except gaseous, oil, or chemical systems. If not available, potable water shall be employed as the test medium. Test media for these systems shall either be the intended fluid or a compatible substitute. The equipment shall be operated within 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. 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, the Contractor shall 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 by the Construction Manager/Resident Project Representative. During the functional test period, the Contractor shall obtain baseline operating data on all equipment with motors greater than 1 horsepower to include amperage, bearing temperatures, and vibration. The baseline data shall be collected for the Owner to enter in a preventive maintenance system.

Test results shall be within the tolerances set forth in the detailed specification sections of this project manual. 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 functional test, any doubt, dispute, or difference should arise between the Construction Manager/Resident Project Representative and the Contractor regarding the test results or the methods or equipment used in the performance of such test, then the Construction Manager/Resident Project Representative may order the test to be repeated. If the repeat test, using such modified methods or equipment as the Construction Manager/Resident Project Representative 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 the Contractor. Where the results of any functional 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 the Contractor at his expense.

The Contractor shall 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.

2. 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 Construction Manager/Resident Project Representative, be repeated within reasonable time and in accordance with the specified conditions. The Contractor shall pay to the Owner all reasonable expenses incurred by the Owner, including the costs of the Construction Manager/Resident Project Representative, as a result of repeating such tests.

3. POSTTEST INSPECTION: Once functional 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 Construction Manager/Resident Project Representative. All machines or devices which exhibit unusual or unacceptable operating characteristics shall be disassembled and inspected. Any defects found during the inspection shall be repaired or the specific part or entire equipment item shall be replaced to the complete satisfaction of the Construction Manager/Resident Project Representative at no cost to the Owner.

### 3.04 OPERATIONAL TESTS

The Contractor shall provide system operation testing. After completion of all performance testing and certification by the Construction Manager/Resident Project Representative that all equipment complies with the requirements of the specifications, the Contractor shall fill all process units and process systems, except those employing domestic water, oil, air, or chemicals, with well water. All domestic water, oil, air, and chemical systems shall be filled with the specified fluid.

Upon completion of the filling operations, the Contractor shall circulate water through the completed facility for a period of not less than 48 hours, during which all parts of the system shall be operated as a complete facility at various loading conditions, as directed by the Construction Manager/Resident Project Representative. The operational testing period shall commence after this initial period of variable operation. The operational testing period shall be 5 days. Should the operational testing period be halted for any reason related to the facilities constructed or the equipment furnished under this contract, or the Contractor's temporary testing systems, 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, and flow.



As-built documents specified in Section 01720 of facilities involved shall be accepted and ready for turnover to the Owner at the time of operational testing.

**\*\*END OF SECTION\*\***

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## SECTION 01662

### COMMISSIONING

#### PART 1--GENERAL

##### 1.01 DESCRIPTION

This section contains requirements for the Contractor's performance during the commissioning of the structures, equipment and systems constructed and installed during this contract. All commissioning work, as described in this section, shall be performed by the Contractor.

##### 1.02 QUALITY ASSURANCE

###### A. CLEANUP:

Following completion of the operational testing period, the Contractor shall remove, clean, and replace all permanent and temporary filters and strainers in all pipeline systems; replace all HVAC filters; dewater and clean all sumps; and dewater all process units for final inspection as a condition precedent to commissioning.

###### B. COMMISSIONING TEAM:

The Contractor shall assemble a commissioning team under the direction of an individual duly authorized to commit the Contractor's personnel and resources to respond to requests for assistance on the part of the Construction Manager or, through the Construction Manager, the Owner. The commissioning team shall consist of representatives of the Contractor's mechanical, electrical, and instrumentation subcontractors, and others as appropriate. The commissioning team shall be available at the site of the work during normal working hours (8 hours a day, 5 days a week, Saturdays, Sundays, and legal holidays excepted) and shall be available within 2 hours' notice at all other times upon notice by telephone. The commissioning team shall always be equipped and ready to provide for emergency repairs, adjustments, and corrections to the equipment and systems installed and modified as a part of this contract.

##### 1.03 SUBMITTALS

The following information shall be submitted to the Construction Manager in accordance with the provisions of Section 01300:

1. Detailed plans for commissioning each process unit and each system constructed or modified as a part of the work performed under this contract.
2. The Contractor's plan for providing a commissioning team conforming to the requirements of paragraph 01662-1.02 B during the commissioning period. The plan shall be complete with a daytime staffing plan and names,

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qualifications, and telephone numbers of those assigned to off-hour standby duty.

## PART 2--PRODUCTS

Working with representatives of the Owner and the Construction Manager, the Contractor shall develop and produce a detailed, written plan for the startup and initial operation, under actual operating conditions, of the equipment and systems installed and constructed under this contract. The document, after acceptance by the Construction Manager, shall serve as the guidance manual for the commissioning process.

## PART 3--EXECUTION

After completion of the equipment and system performance and operational testing, where required, and agreement on the part of the Construction Manager that the systems did meet all test requirements, commissioning will begin. The commissioning period for each modified or new unit process system shall be 4 weeks. The Contractor shall remove all temporary piping, bulkheads, controls and other alterations to the permanent systems that may have been needed during the performance and operational testing and shall perform the tasks necessary to make the improvements constructed under this contract fully operational. The Construction Manager shall confirm in writing the date(s) that the system is ready for commissioning and on which actual commissioning activities commence. Activities conducted prior to such written confirmation shall not constitute commissioning.

The Owner's operation and maintenance personnel will be responsible for operation of the systems to be commissioned. The portion of the work to be commissioned shall be fully operational, performing all functions for which it was designed.

The Contractor shall be available at all times during commissioning periods to provide immediate assistance in case of failure of any portion of the system being constructed. At the end of the commissioning period and when all corrections required by the Construction Manager to assure a reliable and completely operational facility are complete, the Construction Manager shall issue a completion certificate. Each system shall have been issued a completion certificate as a condition precedent to the final acceptance of the work of this contract.

During the commissioning period, the Owner shall be responsible for all normal operational costs and the Contractor shall bear the costs of all necessary repairs or replacements, including labor and materials, required to keep the portion of the plant being commissioned, operational.

**\*\*END OF SECTION\*\***

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## SECTION 01664

### TRAINING

#### PART 1--GENERAL

##### 1.01 DESCRIPTION

This section contains requirements for training the Owner's personnel, by persons retained by the Contractor specifically for the purpose, in the proper operation and maintenance of the equipment and systems installed under this contract.

##### 1.02 QUALITY ASSURANCE

Where required by the detailed specifications, the Contractor shall provide on-the-job training of the Owner's personnel. The training sessions shall be conducted by qualified, experienced, factory-trained representatives of the various equipment manufacturers. Training shall include instruction in both operation and maintenance of the subject equipment.

##### 1.03 SUBMITTALS

The following information shall be submitted to the Construction Manager in accordance with the provisions of Section 01300. The material shall be reviewed and accepted by the Construction Manager as a condition precedent to receiving progress payments more than 50 percent of the contract amount and not less than 3 weeks prior to the provision of training.

1. Lessons plans for each training session to be conducted by the manufacturer's representatives. In addition, training manuals, handouts, visual aids, and other reference materials shall be included.
2. Subject of each training session, identity and qualifications of individuals to be conducting the training, and tentative date and time of each training session.

#### PART 2--PRODUCTS

##### 2.01 GENERAL

Where specified, the Contractor shall conduct training sessions for the Owner's personnel to instruct the staff on the proper operation, care, and maintenance of the equipment and systems installed under this contract. Training shall take place at the site of the work and under the conditions specified in the following paragraphs. Approved operation and maintenance manuals shall be available at least 30 days prior to the date scheduled for the individual training session.

## 2.02 LOCATION

Training sessions shall take place at the site of the work in Lower Greasewood at the new water treatment plant.

## 2.03 LESSON PLANS

Formal written lesson plans shall be prepared for each training session. Lesson plans shall contain an outline of the material to be presented along with a description of visual aids to be utilized during the session. Each plan shall contain a time allocation for each subject.

One complete set of originals of the lesson plans, training manuals, handouts, visual aids, and reference material shall be the property of the Owner and shall be suitably bound for proper organization and easy reproduction. The Contractor shall furnish ten copies of necessary training manuals, handouts, visual aids and reference materials at least 1 week prior to each training session.

## 2.04 FORMAT AND CONTENT

Each training session shall be comprised of time spent both in the classroom and at the specific location of the subject equipment or system. As a minimum, training session shall cover the following subjects for each item of equipment or system:

1. Familiarization
  - a. Review catalog, parts lists, drawings, etc., which have been previously provided for the plant files and operation and maintenance manuals.
  - b. Check out the installation of the specific equipment items.
  - c. Demonstrate the unit and indicate how all parts of the specifications are met.
  - d. Answer questions.
2. Safety
  - a. Using material previously provided, review safety references.
  - b. Discuss proper precautions around equipment.
3. Operation
  - a. Using material previously provided, review reference literature.

- b. Explain all modes of operation (including emergency).
  - c. Check out Owner's personnel on proper use of the equipment.
4. Preventive Maintenance
- a. Using material previously provided, review preventive maintenance (PM) lists including:
    - 1) Reference material.
    - 2) Daily, weekly, monthly, quarterly, semiannual, and annual jobs.
  - b. Show how to perform PM jobs.
  - c. Show Owner's personnel what to look for as indicators of equipment problems.
5. Corrective Maintenance
- a. List possible problems.
  - b. Discuss repairs--point out special problems.
  - c. Open equipment and demonstrate procedures, where practical.
6. Parts
- a. Show how to use previously provided parts list and order parts.
  - b. Check over spare parts on hand. Make recommendations regarding additional parts that should be available.
7. Local Representatives
- a. Where to order parts: name, address, telephone.
  - b. Service problems:
    - 1) Who to call.
    - 2) How to get emergency help.

8. Operation and Maintenance Manuals
  - a. Review any other material submitted.
  - b. Update material, as required.

#### 2.05 VIDEO RECORDING:

The Owner will retain the services of a commercial video taping service to record each training session. After taping, the material will be edited and supplemented with professionally produced graphics to provide a permanent record. The Contractor shall advise all manufacturers providing training sessions that the material will be video taped and shall make available to the Owner's video taping contractor such utility services and accommodation as may be required to facilitate the production of the video tape record.

### PART 3--EXECUTION

Training shall be conducted in conjunction with the operational testing and commissioning periods. Classes shall be scheduled such that classroom sessions are interspersed with field instruction in logical sequence. The Contractor shall arrange to have the training conducted on consecutive days, with no more than 6 hours of classes scheduled for any one day. Concurrent classes shall not be allowed. Training shall be certified on Form 11000-B specified in Section 01999.

Acceptable operation and maintenance manuals for the specific equipment shall be provided to the Owner prior to the start of any training. Video taping shall take place concurrently with all training sessions.

The following services shall be provided for each item of equipment or system as required in individual specification sections. Additional services shall be provided, where specifically required in individual specification sections.

1. As a minimum classroom equipment training for operations personnel will include:
  - a. Using slides and drawings, discuss the equipment's specific location in the plant and an operational overview.
  - b. Purpose and plant function of the equipment.
  - c. A working knowledge of the operating theory of the equipment.



- d. Start-up, shutdown, normal operation, and emergency operating procedures, including a discussion on system integration and electrical interlocks, if any.
  - e. Identify and discuss safety items and procedures.
  - f. Routine preventative maintenance, including specific details on lubrication and maintenance of corrosion protection of the equipment and ancillary components.
  - g. Operator detection, without test instruments, of specific equipment trouble symptoms.
  - h. Required equipment exercise procedures and intervals.
  - i. Routine disassembly and assembly of equipment if applicable (as judged by the Owner on a case-by-case basis) for purposes such as operator inspection of equipment.
2. As a minimum, hands-on equipment training for operations personnel will include:
- a. Identify location of equipment and review the purpose.
  - b. Identifying piping and flow options.
  - c. Identifying valves and their purpose.
  - d. Identifying instrumentation:
    - 1) Location of primary element.
    - 2) Location of instrument readout.
    - 3) Discuss purpose, basic operation, and information interpretation.
  - e. Discuss, demonstrate, and perform standard operating procedures and round checks.
  - f. Discuss and perform the preventative maintenance activities.
  - g. Discuss and perform start-up and shutdown procedures.
  - h. Perform the required equipment exercise procedures.

- i. Perform routine disassembly and assembly of equipment if applicable.
  - j. Identify and review safety items and perform safety procedures, if feasible.
3. Classroom equipment training for the maintenance and repair personnel will include:
- a. Theory of operation.
  - b. Description and function of equipment.
  - c. Start-up and shutdown procedures.
  - d. Normal and major repair procedures.
  - e. Equipment inspection and troubleshooting procedures including the use of applicable test instruments and the "pass" and "no pass" test instrument readings.
  - f. Routine and long-term calibration procedures.
  - g. Safety procedures.
  - h. Preventative maintenance such as lubrication; normal maintenance such as belt, seal, and bearing replacement; and up to major repairs such as replacement of major equipment part(s) with the use of special tools, bridge cranes, welding jigs, etc.
4. Hands-on equipment training for maintenance and repair personnel shall include:
- a. Locate and identify equipment components.
  - b. Review the equipment function and theory of operation.
  - c. Review normal repair procedures.
  - d. Perform start-up and shutdown procedures.
  - e. Review and perform the safety procedures.

- f. Perform Owner approved practice maintenance and repair job(s), including mechanical and electrical adjustments and calibration and troubleshooting equipment problems.

**\*\*END OF SECTION\*\***

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## SECTION 01710

### FINAL CLEANUP

#### 1.0 GENERAL

At the completion of work and immediately prior to final inspection, cleaning of the entire project shall be accomplished according to the following provisions:

1. The Contractor shall thoroughly clean, sweep, wash, and polish all work and equipment provided under the Contract, including finishes. The cleaning shall leave the structures and site in a complete and finished condition to the satisfaction of the Construction Manager.
2. All subcontractors shall similarly perform, at the same time, an equivalent thorough cleaning of all work and equipment provided under their Contracts.
3. The Contractor shall remove all temporary structures and all debris, including all dirt, sand, gravel, rubbish and waste material.
4. Should the Contractor not remove rubbish or debris or not clean the buildings and site as specified, the Owner reserves the right to have the cleaning done at the expense of the Contractor.
5. Only experienced workers, or professional cleaners, shall be employed for final cleaning.
6. Only cleaning materials recommended by the manufacturer of surface to be cleaned shall be used.
7. Cleaning materials shall be used only on surfaces recommended by the cleaning material manufacturers.
8. In preparation for substantial completion or occupancy, a final inspection of sight-exposed interior and exterior surfaces, and of concealed spaces, shall be conducted.
9. Grease, dust, dirt, stains, labels, fingerprints, and other foreign materials shall be removed from sight-exposed interior and exterior finished surfaces. Polish surfaces so designated to shine finish.
10. Marred surfaces shall be repaired, patched, and touched up to specified finish, to match adjacent surfaces.

11. Air-handling filters shall be cleaned if units were operated during construction.
12. Ducts, blowers, and coils shall be cleaned, if air-handling units were operated without filters during construction.
13. All interior spaces shall be vacuum cleaned, including inside cabinets.
14. Materials shall be handled in a controlled manner with as few handlings as possible. Do not drop or throw materials from heights.

## 2.0 OWNER OCCUPANCY

As a condition precedent to final acceptance or release of a structure, space or process unit for use by the Owner, the Contractor and all subcontractors shall thoroughly clean all floors, walls, woodwork, and windows to leave same in first-class condition.

All building roof gutters, downspouts, pits and sumps shall be cleared of silt, sand, debris, and construction materials. Ductwork air intakes and exhaust grilles shall be inspected and cleared of dust and extraneous material, and all grounds shall be cleared of all debris. Finished floors shall be thoroughly cleaned, sealed, and given a final coat of wax. The Contractor shall also remove all paint from and clean all window glass and all plumbing fixtures. Carpeted areas shall be thoroughly vacuumed, and steam cleaned. Blinds, all furniture, and cabinets shall be dusted.

## 3.0 POST-CONSTRUCTION REPAIRS

The Contractor shall make such minor repairs and alterations as may be necessary to make any building or structure ready for occupancy including touch-up paint, refit windows, doors, and cabinets. The Contractor shall replace all broken and scratched glass with material which complies with the Contract Documents. This section shall not apply after or to the extent that the Owner has taken possession of a building on which the Contractor has performed work.

## 4.0 SITE CLEANUP

For all roadway work, the Contractor shall conform the work to acceptable line and grade, as determined by the Construction Manager. In addition, the Contractor shall have the sidewalks and streets affected by the work swept by a street or sidewalk cleaner as determined by the Construction Manager. Other surfaces of the grounds shall be rake cleaned. The Owner will not authorize final payment until the Contractor has removed all rubble and debris from the street and adjoining work areas, including all temporary storage and parking areas used by the Contractor.

For pipelines, storm sewers, catch basins, manholes, and all building floor drains, prior to their activation or at the end of the project, the Contractor shall thoroughly clean all of the new pipes by flushing with water for fluid lines, or compressed air for gas lines. Debris cleaned from the lines shall be removed from the lowest access point.

All temporary utility drops, fencing, and water supply outlets shall be removed.

All plant gate identification signs, barricades, tools, rubbish collection receptacles and other such items shall be removed by the Contractor.

All remaining earthen stockpiles of excess excavated material shall be graded to provide gentle slopes to prevent erosion as directed by the Construction Manager.

**\*\*END OF SECTION\*\***

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## SECTION 01720

### RECORD DRAWINGS

Record drawings refer to those documents maintained and annotated by the Contractor during construction and are defined as (1) a neatly and legibly marked set of contract drawings showing the final location of piping, equipment, electrical conduits, outlet boxes and cables, including X, Y, and Z coordinates for all fittings and valves after installation and before burial; (2) additional documents such as schedules, lists, drawings, and electrical and instrumentation diagrams included in the specifications; and (3) Contractor layout and installation drawings.

Unless otherwise specified, record drawings shall be full size and maintained in a clean, dry, and legible condition. Record documents shall not be used for construction purposes and shall be available for review by the Construction Manager during normal working hours at the Contractor's field office. At the completion of the work, prior to final payment, all record drawings shall be submitted to the Construction Manager.

Marking of the drawings shall be kept current and shall be done at the time the material and equipment are installed. Annotations to the record documents shall be made with an erasable colored pencil conforming to the following color code:

Additions - Red  
Deletions - Green  
Comments - Blue  
Dimensions - Graphite\*

\*Legibly mark to record actual depths, horizontal and vertical location of underground raceways, cables, and appurtenances referenced to permanent surface improvements.

**\*\*END OF SECTION\*\***

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## SECTION 01730

### OPERATING AND MAINTENANCE INFORMATION

#### 1.0 SCOPE

Operation and maintenance (O&M) instructions shall be provided in accordance with this section and as required in the technical sections of this project manual. O&M information shall be provided for each maintainable piece of equipment, equipment assembly or subassembly, and material provided or modified under this contract.

O&M instructions must be submitted and accepted before on-site training may start.

#### 2.0 TYPES OF INFORMATION REQUIRED

##### A. GENERAL:

O&M information shall contain the names, addresses, and telephone numbers of the manufacturer, the nearest representative of the manufacturer, and the nearest supplier of the manufacturer's equipment and parts. In addition, one or more of the following items of information shall be provided as applicable.

##### B. OPERATING INSTRUCTIONS:

Specific instructions, procedures, and illustrations shall be provided for the following phases of operations:

1. **SAFETY PRECAUTIONS:** List personnel hazards for equipment and list safety precautions for all operating conditions.
2. **OPERATOR PRESTART:** Provide requirements to set up and prepare each system for use.
3. **START-UP, SHUTDOWN, AND POSTSHUTDOWN PROCEDURES:** Provide a control sequence for each of these operations.
4. **NORMAL OPERATIONS:** Provide control diagrams with data to explain operation and control of systems and specific equipment.
5. **EMERGENCY OPERATIONS:** Provide emergency procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Include emergency shutdown instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance on emergency

operations of all utility systems including valve locations and portions of systems controlled.

6. **OPERATOR SERVICE REQUIREMENTS:** Provide instructions for services to be performed by the operator such as lubrication, adjustments, and inspection.
7. **ENVIRONMENTAL CONDITIONS:** Provide a list of environmental conditions (temperature, humidity, and other relevant data) which are best suited for each product or piece of equipment and describe conditions under which equipment should not be allowed to run.

**C. PREVENTIVE MAINTENANCE:**

The following information shall be provided for preventive and scheduled maintenance to minimize corrective maintenance and repair:

1. **LUBRICATION DATA:** Provide lubrication data, other than instructions for lubrication in accordance with paragraph 2.0-B6.
  - a. A table showing recommended lubricants for specific temperature ranges and applications;
  - b. Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities; and
  - c. A lubrication schedule showing service interval frequency.
2. **PREVENTIVE MAINTENANCE PLAN AND SCHEDULE:** Provide manufacturer's schedule for routine preventive maintenance, inspections, tests, and adjustments required to ensure proper and economical operation and to minimize corrective maintenance and repair. Provide manufacturer's projection of preventive maintenance man-hours on a daily, weekly, monthly, and annual basis including craft requirements by type of craft.

**D. CORRECTIVE MAINTENANCE:**

Manufacturer's recommendations shall be provided on procedures and instructions for correcting problems and making repairs.

1. **TROUBLESHOOTING GUIDES AND DIAGNOSTIC TECHNIQUES:** Provide step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment

required to determine whether parts and equipment may be reused or require replacement.

2. **WIRING DIAGRAMS AND CONTROL DIAGRAMS:** Wiring diagrams and control diagrams shall be point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide a complete and accurate depiction of the actual job-specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type identically to actual installation numbering.
3. **MAINTENANCE AND REPAIR PROCEDURES:** Provide instructions and list tools required to restore product or equipment to proper condition or operating standards.
4. **REMOVAL AND REPLACEMENT INSTRUCTIONS:** Provide step-by-step procedures and list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings, and adjustments required. Instructions shall include a combination of tests and illustrations.
5. **SPARE PARTS AND SUPPLY LISTS:** Provide lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonable delays. Special consideration is required for facilities at remote locations. List spare parts and supplies that have a long lead time to obtain.
6. **CORRECTIVE MAINTENANCE MANHOURS:** Provide manufacturer's projection of corrective maintenance man-hours including craft requirements by type of craft. Corrective maintenance that requires participation of the equipment manufacturer shall be identified and tabulated separately.

E. **APPENDICES:**

The following information shall be provided; include information not specified in the preceding paragraphs but pertinent to the maintenance or operation of the product or equipment.

1. **PARTS IDENTIFICATION:** Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as use of high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate

listing shall show the index, reference, or key number which will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies.

2. **WARRANTY INFORMATION:** List and explain the various warranties and include the servicing and technical precautions prescribed by the manufacturers or contract documents to keep warranties in force.
3. **PERSONNEL TRAINING REQUIREMENTS:** Provide information available from the manufacturers to use in training designated personnel to operate and maintain the equipment and systems properly.
4. **TESTING EQUIPMENT AND SPECIAL TOOL INFORMATION:** Provide information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.

### 3.0 TRANSMITTAL PROCEDURE

Unless otherwise specified, O&M manuals, information, and data shall be transmitted in accordance with Section 01300 accompanied by Transmittal Form 01730-A and Equipment Record Forms 01730-B and/or 01730-C, as appropriate, all as specified in Section 01999. The transmittal form shall be used as a checklist to ensure the manual is complete. Only complete sets of O&M instructions will be reviewed for acceptance.

Five (5) hard copies and five (5) electronic pdf (CD) copies of the specified O&M information shall be provided. For ease of identification, each manufacturer's brochure and manual shall be appropriately labeled with the equipment name and equipment number as it appears in the project manual. The information shall be organized in the binders in numerical order by the equipment numbers assigned in the project manual. The binders shall be provided with a table of contents and tab sheets to permit easy location of desired information. Binders shall be 3-ring, of uniform color (preferably white) with plastic view covers for cover page and spine inserts. The binders shall be sized adequately to accommodate the appropriate manual. The outside cover page insert, and spine insert shall include the equipment location, project number, all applicable equipment ID numbers, description, supplier name and purchase agreement number. The inside cover page shall include all applicable equipment ID numbers, description, location, "Purchased From" (supplier name), "purchased by" (purchaser name), suppliers contact information, and purchase agreement number. All manuals shall also have a uniform tabbed Table of Contents.

If manufacturers' standard brochures and manuals are used to describe O&M procedures, such brochures and manuals shall be modified to reflect only the model or series of equipment used on this project. Extraneous material shall be crossed out neatly or otherwise annotated or eliminated.

### 4.0 PAYMENT

Acceptable O&M information for the project must be delivered to the Construction Manager prior to the project being 65 percent complete. Progress payments for work more than 65 percent completion will not be made until the specified acceptable O&M information has been delivered to the Construction Manager.

#### 5.0 FIELD CHANGES

Following the acceptable installation and operation of an equipment item, the item's instructions and procedures shall be modified and supplemented by the Contractor to reflect any field changes or information requiring field data.

**\*\*END OF SECTION\*\***

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SECTION 01800

ENVIRONMENTAL CONDITIONS

This section describes the environmental conditions which have been observed at the site of the work and which may reasonably be anticipated throughout the life of the project.

The Bodaway-Gap Well 3 and Gap Tank 2 site are at elevations of **5460 and 5739** feet above mean sea level. The site of work for Well 3 is located at a latitude/longitude of 36°21'39.77"N and 111°25'20.23"W. The site work for Gap Tank 2 is at latitude/longitude of 36°21'13.30"N and 111°23'48.81"W. Climate conditions are described as follows:

Description	Range of Conditions
Winter	<b>-20 to 40 (°F)</b>
Summer	<b>44 to 110 (°F)</b>
Relative humidity, percent	
Indoors	<b>40-60%</b>
Average outdoors	<b>40-60%</b>
Air temperature, degrees F	
Outdoors	<b>53.2 °F Annual Avg</b>
Indoors	<b>70 °F (Varies)</b>
Barometric pressure, inches, mercury	<b>30.01 Annual Avg</b>

Additional conditions which may be applicable are specified in other sections.

**\*\*END OF SECTION\*\***

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## SECTION 01900

### STRUCTURAL DESIGN AND ANCHORAGE REQUIREMENTS FOR NONSTRUCTURAL COMPONENTS AND NONBUILDING STRUCTURES

#### PART 1—GENERAL

##### 1.01 SUMMARY

###### A. SCOPE

This section specifies the minimum structural requirements for the design, anchorage and bracing of architectural/mechanical/HVAC/electrical components, equipment, and systems, and nonbuilding structures. Design of supports, attachments and bracing for all parts or elements of the architectural, mechanical, HVAC and electrical systems shall be provided in accordance with this section. The requirements of this section shall apply to the design of the structural elements and features of equipment and to platforms/walkways that are provided with equipment or nonbuilding structures.

This section applies to nonstructural components that are permanently attached to structures, and nonbuilding structures as defined below in paragraph 1.01-B and ASCE 7-05. Note that equipment is defined as a non-structural component and tanks are defined as a nonbuilding structure.

Design shall be in accordance with the criteria listed within this section and shall conform to the provisions of the design codes listed within this section. Engineering design is not required for attachments, anchorage, or bracing detailed on the drawings or where the size of attachments, anchorage, or bracing is defined in the technical specification sections.

The following nonstructural components are exempt from the seismic design loading requirements of this section.

1. Components in Seismic Design Category C.
2. Architectural components in Seismic Design Category B other than parapets supported by bearing walls or shear walls provided that the component importance factor,  $I_p$ , is equal to 1.0.
3. Mechanical and electrical components in Seismic Design Category B.
4. Mechanical and electrical components in Seismic Design Category C provided that the component importance factor,  $I_p$ , is equal to 1.0.

5. Mechanical and electrical components in Seismic Design Categories D, E or F where the component importance factor,  $I_p$ , is equal to 1.0 and both of the following conditions apply:
  - a. Flexible connections between the components and associated ductwork, piping and conduit are provided, and
  - b. Components are mounted at 4 ft or less above a floor level and weigh 400 lb. or less (4 ft criteria applies to the mounting support elevation relative to the floor).
6. Mechanical and electrical components in Seismic Design Categories D, E or F where the component importance factor,  $I_p$ , is equal to 1.0 and both of the following conditions apply:
  - a. Flexible connections between the components and associated ductwork, piping and conduit are provided, and
  - b. The components weigh 20 lb. or less or, for distribution systems, weighing 5 lb./ft or less.

**B. DEFINITIONS:**

1. **STRUCTURES:** The structural elements of a building that resist gravity, seismic, wind, and other types of loads. Structural components include columns, posts, beams, girders, joists, bracing, floor or roof sheathing, slabs or decking, load-bearing walls, and foundations.
2. **NONSTRUCTURAL COMPONENTS:** The nonstructural portions of a building include every part of the building and all its contents, except the structural portions, that carry gravity loads and that may also be required to resist the effects of wind, snow, impact, temperature and seismic loads. Nonstructural components include, but are not limited to, ceilings, partitions, windows, equipment, piping, ductwork, furnishings, lights, etc.
3. **NONBUILDING STRUCTURES:** All self-supporting structures that carry gravity loads and that may also be required to resist the effects of wind, snow, impact, temperature and seismic loads. Nonbuilding structures include, but are not limited to, pipe racks, storage racks, stacks, tanks, vessels and structural towers that support tanks and vessels.

## 1.02 QUALITY ASSURANCE

### A. QUALITY CONTROL BY OWNER:

Special Inspection of nonstructural components and nonbuilding structures, and their anchorages shall be performed by the Special Inspector under contract with the Owner and in conformance with IBC Chapter 17. Special Inspector(s) and laboratory shall be acceptable to the Owner in their sole discretion. Special Inspection is in addition to, but not replacing, other inspections and quality control requirements herein. Where sampling and testing required herein conforms to Special Inspection standards, such sampling and testing need not be duplicated.

### B. REFERENCES:

Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). 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, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced. When conflicting requirements occur, the most stringent requirements will govern the design.

Reference	Title
AAMA	American Architectural Manufacturer's Association
ACI 318-14	Building Code Requirements for Structural Concrete
ACI 350-06	Code Requirements for Environmental Engineering Concrete Structures
AISC 341	Seismic Provisions for Structural Steel Buildings
ACI 360-10	Specification for Structural Steel Buildings
ASCE 7-10	Minimum Design Loads for Buildings and Other Structures
ASTM C635	Standard Specification for the Manufacture, Performance and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
ASTM C636	Standard Practice for Installation for Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
AWS D1.1	Structural Welding Code – Steel

Reference	Title
AWS D1.2	Structural Welding Code - Aluminum
AWS D1.2	Structural Welding Code – Stainless Steel
IBC	International Building Code with local amendments
NFPA-13	Standard for the Installation of Sprinkler Systems
OSHA	U.S. Dept. of Labor, Occupational Safety and Health Administration
ADOSH	Arizona Division of Occupational Safety and Health
SMACNA	Seismic Restraint Manual Guidelines for Mechanical Systems

### 1.03 SUBMITTALS

For structural elements of nonstructural components and nonbuilding structures required to be designed per this specification section, drawings and design calculations shall be stamped by an Arizona licensed professional engineer qualified to perform structural engineering.

Submit drawings and calculations no less than four weeks in advance of the installation of any component to be anchored to the structure or installation of any structural member to which the component will be attached.

A. The following submittals shall be provided in accordance with Section 01300:

1. List of all nonstructural components and nonbuilding structures requiring wind and seismic design and anchorage.
2. Shop drawings showing details of complete wind and seismic bracing and anchorage attachment assemblies including connection hardware, and embedment into concrete.
3. Shop drawings showing plans, elevations, sections and details of equipment support structures and nonbuilding structures, including anchor bolts, structural members, platforms, stairs, ladders, and related attachments.
4. Identify all interface points with supporting structures or foundations, as well as the size, location, and grip of all required attachments and anchor bolts. Clearly indicate who will be providing each type of attachment/anchor bolt. Equipment vendor shall design anchor bolts, including embedment into concrete, and submit stamped calculations.
5. Calculations for all supports, bracing, and attachments shall clearly indicate the design criteria applied in the design calculations. Concrete embedment calculations shall be coordinated with thickness and strength of concrete members. Submit a tabulation of the magnitude of unfactored (service level)

Structural Design and Anchorage Requirements  
01900-4

Bodaway-Gap Contract 2  
Bid Issue

equipment loads at each support point, broken down by type of loading (dead, live, wind, seismic, etc.). Indicate impact factors applied to these loads in the design calculations.

6. Product Data: Manufacturer’s certificates of compliance with the seismic force requirements of this section.
- 7.

#### 1.04 DESIGN CODES

The following standard codes have application at this site for:

Buildings/Structures:	International Building Code 2015 and ASCE 7-10
Reinforced concrete:	ACI 350-06 for Concrete Liquid Containing Tanks, ACI 318-14 for all other reinforced concrete
Structural steel:	AISC 360-05 and AISC 341-10
Welding:	AWS Welding Codes, Latest Edition
Occupational health and safety requirements:	U.S. Dept. of Labor, Occupational Safety and Health Administration (OSHA)

When conflicting requirements occur, the most stringent requirements will govern the design.

#### 1.05 DESIGN LOADS

All nonstructural components and nonbuilding structures shall be designed for the following loads. Wind and snow loads shall not be applied to nonstructural components and nonbuilding structures that are located inside buildings.

##### A. DEAD LOADS:

An additional allowance will also be added for piping and conduit when supported and hung from the underside of equipment and platforms.

##### B. UNIFORM LIVE LOADS:

Elevated grating floors:	100 psf.
Columns:	No column live load reduction allowed
Stairs, storage areas, and landings:	100 psf.

Equipment platforms, walkways/catwalks (other than exit ways):	100 psf
Utility bridges:	75 psf per level minimum

C. SNOW LOADS:

Code:	IBC 2015 & ASCE 7-10
Ground Snow Load ( $p_g$ ):	25 psf (Navajo County Addenda and Additions to the IBC)
Exposure Factor ( $C_e$ ):	1.0
Importance Factor (I):	1.2
Minimum Roof Snow Load:	22 psf

D. WIND LOADS:

Code:	IBC 2015 & ASCE 7-10
Basic Wind Speed (3-second gust):	125 mph
Exposure:	C
Topographic Factor ( $K_{zt}$ ):	1.0
Importance Factor (I):	1.15 (Water Treatment facilities are Risk Category IV)

All exterior nonstructural components and nonbuilding structures, unless located in a pit or basin, shall be designed to withstand the design wind loads without consideration of shielding effects by other structures.

E. SEISMIC LOADS:

Code:	IBC 2015 & ASCE 7-10
0.2 Sec. Mapped Spectral Response, $S_S$ :	0.336 g
1.0 Sec. Mapped Spectral Response, $S_1$ :	0.099 g
Site Class:	D
0.2 Sec. Design Spectral Response, $S_{DS}$ :	0.343 g
1.0 Sec. Design Spectral Response, $S_{D1}$ :	0.158 g



Importance Factor (I):	1.5 (Water Treatment facilities are Risk Category IV)
Component Importance Factor ( $I_p$ ):	1.0, except $I_p=1.5$ for fire protection sprinkler systems or components containing hazardous materials
Seismic Design Category	C

Seismic loads shall be calculated based on the governing building code. The structure dead load shall include equipment operating loads.

Individual members shall be checked for seismic and full member live load acting simultaneously, except that flooded equipment loads (infrequent occurrence) need not be combined with seismic loads. Equipment operating loads shall be combined with seismic loads.

#### F. IMPACT LOADS:

Impact loads shall be considered in the design of support systems.

The following impact load factors shall be used unless recommendations of the equipment manufacturer will cause a more severe load case.

Rotating machinery:	20% of moving load
Reciprocating machinery:	50% of moving load
Monorail Hoists:	
Vertical	25% of lifted load
Longitudinal	10% of lifted load
Hangers supporting floors and platforms:	33% of live and dead load

#### G. TEMPERATURE:

The effects of temperature shall be included in design where nonstructural components and nonbuilding structures are exposed to differential climatic conditions. See Section 1.07 for temperature extremes.

### 1.06 LOAD COMBINATIONS

All nonstructural components and nonbuilding structures shall be designed to withstand the load combinations as specified in the governing building code. Where the exclusion of live load or impact load would cause a more severe load condition for the member under investigation, then the load shall be ignored when evaluating that member.

## 1.07 DESIGN CONSIDERATIONS

All nonstructural components and nonbuilding structures shall be designed for the following conditions:

### A. CLIMATIC CONDITIONS:

Maximum design temperature:	100	degrees Fahrenheit
Minimum design temperature:	10	degrees Fahrenheit

### B. FOUNDATIONS:

Foundations supporting nonstructural components and nonbuilding structures shall extend below the frost line or be supported on non-frost susceptible structural fill down to the frost line.

Frost line for foundations:	30 inches
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Consult project geotechnical report for allowable soil bearing recommendations at location of structure.

## 1.08 COLUMN BASE FIXITY

Column bases shall be designed as pinned connections. No moments shall be assumed to be transferred to the foundations.

Where significant shear loads (greater than 5,000 lb. per anchor bolt) are transferred at column base plates, the equipment vendor shall provide a shear key.

## 1.09 DEFLECTIONS

Maximum beam deflections as a fraction of span for walkways and platforms shall be  $L/240$  for total load and  $L/360$  for live load. Maximum total load deflection for equipment supports shall be  $L/450$ .

## PART 2—PRODUCTS

### 2.01 GENERAL

Materials shall be in conformance with information shown on the drawings and in other technical specification sections. See individual component and equipment specifications for additional requirements.

## PART 3—EXECUTION

### 3.01 GENERAL

- A. Attachments and braces shall be made in such a manner that the component force is transferred to the lateral force-resisting system of the structure. Attachment requirements and size and number of braces shall be based on the calculations submitted by the Contractor.
- B. All anchorage of equipment is specified to be made by cast-in anchor bolts in concrete elements unless specifically noted otherwise on the drawings or other specification Sections. Contractor shall be responsible for any remedial work or strengthening of concrete elements because of superimposed seismic loading if anchor bolts are improperly installed or omitted due to lack of submittal review or improper placement for any reason, at no additional cost to the Owner.
- C. Anchor bolts shall be provided and installed by the Contractor in accordance with Section 05502. Size of anchor bolts and embedment of anchor bolts shall be based on the calculations submitted by the Contractor.
- D. Details of and calculations for all anchorages shall be submitted and accepted in accordance with paragraph 1.03 prior to placement of concrete or erection of other structural supporting members. Submittals received after structural supports are in place will be rejected if proposed anchorage method would create an overstressed condition of the supporting member. The Contractor shall be responsible for revisions to the anchorages and/or strengthening of the structural support so that there is no overstressed condition at no additional cost to the Owner.

**\*\*END OF SECTION\*\***

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SECTION 01999

REFERENCE FORMS

The forms listed below and included in this section are referenced from other sections of the project manual:

Form No.	Title
01300-A	Submittal Transmittal Form
01660-A	Equipment Test Report Form
01730-A	Operation and Maintenance Transmittal Form
01730-B	Equipment Record Form
01730-C	Equipment Record Form
09900-A	Coating System Inspection Checklist
11000-A	Manufacturer's Installation Certification Form
11000-B	Manufacturer's Instruction Certification Form
11000-C	Unit Responsibility Certification Form
11002-A	Rigid Equipment Mount Installation Inspection Checklist
11060-A	Motor Data Form
16000-A	Wire and Cable Resistance Test Data Form
16000-B	Installed Motor Test Data Form
16000-C	Dry Transformer Test Data Form
16000-D	Motor Control Center Test Form
16000-M	Starter Panel Test Form
17000-A	Loop Wiring and Insulation Resistance Test Data Form
17000-B	Control Circuit Piping Leak Test Form
17000-G	Field Switch Calibration Test Data Form
17000-H	Transmitter Calibration Test Data Form
17000-I	Miscellaneous Instrument Calibration Test Data Form
17000-J	Individual Loop Test Data Form
17000-K	Loop Commissioning Test Data Form
17000-L	PLC Control Panel Test Data Form
17000-M	Radio Test Data Form

Submittal Description: \_\_\_\_\_ Submittal No:<sup>1</sup> \_\_\_\_\_  
 Spec Section: \_\_\_\_\_

	Routing	Sent	Received
OWNER: Navajo Tribal Utility Authority (NTUA)	Contractor/CM		
PROJECT: Navajo Nation Western Navajo Pipeline Phase 1 Bodaway-Gap Well, Tank and Pipeline	CM/Engineer		
	Engineer/CM		
CONTRACTOR:	CM/Contractor		

We are sending you  Attached  Under separate cover via \_\_\_\_\_  
 Submittals for review and comment  Product data for information only

Remarks: \_\_\_\_\_

Item	Copies	Date	Section No.	Description	Review action <sup>a</sup>	Reviewer initials	Review comments attached

<sup>a</sup>Note: NET = No exceptions taken; MCN = Make corrections noted; A&R = Amend and resubmit; R = Rejected Attach additional sheets if necessary.

**Contractor**

Certify either A or B:

- A. We have verified that the material or equipment contained in this submittal meets all the requirements, including coordination with all related work, specified (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

Certified by: \_\_\_\_\_  
 Contractor's Signature

<sup>1</sup>See paragraph 01300-4.0 A, Transmittal Procedure.

01660-A. EQUIPMENT TEST REPORT FORM

NOTE: This example equipment test report is provided for the benefit of the 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.

**CITY OF SAMPLE**

**EXAMPLE WATER TREATMENT PLANT  
STAGE IV EXPANSION PROJECT**

ABC Construction Company, Inc., General Contractor  
XYZ Engineering, Inc., Construction Manager

**EQUIPMENT TEST REPORT**

Equipment Name: Sludge Pump 2  
 Equipment Number: P25202  
 Specification Ref: 11390  
 Location: East Sedimentation Basin Gallery

	Contractor		Construction Manager	
	Verified	Date	Verified	Date
<b>PREOPERATIONAL CHECKLIST</b>				
<u>Mechanical</u>				
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 complete				
<u>Electrical</u> (circuit ring-out and high-pot tests)				
Circuits:				
Power to MCC 5				
Control to HOA				

	Contractor		Construction Manager	
	Verified	Date	Verified	Date
Indicators at MCC:				
Red (running)				
Green (power)				
Amber (auto)				
Indicators at local control panel				
Wiring labels complete				
Nameplates:				
MCC				
Control station				
Control panel				
Equipment bumped for rotation				
<u>Piping Systems</u>				
Cleaned and flushed:				
Suction				
Discharge				
Pressure tests				
Temporary piping screens in place				
<u>Instrumentation and Controls</u>				
Flowmeter FE2502F calibration				
Calibration Report No.				
Flow recorder FR2502G calibrated against transmitter				
VFD speed indicator calibrated against independent reference				
Discharge overpressure shutdown switch calibration				
Simulate discharge overpressure Shutdown				
<b>FUNCTIONAL TESTS</b>				
<u>Mechanical</u>				
Motor operation temperature satisfactory				
Pump operating temperature satisfactory				
Unusual noise, etc.?				
Pump operation: 75 gpm / 50 psig				
Measurement:				
Flow:				
Pressure:		Test gage number:		
Alignment hot				
Dowelled in				
Remarks:				



	Contractor		Construction Manager	
	Verified	Date	Verified	Date
<hr/>				
	Contractor		Construction Manager	
	Verified	Date	Verified	Date
<b>Electrical</b>				
Local switch function:				
Runs in <i>HAND</i>				
No control power in <i>OFF</i>				
Timer control in <i>AUTO</i>				
Overpressure protection switch PS2502C functional in both <i>HAND</i> and <i>AUTO</i>				
Overpressure protection switch PS2502C set at 75 psig				
PLC 2500 set at 24-hour cycle, 25 min <i>ON</i>				
<b>OPERATIONAL TEST</b>				
48-hour continuous test. Pump cycles as specified, indicators functional, controls functional, pump maintains capacity, overpressure protection remains functional, hour meter functional				

RECOMMENDED FOR BENEFICIAL OCCUPANCY

\_\_\_\_\_

Construction Manager \_\_\_\_\_ Date \_\_\_\_\_

ACCEPTED FOR BENEFICIAL OCCUPANCY

\_\_\_\_\_

Owner's Representative \_\_\_\_\_ Date \_\_\_\_\_

01730-A. OPERATION AND MAINTENANCE TRANSMITTAL FORM

Date: \_\_\_\_\_ Submittal No:<sup>2</sup> \_\_\_\_\_  
 To: \_\_\_\_\_ Contract No: Contract 3  
 \_\_\_\_\_ Spec. Section: \_\_\_\_\_  
 \_\_\_\_\_ Submittal Description: \_\_\_\_\_  
 \_\_\_\_\_ From: \_\_\_\_\_  
 Attention: \_\_\_\_\_

Checklist	Contractor		Construction manager	
	Satisfactory	N/A	Accept	Deficient
1. Table of contents				
2. Equipment record forms				
3. Manufacturer information				
4. Vendor information				
5. Safety precautions				
6. Operator prestart				
7. Start-up, shutdown, and post shutdown procedures				
8. Normal operations				
9. Emergency operations				
10. Operator service requirements				
11. Environmental conditions				
12. Lubrication data				
13. Preventive maintenance plan and schedule				
14. Troubleshooting guides and diagnostic techniques				
15. Wiring diagrams and control diagrams				
16. Maintenance and repair procedures				
17. Removal and replacement instructions				
18. Spare parts and supply list				
19. Corrective maintenance man-hours				
20. Parts identification				
21. Warranty information				
22. Personnel training requirements				
23. Testing equipment and special tool information				

Remarks: \_\_\_\_\_

Contractor's Signature \_\_\_\_\_

<sup>2</sup>See paragraph 01300-4.0 A, Transmittal Procedure.

01730-B. EQUIPMENT RECORD FORM

EQUIP DESCRIP		EQUIP LOC	
EQUIP NO.	SHOP DWG NO.	DATE INST	COST
MFGR		MFGR CONTACT	
MFGR ADDRESS			PHONE
VENDOR		VENDOR CONTACT	
VENDOR ADDRESS			PHONE

MAINTENANCE REQUIREMENTS							D	W	M	Q	S	A	Hours
LUBRICANTS: RECOMMENDED:													
ALTERNATIVE:													
MISC. NOTES:													

RECOMMENDED SPARE PARTS			
PART NO	QUAN	PART NAME	COST

ELECTRICAL NAMEPLATE DATA			
EQUIP			
MAKE			
SERIAL NO.		ID NO.	
MODEL NO.		FRAME NO.	
HP	V	AMP	HZ
PH	RPM	SF	DUTY
CODE	INSL. CL	DES	TYPE
NEMA DES	C AMB	TEMP RISE	RATING
MISC.			
MECHANICAL NAMEPLATE DATA			
EQUIP			
MAKE			
SERIAL NO.		ID NO.	
MODEL NO.		FRAME NO.	
HP	RPM	CAP	SIZE
TDH	IMP SZ	BELT NO.	CFM
PSI	ASSY NO.	CASE NO.	
MISC			

# 01730-C. EQUIPMENT RECORD FORM

EQUIP DESCRIP		EQUIP LOC	
EQUIP NO.	SHOP DWG NO.	DATE INST	COST
MFGR		MFGR CONTACT	
MFGR ADDRESS			PHONE
VENDOR		VENDOR CONTACT	
VENDOR ADDRESS			PHONE

MAINTENANCE REQUIREMENTS	D	W	M	Q	S	A	Hours

09900-A COATING SYSTEM INSPECTION CHECKLIST

09900-A Coating System Inspection Checklist			
Project Name	Navajo Nation Lower Greasewood Water System Improvements		
Owner	Navajo Tribal Utility Authority (NTUA)	Coating System Manufacturer (CSM)	
General Contractor (GC)		Coating System Applicator (CSA)	
Area or Structure		Location within Structure	
Coating System (eg E-1)		Coating Type (eg Epoxy, etc.)	

Step	Description		Name	Signature	Date
1	Completion of cleaning and substrate decontamination prior to abrasive blast cleaning.	GC QC			
		CSM QC			
		CSA QC			
2	Installation of protective enclosure of structure or area and protection of adjacent surfaces or structures that are not to be coated.	GC QC			
		CSM QC			
		CSA QC			
3	Completion of ambient condition control in structure or building area and acceptance of ventilation methods in structure or Area.	GC QC			
		CSM QC			
		CSA QC			
4	Completion of Surface Preparation for Substrates to Be Coated.	GC QC			
		CSM QC			
		CSA QC			

Step	Description		Name	Signature	Date
5	Completion of Primer Application.	GC QC			
		CSM QC			
		CSA QC			
6	Completion of Concrete Repairs If Required and Related Surface Preparation Rework Prior to Coating System Application.	GC QC			
		CSM QC			
		CSA QC			
7	Completion of Concrete Filler/ Surface Application to Concrete.	GC QC			
		CSM QC			
		CSA QC			
8	Completion of First Finish Coat Application and of Detail Treatment at Transitions or Terminations.	GC QC			
		CSM QC			
		CSA QC			
9	Completion of Second Finish Coat Application and of Detail Treatment at Transitions and Terminations.	GC QC			
		CSM QC			
		CSA QC			
10	Completion of Full and Proper Cure of Coating System.	GC QC			
		CSM QC			
		CSA QC			
11	Completion of Testing of Cured Coating System including Adhesion, Holiday (Continuity) Testing and Dry Film Thickness.	GC QC			
		CSM QC			
		CSA QC			

Step	Description		Name	Signature	Date
12	Completion of Localized Repairs to Coating System Following Testing.	GC QC			
		CSM QC			
		CSA QC			
13	Final Acceptance of Coating System Installation Including Final Clean-Up Complying with Specification Requirements and the CSM's Quality Requirements.	GC QC			
		CSM QC			
		CSA QC			

11000-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 project manual, 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



11000-B. 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 wastewater treatment plant operating personnel in the proper maintenance and operation of the equipment designated herein.

<u>Operations Check List</u> (check appropriate spaces)	
Start-up procedure reviewed	
Shutdown procedure reviewed	
Normal operation procedure reviewed	
Others:	
<u>Maintenance Check List</u> (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

(Project Title)

**CERTIFICATE OF UNIT RESPONSIBILITY**  
for Specification Section \_\_\_\_\_

\_\_\_\_\_  
(Section title)

*In accordance with paragraph 11000-1.02 C of the contract documents, the undersigned manufacturer of driven equipment (“manufacturer”) accepts unit responsibility for all components of equipment furnished to the Project under specification Section \_\_\_\_\_, and for related equipment manufactured under Sections \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_.*

*We have reviewed the requirements for Sections 11000 (and 11050 where applicable) and all sections referencing this (these) section(s), including but not limited to drivers, supports for driving and driven equipment and all other specified appurtenances to be furnished to the Project by manufacturer. And, we have further reviewed, and modified as necessary, the requirements for associated variable speed drives and motor control centers. We hereby certify that all specified components are compatible and comprise a functional unit suitable for the specified performance and design requirements whether or not the equipment was furnished by us. We will make no claim nor establish any condition that problems in operation for the product provided under this specification Section \_\_\_\_\_ are due to incompatibility of any components covered by this Certificate of Unit Responsibility. Nor will we condition or void any warranty for the performance of the product of this specification Section \_\_\_\_\_ due to incompatibility of any components covered under this Certificate of Unit Responsibility.*

*Our signature on this Certificate of Unit Responsibility does not obligate us to take responsibility for, nor to warrant the workmanship, quality, or performance of related equipment provided by others under specification Sections \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_. Our obligation to warranty all equipment provided by us shall remain unaffected.*

\_\_\_\_\_  
Notary Public

\_\_\_\_\_  
Name of Corporation

\_\_\_\_\_  
Commission expiration date

\_\_\_\_\_  
Address

Seal:

By: \_\_\_\_\_  
Duly Authorized Official

\_\_\_\_\_  
Legal Title of Official

Date: \_\_\_\_\_

11002-A. RIGID EQUIPMENT MOUNT INSTALLATION CHECKLIST

(CLIENT, PROJECT NAME)

Equipment Tag No.: \_\_\_\_\_ Date: \_\_\_\_\_

Grout Product Name and Type: \_\_\_\_\_

Grouting System Manufacturer: \_\_\_\_\_

Grouting Application Contractor: \_\_\_\_\_

General Contractor: \_\_\_\_\_

**Step 1: Verify Equipment Anchor Installation Conformance to Equipment Pad Details**

Name: \_\_\_\_\_ Date \_\_\_/\_\_\_/\_\_\_  
Contractor Rep.

Name: \_\_\_\_\_ Name: \_\_\_\_\_  
Construction Manager Millwright

**Step 2: Completion of Cleaning and Concrete Substrate Preparation Prior to Grouting**

Name: \_\_\_\_\_ Date \_\_\_/\_\_\_/\_\_\_  
Contractor Rep.

Name: \_\_\_\_\_ Name: \_\_\_\_\_  
Construction Manager Grouting Contractor Rep.

Name: \_\_\_\_\_  
Grout Manufacturer's Technical Rep.

**Step 3: Equipment Leveling**

Name: \_\_\_\_\_ Date \_\_\_/\_\_\_/\_\_\_  
Contractor Rep.

Name: \_\_\_\_\_ Name: \_\_\_\_\_  
Construction Manager Millwright

**Step 4: Installation of Protection of Adjacent Surfaces or Structures  
NOT TO BE GROUTED**

Name: \_\_\_\_\_ Date \_\_\_/\_\_\_/\_\_\_  
Contractor Rep.

Name: \_\_\_\_\_ Name: \_\_\_\_\_  
Construction Manager Grouting Contractor Rep.

Name: \_\_\_\_\_  
Grout Manufacturer's Technical Rep.

**Step 5: Preparation and Construction of Forms and Epoxy Grout Filling  
Standpipes**

Name: \_\_\_\_\_ Date \_\_\_/\_\_\_/\_\_\_  
Contractor Rep.

Name: \_\_\_\_\_ Name: \_\_\_\_\_  
Construction Manager Grouting Contractor Rep.

Name: \_\_\_\_\_  
Grout Manufacturer's Technical Rep.

**Step 6: Completion of Ambient Condition Control in Structure or Building Area  
and Acceptance of Ambient Conditions as They Apply to Application and  
Curing Requirements for the Grouting System**

Name: \_\_\_\_\_ Date \_\_\_/\_\_\_/\_\_\_  
Contractor Rep.

Name: \_\_\_\_\_ Date \_\_\_/\_\_\_/\_\_\_  
Grouting Contractor Rep.

Name: \_\_\_\_\_ Date \_\_\_/\_\_\_/\_\_\_  
Grout Manufacturer's Technical Rep.

Name: \_\_\_\_\_ Date \_\_\_/\_\_\_/\_\_\_  
Construction Manager

**Step 7: Epoxy Grout Installation**

Name: \_\_\_\_\_ Date \_\_\_/\_\_\_/\_\_\_  
Contractor Rep.

Name: \_\_\_\_\_ Name: \_\_\_\_\_  
Construction Manager Grouting Contractor Rep.

Name: \_\_\_\_\_  
Grout Manufacturer's Technical Rep.

**Step 8: Completion of Full and Proper Cure of Epoxy Grout**

Name: \_\_\_\_\_ Date \_\_\_/\_\_\_/\_\_\_  
Contractor Rep.

Name: \_\_\_\_\_ Date \_\_\_/\_\_\_/\_\_\_  
Grouting Contractor Rep.

Name: \_\_\_\_\_ Date \_\_\_/\_\_\_/\_\_\_  
Grout Manufacturer's Technical Rep.

Name: \_\_\_\_\_ Date \_\_\_/\_\_\_/\_\_\_  
Construction Manager

**Step 9: Completion of Localized Repair of Grout Voids**

Name: \_\_\_\_\_ Date \_\_\_/\_\_\_/\_\_\_  
Contractor Rep.

Name: \_\_\_\_\_ Date \_\_\_/\_\_\_/\_\_\_  
Grouting Contractor Rep.

Name: \_\_\_\_\_ Date \_\_\_/\_\_\_/\_\_\_  
Grout Manufacturer's Technical Rep.

Name: \_\_\_\_\_ Date \_\_\_/\_\_\_/\_\_\_  
Construction Manager

**Step 10: Final Acceptance of Grouting System Installation Including Final Clean-Up of the Work Site Complying with All Specification Requirements and the GSM's Quality Requirements**

Name: \_\_\_\_\_ Date \_\_\_/\_\_\_/\_\_\_  
Contractor Rep.

Name: \_\_\_\_\_ Date \_\_\_/\_\_\_/\_\_\_  
Grouting Contractor Rep.

Name: \_\_\_\_\_ Date \_\_\_/\_\_\_/\_\_\_  
Grout Manufacturer's Technical Rep.

Name: \_\_\_\_\_ Date \_\_\_/\_\_\_/\_\_\_  
Construction Manager

11060-A. MOTOR DATA FORM

Equipment Name: \_\_\_\_\_ Equipment No(s): \_\_\_\_\_

Project Site Location: \_\_\_\_\_

Nameplate Markings

Mfr:		Mfr. Model:		Frame:		Horsepower:	
Volts:		Phase:		RPM:		Service Factor:	
FLA:		LRA:		Frequency:		Amb. Temp Rating:	°C
Time rating:				Design Letter:			
	(NEMA MG1-10.35)				(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. \_\_\_\_\_, Group \_\_\_\_\_
- B. UL frame temperature code \_\_\_\_\_ (NEC Tables 500-8B)

The following information is required for all motors 1/2 horsepower and larger:

- A. Guaranteed minimum efficiency \_\_\_\_\_  
(Paragraph 11060-2.04 G)
- B. Nameplate or nominal efficiency \_\_\_\_\_

Data Not Necessarily Marked on Nameplate

Type of Enclosure:		Enclosure Material:	
Temp Rise:	°C (NEMA MG1-12.41,42)		
Space Heater included?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	If Yes: Watts Volts
Type of motor winding over-temperature protection, if specified:			

Provide information on other motor features specified:

\_\_\_\_\_

16000-A. WIRE AND CABLE RESISTANCE TEST DATA FORM

Wire or Cable No.: \_\_\_\_\_ Temperature, °F: \_\_\_\_\_

Location of Test	Insulation resistance, megohms
1.	
2.	
3.	
4.	
5.	
6.	
7	

CERTIFIED \_\_\_\_\_ Date \_\_\_\_\_  
Contractor's Representative

WITNESSED \_\_\_\_\_ Date \_\_\_\_\_  
Owner's Representative



16000-B. INSTALLED MOTOR TEST 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. Model		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

# 16000-C. DRY TRANSFORMER TEST DATA FORM

(Note: Use Data Form for dry type transformers with voltage rating of 600 Vac or less and sizes to 167 kVA single phase and 500 kVA three phase. Use NETA Test Forms and Test Procedures for higher voltages and larger transformers.)

Equipment Tag No.: \_\_\_\_\_ Temperature Rating: \_\_\_\_\_

Description/Location: \_\_\_\_\_ Feeder size/Source: \_\_\_\_\_

Primary Voltage: \_\_\_\_\_ Secondary Voltage: \_\_\_\_\_ Winding Connection: \_\_\_\_\_

## A. VISUAL INSPECTION

Transformer Inspection	Pass	Fail	Note
1. Nameplate data as specified			
2. Mechanical condition			
a. Free of dents and scratches			
b. Anchored properly			
c. Shipping brackets removed			
d. Spacing from wall per nameplate			
3. Grounding *			
a. Equipment grounding			
b. System grounding			

## B. INSULATION-RESISTANCE TESTS:

Perform tests with calibrated megohmmeter. Apply 1000 Vdc test voltage for 60 seconds and record readings in megohms at 30-seconds and 60-seconds intervals.

Test Group	Resistance between		30-second reading	60-second reading	Absorption Ratio Index 60-sec. / 30-sec.
	A	GRD			
Primary Winding to ground	A	GRD			
	B	GRD			
	C	GRD			
Secondary Winding to ground with * N-G Bond removed	a	GRD			
	b	GRD			
	c	GRD			
Primary Winding to Secondary Winding	A	a			
	B	b			
	C	c			

Submit resistance readings to the Construction Manager immediately after the tests that are less than the manufacturer's recommended value or less than 10-megohms. Record the Absorption Ratio Index values for future reference. Ratio must be 1.0 or greater, with infinity (∞) equal to 1.0.

Contractor Representative Certified: \_\_\_\_\_ Date \_\_\_\_\_

Owner Representative Witnessed: \_\_\_\_\_ Date \_\_\_\_\_

16000-D. MOTOR CONTROL CENTER TEST FORM

Equipment No.: \_\_\_\_\_ Ambient room temperature: \_\_\_\_\_

Location: \_\_\_\_\_

A. MECHANICAL CHECK:

All bolted connections either bus to bus or cable to bus shall be torqued to the manufacturer's recommendations.

B. ELECTRICAL TESTS:

1. Measure insulation resistance of each bus section phase to phase and phase to ground for 1 minute using a megohmmeter at 1000 volts.

Test results (megohms)			
Phase		Phase	
A-GRD		A-B	
B-GRD		B-C	
C-GRD		C-A	

2. Set the circuit breaker in the starter unit to comply with the requirements of NEC, Article 430-52 and Table 430-152.
3. Motor overload heater elements shall be sized and installed based on the actual nameplate full load amperes of the motor connected to the starter.

CERTIFIED \_\_\_\_\_ Date \_\_\_\_\_  
Contractor's Representative

WITNESSED \_\_\_\_\_ Date \_\_\_\_\_  
Owner's Representative

16000-M. STARTER PANEL TEST DATA FORM

Location: \_\_\_\_\_

A. PHYSICAL TEST:

List any discrepancies with respect to the panel specifications:

1. Dimensions, component layout and wiring specifications.
2. Panel and component hardware.
3. Quality of Workmanship (wiring and general panel assembly).
4. Inventory of all panel parts and documentation (operations and maintenance manual).

B. FUNCTIONAL TEST:

Components	
Disconnect Switch	
HOA Switch - Auto	
HOA Switch - Off	
HOA Switch - Hand	

CERTIFIED \_\_\_\_\_ Date \_\_\_\_\_  
Contractor's Representative

WITNESSED \_\_\_\_\_ Date \_\_\_\_\_  
Owner's Representative

17000-A. LOOP WIRING AND INSULATION RESISTANCE TEST DATA FORM

Loop No.: \_\_\_\_\_

List all wiring associated with a loop in table below. Make applicable measurements as indicated after disconnecting wiring.

Wire No.	Panel Tie	Field TB	Continuity Resistance <sup>a</sup>		Insulation Resistance <sup>b</sup>			
			Cond./ Cond.	Cond./ Shield	Shield/ Gnd.	Shield/ Cond.	Cond./ Gnd.	Shield/ Shield
A			--	(A/SH)				
B			(A/B)	--				
C			(A/C)	--				
D			(A/D)	--				
etc.								

NOTES:

- a. Continuity Test. Connect ohmmeter leads between wires A and B and jumper opposite ends together. Record resistance in table. Repeat procedure between A and C, A and D, etc. Any deviation of  $\pm 2$  ohms between any reading and the average of a particular run indicates a poor conductor, and corrective action shall be taken before continuing with the loop test.
- b. Insulation Test. Connect one end of a 500 volt megger to the panel ground bus and the other sequentially to each completely disconnected wire and shield. Test the insulation resistance and record each reading.

CERTIFIED \_\_\_\_\_ Date \_\_\_\_\_  
Contractor's Representative

WITNESSED \_\_\_\_\_ Date \_\_\_\_\_  
Owner's Representative

17000-B. CONTROL CIRCUIT PIPING LEAK TEST FORM

Loop No.: \_\_\_\_\_

List tubing associated with loop in table below. Make applicable measurements after isolating any air consuming pilots from circuit.

Tube No.	Tubing Equivalent Length of 1/4-Inch Copper <sup>a</sup>	Test Period (seconds)	Permitted Pressure Drop (psi) <sup>b</sup>	Measured Pressure Drop (psi)
A				
B				
C				
D				
etc.				

NOTES:

- a. Convert actual tubing and air motor volume to equivalent 1/4-inch copper tubing.
- b. Pressure drop shall not exceed 1 psi per hundred feet 1/4-inch tubing per 5 seconds.

CERTIFIED \_\_\_\_\_ Date \_\_\_\_\_  
 Contractor's Representative

WITNESSED \_\_\_\_\_ Date \_\_\_\_\_  
 Owner's Representative

17000-G. FIELD SWITCH CALIBRATION TEST DATA FORM

Tag No. and Description: \_\_\_\_\_

Make & Model No.: \_\_\_\_\_ Serial No: \_\_\_\_\_

Input: \_\_\_\_\_

Range: \_\_\_\_\_

Set Point(s): \_\_\_\_\_

Simulate process variable (flow, pressure, temperature, etc.) and set desired set point(s). Run through entire range of switch and calculate deadband.

Set Point	Incr. Input Trip Point	Decr. Input Trip Point	Calc. Deadband	Required Deadband

CERTIFIED \_\_\_\_\_ Date \_\_\_\_\_  
 Contractor's Representative

WITNESSED \_\_\_\_\_ Date \_\_\_\_\_  
 Owner's Representative

17000-H. TRANSMITTER CALIBRATION TEST DATA FORM

Tag No. and Description: \_\_\_\_\_

Make & Model No.: \_\_\_\_\_ Serial No.: \_\_\_\_\_

Input: \_\_\_\_\_

Output: \_\_\_\_\_

Range: \_\_\_\_\_ Scale: \_\_\_\_\_

Simulate process variable (flow, pressure, temperature, etc.) and measure output with appropriate meter.

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				
% Deviation Allowed:				

CERTIFIED \_\_\_\_\_ Date \_\_\_\_\_  
 Contractor's Representative

WITNESSED \_\_\_\_\_ Date \_\_\_\_\_  
 Owner's Representative



17000-I. MISCELLANEOUS INSTRUMENT CALIBRATION TEST DATA FORM

(For instruments not covered by any of the preceding test forms, the Contractor shall create a form containing all necessary information and calibration procedures.)

CERTIFIED \_\_\_\_\_ Date \_\_\_\_\_  
Contractor's Representative

WITNESSED \_\_\_\_\_ Date \_\_\_\_\_  
Owner's Representative

17000-J. INDIVIDUAL LOOP TEST DATA FORM

Loop No.: \_\_\_\_\_

Description: (Give complete description of loop's function using tag numbers where appropriate.)

P&ID No.: (Attach copy of P&ID.)

- a. Wiring tested:  
(Attach test form 17000-A)
- b. Not used.
- c. Instruments calibrated:  
(Attach test forms 17000-G through I)
- d. List step-by-step procedures for testing loop parameters. Test loop with instruments, including transmitters and control valves, connected and functioning. If it is not possible to produce a real process variable, then a simulated signal may be used with the Construction Manager's approval.

CERTIFIED \_\_\_\_\_ Date \_\_\_\_\_  
Contractor's Representative

WITNESSED \_\_\_\_\_ Date \_\_\_\_\_  
Owner's Representative

17000-K. LOOP COMMISSIONING TEST DATA FORM

Loop No.: \_\_\_\_\_

- a. Loop tested:  
(Attach test form 17000-J)
- b. Controlled or connected equipment tests confirmed:
- c. Give complete description of loop's interface with process.
- d. With associated equipment and process in operation, demonstrate automatic start/stop and control operation.

CERTIFIED \_\_\_\_\_ Date \_\_\_\_\_  
Contractor's Representative

WITNESSED \_\_\_\_\_ Date \_\_\_\_\_  
Owner's Representative

17000-L. PLC CONTROL PANEL TEST DATA FORM

Location: \_\_\_\_\_

A. PHYSICAL TEST:

List any discrepancies with respect to the panel specifications:

1. Dimensions, component layout and wiring specifications.
2. Panel and component hardware.
3. Quality of Workmanship (wiring and general panel assembly).
4. Inventory of all panel parts and documentation (operations and maintenance manual).

B. FUNCTIONAL TEST:

Discrete Inputs	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	

Discrete Outputs	
1	
2	
3	

4	
5	
6	
7	
8	
9	
10	
11	
12	

Analog Inputs	
Loop Powered	
Loop Powered	
Self-Powered	
Self-Powered	

Analog Outputs	
Loop Powered	
Loop Powered	

Power	
24 VDC Power	
12 VDC Power	
PS Fail Relay	
GFI	
Radio Power	
Touchscreen	

Comments: \_\_\_\_\_

CERTIFIED \_\_\_\_\_ Date \_\_\_\_\_  
 Contractor's Representative

WITNESSED \_\_\_\_\_ Date \_\_\_\_\_  
 Owner's Representative

17000-M. RADIO TEST DATA FORM

Location: \_\_\_\_\_

Radio Model Number: \_\_\_\_\_

A. PHYSICAL TEST:

1. Reflected Power: \_\_\_\_\_
2. Radio System Address: \_\_\_\_\_
3. RSSI reading (Remote): \_\_\_\_\_
4. Mode: \_\_\_\_\_
5. Long Polling (Master), Buff = OnData
6. Interface Parameters:
  - a. Baud Rate: \_\_\_\_\_
  - a. Data Bits: \_\_\_\_\_
  - a. Parity: \_\_\_\_\_
7. Quality of Workmanship – Antenna/Cable assembly: \_\_\_\_\_

CERTIFIED \_\_\_\_\_ Date \_\_\_\_\_  
Contractor's Representative

WITNESSED \_\_\_\_\_ Date \_\_\_\_\_  
Owner's Representative

Navajo Nation  
WESTERN NAVAJO PIPELINE PHASE 1

BC PROJECT NO.: 150360

BODAWAY-GAP WELL, STORAGE TANK AND PIPELINE

DIVISION 2

SITE CONSTRUCTION

02100	Site Preparation
02200	Earthwork
02270	Erosion Control (Vegetative)

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## SECTION 02100

### SITE PREPARATION

#### PART 1--GENERAL

##### 1.01 DESCRIPTION

###### A. SCOPE:

This section specifies site preparation which consists of clearing, grubbing, topsoil stripping, storage, demolition and salvage.

Removal and disposal of electrical Work is included in Division 16. Coordinate with the subcontractor and Owner for all materials required to be turned over to Owner.

###### B. EXISTING CONDITIONS:

The CONTRACTOR shall determine the actual condition of the site as it affects this portion of work.

###### C. PROTECTION:

Site preparation shall not damage existing utilities to remain in service, structures, landscaping or vegetation adjacent to the site. The CONTRACTOR shall repair or replace any damaged property.

Demolition activities shall not damage utilities to remain in service, structures, landscaping or vegetation adjacent to the site. The Contractor shall repair, or replace any property damaged by demolition activities.

###### D. DEFINITIONS

1. **REMOVAL:** Facilities to be removed shall be completely removed from the site as shown and specified in the Contract Documents. Disposal shall conform to applicable codes and procedures when hazardous or contaminated materials are removed and disposed of.
2. **ABANDON:** Facilities to be abandoned shall remain in place and be abandoned in accordance with procedures as shown and specified in the Contract Documents.
3. **SALVAGE:** Equipment and appurtenances to be salvaged shall be removed without damage and delivered to Owner as shown and specified in the Contract Documents.

## PART 2--PRODUCTS

No products are included in this section.

## PART 3--EXECUTION

### 3.01 CLEARING AND GRUBBING

Unless otherwise specified, the CONTRACTOR shall remove obstructions such as brush, trees, logs, stumps, roots, heavy sod, vegetation, rock, stones larger than 6 inches in any dimension, broken or old concrete and pavement, debris, and structures where the completion of the work require their removal.

Material that is removed and is not to be incorporated in the work shall be properly disposed of off the site in accordance with local, state and federal regulations.

### 3.02 DEMOLITION AND REMOVAL

A. STRUCTURES: (NOT USED)

B. PAVEMENT:

When portions of asphalt pavements and concrete pads are to be removed and later construction is to be connected, edges shall be saw cut, on a neat line at right angles to the curb face.

C. SALVAGE: (NOT USED)

### 3.03 UTILITY INTERFERENCE

Where existing utilities interfere with the prosecution of the work, the CONTRACTOR shall protect or relocate them in accordance with Division 0 (Bidding and Contracting Requirements – Section 00700).

**\*\*END OF SECTION\*\***

## SECTION 02200

### EARTHWORK

#### PART 1--GENERAL

##### 1.01 DESCRIPTION

###### A. SCOPE:

This section specifies earthwork which consists of excavation, filling, grading, and disposal of excess material.

###### B. DEFINITIONS:

1. **COMPACTION:** The degree of compaction is specified as percent compaction. Maximum or relative densities refer to dry soil densities obtainable at optimum moisture content.
2. **EXCAVATION SLOPE:** Excavation slope shall be defined as an inclined surface formed by removing material from below existing grade.
3. **EMBANKMENT SLOPE:** Embankment slope shall be defined as an inclined surface formed by placement of material above existing grade.
4. **EMBEDMENT ZONE:** Embedment zone shall be defined as the area from the trench bottom to a level at least 12-inches over the top of the pipe including bedding, haunching and initial backfill.

##### 1.02 QUALITY ASSURANCE

###### A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). 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.

Reference	Title
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft <sup>3</sup> (2,7000 kN-m/m <sup>3</sup> ))
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D4253	Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

**B. TESTS:**

The CONTRACTOR will take samples and perform moisture content, gradation, compaction, and density tests during placement of backfill materials to check compliance with these specifications. The CONTRACTOR shall remove surface material at locations designated by the CONSTRUCTION MANAGER and provide such assistance as necessary for sampling and testing. The CONSTRUCTION MANAGER may direct the CONTRACTOR to construct inspection trenches in compacted or consolidated backfill to determine that the CONTRACTOR has complied with these specifications.

Tests will be made by the CONTRACTOR in accordance with the following:

Test	Standard Procedure
Moisture content	ASTM D6938
Gradation	ASTM C136
Density in-place	ASTM D1556 or D6938

Moisture-density relationships	ASTM D1557
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The CONTRACTOR shall provide safe access to the trench or excavation for the inspection and compaction testing. This shall include providing all safety equipment and temporary shoring to enable inspection of the trench foundation and compaction testing at multiple levels in the trench.

1.03 SUBMITTALS

Samples of fill materials to be used shall be submitted 2 weeks in advance of use. Samples shall consist of 0.5 cubic feet of each type of material.

PART 2--MATERIALS

2.01 FILL MATERIALS

A. TYPE A:

Type A material (3/4" Minus) shall be a clean gravel-sand mixture free from organic matter and shall conform to the following gradation:

U.S. standard sieve size	Percent by weight passing
3/4 inch	100
3/8 inch	70-100
No. 4	40-99
No. 10	35-95
No. 20	20-80
No. 40	0-55
No. 100	0-2

B. TYPE B:

Type B material (3-inch Minus) shall be a select granular material free from organic matter and of such size and gradation that the specified compaction can be readily attained. Material shall conform to the following gradation:

U.S. standard sieve size	Percent by weight passing
3 inch	100
3/4 inch	70-100

U.S. standard sieve size	Percent by weight passing
No. 4	40-100
No. 200	15-50

The coefficient of uniformity shall be 3 or greater.

The plasticity index of the material, as determined in accordance with ASTM D4318, shall not exceed 10.

The material may be an imported quarry waste, clean natural sand or gravel, select trench excavation or a mixture thereof.

C. TYPE C:

Type C material shall be unclassified silty sand material which is free from peat, wood, roots, bark, debris, garbage, rubbish or other extraneous material. The maximum size of stone shall not exceed 3 inches. The material shall have a maximum of 65% passing #4 sieve and maximum of 20% passing #200 sieve. If the native material excavated from the site meets these requirements, it may be segregated from non-conforming material and classified as Type C.

D. TYPE D:

Type D material shall be granular base material and shall conform to the following gradation:

U.S. standard sieve size	Percent by weight passing
1 inch	100
3/4 inch	85-100
No. 4	45-95
No. 200	0-8

The granular base shall have a plasticity index of no greater than 3 when tested in accordance with ASTM D4318.

The coarse aggregate shall have a percent of wear, when subjected to the Los Angeles abrasion test (ASTM C131) of no greater than 50.

E. TYPE E:

Type E material shall be crushed rock commonly known as drain rock and shall conform to the following gradation:

U.S. standard sieve size	Percent by weight passing
1-1/2 inch	100
3/4 inch	30-75
1/2 inch	15-55
1/4 inch	0-5

Type E material shall be composed of hard, durable, sound pieces having a specific gravity of not less than 2.65

F. TYPE F:

Type F material shall be crushed rock and shall conform to the following gradation:

U.S. standard sieve size	Percent by weight passing
1-1/2 inch	87-100
3/4 inch	45-90
No. 4	20-50
No. 30	6-29
No. 200	0-12

Type F material shall be composed of hard, durable, sound pieces having a specific gravity of not less than 2.65.

G. TYPE G:

Type G material shall be Class 1 crushed stone (manufactured angular, crushed stone, crushed rock, or crushed slag), commonly known as chips and shall conform to the following gradation:

U.S. standard sieve size	Percent by weight passing
3/4 inch	100
No. 4	30-50
No. 200	0-5

The material shall have a minimum sand equivalent value of 75.

H. TYPE H:

Type H material shall be 6-inch crushed/angular riprap. Riprap shall be graded rock having a range of individual rock weights as follows:

Weight of stone	Percent smaller by weight
10 pounds	100
5 pounds	80-100
2 pounds	45-80
1 pound	15-45
1/2 pound	5-15
Below 1/2 pound	0-5

Specific gravity shall be between 2.5 and 2.82.

I. TYPE I:

Type I material shall be 12-inch riprap. Riprap shall be graded rock having a range of individual rock weights as follows:

Weight of stone	Percent smaller by weight
160 pounds	100
100 pounds	80-100
50 pounds	45-80
20 pounds	15-45
5 pounds	5-15
1 pound	0-5

Specific gravity shall be between 2.5 and 2.82.

J. TYPE J:

Type J material shall be unclassified material and may be obtained from excavation on site. The material may contain extraneous material such as demolition waste, unsuitable material excavated from beneath structures, and clearing and grubbing debris up to 50 percent by volume. Extraneous material shall be thoroughly mixed, and the maximum size of organic particles shall be 6 inches.

K. TYPE K

Native material, segregated from non-conforming material, may be used for bedding and backfill outside roadway and public right of ways or easements. The material shall be

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granular, free from peat, wood, roots, bark, clay lumps, debris, garbage, rubbish or other material as defined by the Construction Manager. All materials used as final backfill shall pass a 3-inch sieve. Materials used for select backfill or bedding shall meet the following gradation requirements:

U.S. standard sieve size	Percent by weight passing
3/4 inch	100
No. 4	40-90
No. 200	30 or less

The plasticity index of the material, as determined in accordance with ASTM D4318, shall not exceed 10. Native soils including high plasticity clay soils, sandy clay and clayey sand soils shall not be used as bedding or backfill.

The Contractor shall furnish sieve analyses per ASTM C 136, plasticity indexes PI - per ASTM D 4318 and baseline maximum density tests, Modified Proctor per ASTM D 1557, for conditioned native material. Acceptance by the Construction Manager of the tests shall be required prior to using these materials. All costs for testing shall be paid for by the Contractor. Native materials shall be tested once per 400 feet of trench or as directed by the Construction Manager. In all cases, soil samples for testing shall be taken in the presence of the Construction Manager.

The Contractor will be solely responsible to demonstrate compliance and where native materials do not meet the requirements, shall provide imported bedding and backfill at no additional cost to the Owner.

## PART 3--EXECUTION

### 3.01 GENERAL

#### A. CONTROL OF WATER:

The CONTRACTOR shall keep excavations reasonably free from water during construction. The static water level shall be drawn down a minimum of 1 foot below the bottom of excavations to maintain the undisturbed state of natural soils and allow the placement of any fill to the specified density. Disposal of water shall not damage property or create a public nuisance.

The CONTRACTOR shall have pumping equipment and machinery on hand in good working condition for emergencies and shall have workmen available for its operation. Dewatering systems shall operate continuously until backfill has been completed to 1 foot above the normal static groundwater level.

Groundwater shall be controlled to prevent softening of the bottom of excavations, or formation of "quick" conditions. Dewatering systems shall not remove natural soils. The CONTRACTOR shall control surface runoff to prevent entry or collection of water in excavations.

Release of groundwater to its static level shall be controlled to prevent disturbance of the natural foundation soils or compacted fill and to prevent flotation or movement of structures or pipelines.

The CONTRACTOR shall incorporate the use of temporary detention ponds, rock checks or rock socks to allow settlement or filtering of silt carried by the water before entering storm drains or natural waterways. Straw bales are not acceptable for this purpose.

If a National Pollutant Discharge Elimination System (NPDES) permit is required for disposal of water from construction dewatering activities, it shall be obtained by the CONTRACTOR prior to any dewatering activities.

**B. OVEREXCAVATION:**

The CONTRACTOR shall take care to avoid excavation below the depths indicated. However, where the undisturbed condition of natural soils is inadequate for support of the planned construction, the CONSTRUCTION MANAGER may direct the CONTRACTOR to over excavate and install additional bedding material.

The quantity of overexcavation and placement of additional bedding material will be paid for on a unit price basis per cubic yard of over excavation and additional material installed. The unit price shall include all costs associated with the overexcavation and installation of the additional material including but not limited to: bedding material, geotextile material, installation, and all testing.

**C. SURPLUS MATERIAL:**

Unless otherwise specified, surplus excavated material shall be disposed of off site in accordance with applicable ordinances and environmental requirements.

If the quantity of surplus material is specified, the quantity specified is approximate. The CONTRACTOR shall satisfy himself that there is sufficient material available for the completion of the embankments before disposing of any material inside or outside the site. Shortage of material, caused by premature disposal of any material by the CONTRACTOR, shall be replaced by the CONTRACTOR.

Material shall not be stockpiled to a depth greater than 5 feet above finished grade within 25 feet of any excavation or structure except for those areas designated to be preconsolidated. For these areas, the depth of stockpiled material shall be as specified. The CONTRACTOR shall maintain stability of the soil adjacent to any excavation.

D. BORROW MATERIAL:

If the quantity of acceptable material from excavation is not sufficient to construct the embankments or trench backfill required by the work, the quantity of material needed to complete the embankments or trench backfill shall consist of imported borrow conforming to specified requirements.

E. HAULING:

When hauling is done over highways or city streets, the loads shall be trimmed, and the vehicle shelf areas shall be cleaned after each loading. The loads shall be watered after trimming to eliminate dust.

F. HAUL ROADS:

The CONTRACTOR shall construct haul roads required to transport materials on site. Alignment of haul roads shall be selected to avoid interference with plant operations. Haul roads must stay within the designated limit of disturbance as shown in the drawings. Haul roads shall be removed after completion of construction.

G. FINISH GRADING:

Finished surfaces shall be smooth, compacted and free from irregularities. The degree of finish shall be that normally obtainable with a blade-grader.

Finished grade shall be as specified plus or minus 0.10 foot except where a local change in elevation is required to match sidewalks, curbs, manholes and catch basins, or to ensure proper drainage. Allowance for topsoil and grass cover, and subbase and pavement thickness shall be made so that the specified thickness of topsoil can be applied to attain the finished grade.

When the work is an intermediate stage of completion, the lines and grades shall be as specified plus or minus 0.5 foot to provide adequate drainage.

If the soil is to be cultivated or straw is to be incorporated into the surface, rocks larger than 2-1/2 inches in maximum dimension, roots and other debris on the surface of the slope shall be removed and disposed of prior to cultivation or placement of straw.

H. CONTROL OF EROSION:

The CONTRACTOR shall maintain earthwork surfaces true and smooth and protected from erosion. Where erosion occurs, the CONTRACTOR shall provide fill or shall excavate as necessary to return earthwork surfaces to the grade and finish specified.

The CONTRACTOR shall provide trench dikes along the trench as specified. Water bars shall be constructed of a 1-foot nominal thickness of cement slurry with 50 to 100 psi compressive strength after 28 days or a 3-foot nominal thickness of clay compacted to a minimum of 95-percent modified Proctor Density and having permeability when completed of not more than 0.00001 centimeters per second. Trench dikes shall extend the full width of the trench and keyed into the undisturbed trench wall and shall extend from the undisturbed trench bottom to a height equal to top of established water table or 2-feet above top of pipe, whichever is greater.

I. STABILIZATION:

Instead of or in addition to over excavation and additional material as described in 02200-3.01B, the CONSTRUCTION MANAGER may direct the CONTRACTOR to stabilize the subgrade by pressing large riprap into the soft unstable subgrade to support the compaction of bedding, initial backfill and subsequent backfill. The quantity and placement of stabilization material will be paid for on a unit price basis per cubic yard of stabilization material installed. The unit price shall include all costs associated with the installation of the stabilization material including but not limited to: stabilization material, installation, and all testing.

J. BLASTING:

1. Obtain CONSTRUCTION MANAGER approval to blast for excavation. If approved, the CONSTRUCTION MANAGER will establish the time limits blasting will be permitted.
2. Use utmost care to protect life and property during blasting. Use only a licensed blaster with experience in the type of blasting required for the work.
3. Safely and securely store all blasting materials meeting local laws and ordinances and clearly mark all storage places "Dangerous Explosives". Do not leave any explosives where they could endanger persons or property.
4. Blasting Rock in Trenches
  - a. When blasting rock in trenches, cover the blasting area with earth backfill or approved blasting mats. Before blasting, station workers and provide danger signals to warn people and stop vehicles.
  - b. Assume responsibility for all damage to property and injury to persons resulting from blasting or accidental explosions during the work.
  - c. Furnish the following information to the OWNER and CONSTRUCTION MANAGER at least 48 hours before the commencement of blasting operations: Name of the CONTRACTOR's powder man, powder man's experience, type of

shot, type of explosives and detonator being used, proof of insurance covering liability for such operation, traffic control plans and planned procedures for protecting the public.

5. Assure blasting plan meets federal, state and local ordinances. Obtain all required permits before blasting starts.

## K. PROTECTION, PRESERVATION, AND REPAIR

### 1. General

- a. Take precautions to protect all adjoining private and public property and facilities, including underground and overhead utilities, curbs, sidewalks, driveways, structures, and fences. Restore or replace all disturbed or damaged facilities to its original condition at CONTRACTOR's expense.
- b. Contact utility owners using the one-call system for utility locates before starting work. Protect the utilities exposed during the work and prevent damaging underground utilities adjacent to excavations. Immediately notify the utility owner of any construction damage. Repairs of damage to marked utilities are at the expense of the CONTRACTOR.
- c. Re-locate existing water mains, sanitary sewers and storm drains shown on the plans, that conflict with new pipelines or structures as indicated in the contract documents. No separate payment will be made for this work unless shown as a payment item. If the OWNER authorizes the relocation of mains or sewers which are not indicated in the bid documents, and the CONSTRUCTION MANAGER determines the work was not included in the original contract, payment will be made under the applicable sections of the General Conditions.
- d. Cut and replace existing service lines interfering with trenching operations only with the CONSTRUCTION MANAGER's permission and at the contractor's expense. Show all repaired and/or adjusted water and sewer lines on the as-built plans.

### 2. Privately Owned Utilities

- a. If any existing private utility interferes with the work in either alignment or grade, and has to be moved, the work will be performed by the appropriate utility owner, unless otherwise specified in the contract documents. Such private utilities may include gas mains, underground electrical and telephone cables, telephone poles, light poles, etc.

### 3. Existing Structures

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- a. Prevent damage to existing buildings or structures in the work area. Repair all construction related damage to the satisfaction of the OWNER.
4. Existing Overhead Utilities
    - a. Use extreme caution to avoid conflict, contact or damage to overhead utilities during the work.
5. Exploratory Excavation
    - a. The location of existing buried public utilities may need to be field verified and pothole as required before construction.
    - b. Exercise care to prevent damaging all utilities and repair any utility damage caused by field verification and potholing as required.
6. Pavement Removal and Stripping
    - a. Where trench excavation or appurtenant structure excavation requires removing curb and gutter, concrete sidewalks, asphalt concrete pavement, or Portland cement concrete pavement, cut the concrete or pavement in a straight line parallel to the excavations edge using a spade-bitted air hammer, concrete saw or other suitable equipment to produce a straight, square and clean break. Re-cut edges broken during construction, before concrete or paving operations.
    - b. For trenches passing through existing pavement, cut the pavement along a neat vertical line at least 12 inches (30cm) from the trench edge. Where the neat line cut is less than 3 feet (0.9m) from the edge of the existing pavement, remove and replace the entire pavement section between trench and edge of pavement.
    - c. Dispose of the asphalt concrete and/or Portland cement concrete debris off-site according to applicable state and local regulations.
7. When excavating across existing gravel streets or other developed surfaces, remove the surfacing material full depth and stockpile for inclusion as trench backfill or legally dispose of the surfacing material.
8. When excavating across cultivated or sodded areas, remove topsoil full depth or to a maximum 12-inch (30cm) depth, whichever is less, and stockpile for possible project use. Re-sod or reseed, as specified in the contract documents, all established lawn areas cut by trenching or damaged during the construction to the satisfaction of the CONSTRUCTION MANAGER.

### 3.02 CLASSIFICATION OF FILL

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Fill material shall be placed in horizontal layers and compacted with power-operated tampers, rollers, idlers, or vibratory equipment. Material type, maximum layer depth, relative compaction, and general application are specified in Table A. Unless otherwise specified, fill classes shall be used where specified in Table A under general application.

**Table A, Fill Classifications**

Fill class	Material type	Maximum uncompressed layer depth, inches	Minimum compaction, percent	General application
A1	A	6	95	Subsequent, near-surface pipeline backfill under paved roadways, roadway shoulders, roadway embankments and public right of ways or easements; pipeline bedding; initial utility pipeline backfill per trench detail in project drawings
NOT REQD	A	48	95	NOT REQUIRED
B1	B	8	95	Structural Fill, Subsequent pipeline backfill; compaction as specified
B2	B	8	90	Site fill; compaction as specified
C1	C	8	95	Subsequent pipeline backfill; compaction as specified
C2	C	8	90	Site fill for embankments and dikes
D1	D	8	95	Concrete slab support fill only for utility vaults and in areas where structural fill is not specified
E1 <sup>a,b</sup>	E	8	95 <sup>c</sup>	Bedding and initial pipeline backfill for RCP only, backfill for over excavated zone; Requires layer of non-woven filter fabric between Type E and any other material containing fines (including native)
NOT REQD	F	12	95	NOT REQUIRED.
NOT REQD	G	8	95	NOT REQUIRED
H1 <sup>c</sup>	H	-	-	Floor drain discharge area, Embankment slope face, channel slope face, stream bed installation above pipeline
H2 <sup>d</sup>	H	-	-	Trench or Excavation bottom soil stabilization.
I1	I	-	-	Embankment slope face, channel slope face
J1 <sup>e</sup>	J	8	90	Excess fill

Fill class	Material type	Maximum uncompressed layer depth, inches	Minimum compaction, percent	General application
K1	K	6	90	Subsequent, near-surface pipeline backfill nonpaved areas outside roadway and public Right of ways or easements; per trench detail in project drawings; compaction as specified
K2	K	6	95	Pipeline bedding; initial utility pipeline backfill; per trench detail in project drawings; compaction as specified

<sup>a</sup>Compaction of layers shall be accomplished in two passes of equipment with complete coverage across the width of the fill. Dry density compaction shown is per ASTM D1557. Use 70% of ASTM D4253 maximum relative density, as applicable, based on the soil used for fill.

<sup>b</sup>NOT USED.

<sup>c</sup>NOT USED.

<sup>d</sup>Riprap to be pressed into unstable trench bottom soil until trench bottom will support placement and compaction requirements for backfill.

<sup>e</sup>Asphalt and concrete slabs from demolition may be placed at the bottom of the fill side by side to form a continuous pad. Clearing and grubbing is not required unless shrubs are taller than 3 feet. Mucking of the subgrade and keying or benching of adjoining embankments is not required.

### 3.03 EARTHWORK FOR STRUCTURES

#### A. STRUCTURE EXCAVATION:

The bottom shall not be more than 0.15 foot above or below the lines and grades specified. If the elevation of structure excavation is not specified, the excavation shall be not more than 0.15 foot above or below the elevation specified for fill material below the structure. Slopes shall vary no more than 0.5 foot from specified grade unless the excavation is in rock where the maximum variation shall be 2 feet.

Should the excavation be carried below the lines and grades specified on the drawings or should the bottom of the excavation be disturbed because of the CONTRACTOR's operations and require overexcavation and backfill, the CONTRACTOR shall refill such excavated space to the proper elevation in accordance with the procedure specified for backfill. The cost of such work shall be borne by the CONTRACTOR.

Unless otherwise specified, excavations shall extend a sufficient distance from walls and footings to allow for placing and removal of forms, installation of services, and for inspection, except where concrete is specified to be placed directly against excavated surfaces.

Upon completion of foundation excavations, the CONTRACTOR shall coordinate the inspection of the bottom of the excavation prior to the placement of structural fill or auger cast piles.



## B. FOUNDATION TREATMENT:

Rock foundations for concrete or masonry footings shall be excavated to sound material. The rock shall be roughly leveled or cut to steps and shall be roughened. Seams in the rock shall be grouted under pressure as directed by the CONSTRUCTION MANAGER and paid for as extra work.

When footings are to be supported on piles, excavations shall be completed to the bottom of the footings before any piles are drilled or driven therein. When swell or subsidence results from driving piles, the CONTRACTOR shall excavate, or backfill the footing area to the grade of the bottom of the footing with suitable material as specified. If material under footings is such that it would mix into the concrete during footing placement or would not support the weight of the fluid concrete, the CONTRACTOR shall replace the material with suitable material, install soffit forms or otherwise provide a suitable platform on which to cast the footing as directed by the CONSTRUCTION MANAGER. This shall be paid for as extra work.

Where clay soils are encountered at the bottom of cut surfaces, the clay surface shall be scarified and mixed to a minimum depth of 12 inches and watered as necessary to bring the upper foot of soil to between 1 and 3 percent above the optimum moisture content and compacted to between 95 and 98 percent of maximum dry density.

Whenever solid or loose rock, rocky soil with rocks larger than 3/4 inches in their largest dimension, or otherwise unsuitable soils which are incapable of properly supporting the pipe are encountered in the trench bottom, all unsuitable material shall be overexcavated to a minimum depth of 6 inches (or 24 inches for soft or unstable areas) below the pipe and replaced with suitable bedding material.

Whenever any structure excavation is substantially completed to grade, the CONTRACTOR shall notify the CONSTRUCTION MANAGER who will make an inspection of the foundation. No concrete or masonry shall be placed until the foundation has been inspected by the CONSTRUCTION MANAGER. The CONTRACTOR shall, if directed by the CONSTRUCTION MANAGER, dig test pits and make test borings and foundation bearing tests. If the material tested is undisturbed soil, the cost thereof will be paid for as extra work. If the material tested is backfill material, the cost thereof will be paid as specified in 00700-14.02.

## C. STRUCTURE BACKFILL:

Unless otherwise specified, structure backfill shall be Class B1.

After completion of construction below the elevation of the final grade, and prior to backfilling, forms shall be removed, and the excavation shall be cleaned of debris.

Structure backfill shall not be placed until the subgrade portions of the structure have been inspected by the CONSTRUCTION MANAGER. No backfill material shall be deposited against concrete structures until the concrete has developed the specified compressive design strength or until the concrete has been in place for 28 days, whichever occurs first.

Backfill material shall be placed in uniform layers and shall be brought up uniformly on all sides of the structure. When compaction is done by ponding and jetting, thickness of uncompacted layers shall not exceed 4 feet. Moisture content at the time of compaction of structural backfill shall be within 2 percent of optimum moisture content.

Compaction of structure backfill by ponding and jetting will not be allowed.

### 3.04 EARTHWORK FOR PIPELINES AND CONDUITS

#### A. GENERAL:

Earthwork for pipelines and conduits is specified in paragraph 02200-3.02, Table A; in the standard details; and in the following paragraphs.

#### B. PIPELINE EXCAVATION:

Unless otherwise specified, shown on the drawings, or approved by the CONSTRUCTION MANAGER, pipelines shall have a minimum 42-inch depth of cover and maximum 72-inch depth of cover. The top 12 inches of soil shall be removed and stored in such a manner that it will not become mixed with unsatisfactory soils. Excavate the trench to line and grade with allowance for pipe thickness, sheeting and shoring, pipe bedding and over excavation.

The CONTRACTOR shall be responsible to deflect joints and/or provide shop-fabricated fittings as required to achieve the vertical and horizontal alignment. The provided alignment shall not include isolated high or low points requiring an air release valve or flush valve that is not shown on the drawings but required for the proper operation and maintenance of the pressure pipeline as determined by the CONSTRUCTION MANAGER. Where the CONSTRUCTION MANAGER determines the Contractor's alignment has created a high or low point that requires an air release or flush valve not shown on the drawings the Contractor shall provide an air release or flush valve in accordance with the Standard Details at no additional cost to the OWNER.

The allowable joint deflection shall not exceed 50% of the manufacturer's written maximum recommendation unless otherwise specified. When gasketed pipe is laid on a curve, the pipe shall be jointed in a straight alignment and then deflected to the curved alignment. CONTRACTOR shall provide a wider trench as required for this purpose at no additional cost to the OWNER. Longitudinal bending of the pipe shall not be allowed.

In the event obstructions are encountered which require exceptions to the allowable depth of cover, the CONSTRUCTION MANAGER shall have the authority to change the plans and order the necessary deviation from the line and grade.

Remove hard spots that would prevent a uniform thickness of bedding or result in concentrated loads on the pipe. If the trench is excavated below the required grade, refill any part of the trench excavated below the grade with specified bedding materials or in accordance with over-excavation requirements where unsuitable material is encountered.

Prior to placement of bedding, the exposed subgrade at the base of the trench excavation shall be examined to detect soft, loose, or unstable areas. Loose materials in the trench bottoms resulting from excavation disturbance should be removed until firm material is encountered. If soft or unstable areas are encountered, these areas should be overexcavated to a minimum depth of 24 inches below the pipe or to firm material and replaced with suitable bedding material.

Where clay soils are encountered at the bottom of cut surfaces, the clay surface shall be scarified and mixed to a minimum depth of 12 inches and watered as necessary to bring the upper foot of soil to between 1 and 3 percent above the optimum moisture content, and compacted to between 95 and 98 percent of maximum dry density.

#### C. PIPELINE EMBEDDMENT ZONE:

Bedding and backfill material in the embedment zone shall be as specified and as shown on the project trench detail.

1. **BEDDING:** The CONTRACTOR shall not proceed with bedding placement in excavated areas until the subgrade has been inspected by the CONSTRUCTION MANAGER.

All pipe shall have a minimum thickness of 6 inches of bedding material below the barrel of the pipe to provide uniform and adequate longitudinal support under the pipe as specified. Bedding material shall be placed in the bottom of the trench, leveled and compacted.

Bell holes shall be excavated to provide a minimum clearance of 2-inches below the coupling or bell at each pipe joint and to permit proper inspection of the joint. Imported Type A or conditioned Type K bedding material shall be placed at bell holes and beneath the pipe as required to provide uniform and adequate longitudinal support.

2. **HAUNCHING:** After pipe has been properly bedded and laid to alignment and grade, additional bedding material shall be placed in layers the full width of the trench and compacted. CONTRACTOR shall place and compact haunching, defined as the area between the top of bedding to the springline

of the pipe, simultaneously on both sides of the pipe, keeping the level of material the same on each side.

Haunching shall be carefully placed in 6" lifts and hand compacted around the pipe to ensure that the pipe barrel is completely supported with no voids or uncompacted areas and adequate side support to the pipe is provided without either vertical or lateral displacement of the pipe from proper alignment.

3. INITIAL BACKFILL: After placement of haunching material, CONTRACTOR shall place, and compact initial backfill from the springline to at least 12-inches above the top of the pipe.

Initial backfill shall be placed and compacted in lifts not to exceed 6-inches in loose measure. Placement and compaction shall be performed in such a manner as to avoid damage or disturbance of the haunching material or pipe.

Moisture content of trench backfill at the time of compaction shall be within 2 percent of optimum moisture content.

4. FINAL OR SUBSEQUENT BACKFILL:

Backfill material, placement and compaction above the pipe zone shall be as specified. Backfill above the pipe zone shall not commence until pipe zone backfill has been inspected and accepted by the CONSTRUCTION MANAGER.

- a. IMPROVED AREAS: Unless otherwise specified, select granular backfill (Class A) shall be used under all paved and unpaved roadways and paved and unpaved roadway shoulders, roadway embankments, and in all public right-of-ways and easements. The trench shall be backfilled to an elevation which will permit the placement of the specified surface and paving as specified. Roadway surface and paving shall be restored, including compaction, to the condition existing prior to construction including restoration of yard areas.
- b. UNIMPROVED AREAS: Class C1 or Class K backfill shall be used for all trenches in pastureland, cultivated land, undeveloped land, and for other unimproved areas where specified. Class C1 backfill shall not be used in any public right-of-way or under roadways. Excavated trench material that meets the requirements of Type C material may be used. The CONTRACTOR shall maximize the use of fine-grained materials (e.g., sand, silty sand, sandy silt) as Class C1 backfill.

The trench above the pipe zone shall be backfilled to within 12 inches of original ground surface. Moisture content of trench backfill at the time of compaction shall be within 2 percent of optimum moisture content.

After the trench has been backfilled, the stored topsoil shall be replaced at a uniform depth in its original area compacted to its original condition. The CONTRACTOR shall leave the backfilled trench neatly mounded not more than 6 inches above existing grade for the full width of the backfill area.

The CONTRACTOR will be required to perform the work so that trenches will remain open for the minimum time required to accomplish the work. Do not begin trench excavation until appropriate compaction equipment is at the excavation site. During non-working hours, open trenches shall be completely covered or fenced to prevent access.

### 3.05 EARTHWORK FOR EMBANKMENTS

#### A. FOUNDATION PREPARATION:

The surface of the foundation shall not contain standing water and shall be free of loose material, foreign objects and rocks greater than 6 inches in maximum dimension. Immediately prior to placement of embankment fill material, the foundation surface shall be thoroughly moistened, scarified to a depth of 6 inches, moisture conditioned again as necessary and recompacted to 95 percent relative compaction. After the preparation has been completed, the CONTRACTOR shall promptly place and compact the first lift of embankment on the foundation to prevent damage to the surface. If the foundation surface is damaged, the CONTRACTOR shall repair the surface to the specified condition. In any areas where materials become soft or yielding, such materials shall be removed, disposed of, and replaced with specified material. The surface of the embankment shall be maintained to permit travel of construction equipment. Ruts in the surface of any layer shall be filled and leveled before compacting.

#### B. EMBANKMENT FILL:

Rocks, broken concrete, or other solid materials, which are larger than 4 inches in greatest dimension, shall not be placed in embankment areas where piles are to be placed or driven.

Fill material having a sand equivalent value less than 10 shall be placed in the lower portions of embankments and shall not be placed within 2.5 feet of finished grade.

When the embankment material consists of large, rocky material, or hard lumps, such as hardpan or cemented gravel which cannot be broken readily, such material shall be well distributed throughout the embankment. Sufficient earth or other fine material shall be placed around the larger material as it is deposited so as to fill the interstices and produce a dense, compact embankment.

Unless otherwise specified, the embankment shall be raised to form an approximately horizontal plane extending transversely to the final slopes. The embankment shall be crowned at all times during construction so that water will drain readily off the embankment.

The temporary differential elevation between any two adjoining zones of the embankment due to construction operations shall not exceed 24 inches.

If the compacted surface of any layer of material is too smooth to bond properly with the succeeding layer, the surface shall be scarified. If required, the surface shall be sprinkled or otherwise moisture conditioned before the succeeding lift is placed. Any surface crust formed on a layer of fill material that has been dumped and spread shall be broken up by harrowing and, if required, the full depth of the affected layer shall be moisture conditioned immediately prior to rolling.

**C. KEY CONSTRUCTION:**

Where specified, a key shall be excavated along the length of the toe of fill slopes. The exposed soils along the key and under fill areas shall be disced and/or scarified to a depth of at least 12 inches, moisture conditioned to within 3 percent of optimum moisture content, and compacted to at least 90 percent of maximum dry density.

**D. EMBANKMENT TOLERANCES:**

1. **GENERAL:** Embankment slopes within 4 feet of shoulder grade shall vary less than 0.5 foot from the designated slope. Slopes beyond 4 feet from shoulder grade shall vary less than 1 foot from the designated slope. Measurements for variance shall be made perpendicular to the slope. Slopes which are 6 to 1 or flatter shall vary less than 0.2 foot from the designated slope.

If embankments are constructed of rock greater than 12 inches in diameter, the slopes more than 4 feet below shoulder grade may vary up to 2 feet from the designated slope.

2. **ROADWAY EMBANKMENT TOLERANCES:** The excavated surface shall be less than 0.08 foot above or below the grades specified after deducting for the roadway pavement thickness.

Vertical alignment tolerances permitted on the roadway surface shall not exceed plus or minus 0.30 feet from the vertical alignment specified, with the provision that within the tolerance range local surface irregularities shall not exceed 0.15 feet as measured by the gap between the roadway surface and a 10-foot straightedge placed on any flat graded surface. On vertical

curves, the same standards will apply except that an additional gap allowance will be made for the road surface curvature over the 10-foot length of the straightedge.

Horizontal alignment tolerances permitted shall not exceed plus or minus 1 foot providing the departure is relatively uniform over any specific length of the roadway.

### 3.06 SUBGRADE FOR PAVEMENT

The prepared subgrade shall be scarified to a depth of at least 12 inches and recompact to at least 95 percent of the maximum density.

### 3.07 SITE FILL

Unless otherwise specified, site fill shall be Class C2 fill. If the existing slope in an area to be filled is greater than 5:1, the CONTRACTOR shall bench the area prior to filling.

**\*\*END OF SECTION\*\***

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Earthwork  
02200-22

Bodaway-Gap Contract 2  
Agency Review



## SECTION 02270

### EROSION CONTROL (VEGETATIVE)

#### PART 1- GENERAL

##### 1.01 THE REQUIREMENT

- A. The CONTRACTOR shall provide erosion protection including fertilizing, seeding, and mulching for all disturbed areas.
- B. The CONTRACTOR shall provide biodegradable erosion control blanket on all slopes greater than 4H:1V.

##### 1.02 CONTRACTOR SUBMITTALS

- A. Submittals shall be in accordance with Section 01300 - Submittals.
- B. Product Data: Manufacturer's catalog sheets and sample of erosion control fabrics.

#### PART 2- PRODUCTS

##### 2.01 MATERIALS

- A. Fertilizer: Fertilizer shall be a commercial, chemical type, uniform in composition, free- flowing, conforming to state and federal laws and suitable for application with equipment designed for that purpose. Fertilizer shall have a guaranteed analysis showing not less than 11 percent nitrogen, 8 percent available phosphoric acid, and 4 percent water soluble potash.
- B. Seed: Seed shall be delivered in original unopened packages bearing an analysis of the contents. Seed shall be guaranteed 95 percent pure with a minimum germination rate of 80 percent. Seed mix shall be native vegetation consisting of 3 lb – Crested Wheatgrass, 1 lb – Pubescent Wheatgrass, 2 lb – Indian Ricegrass, 3 lb – Western Wheatgrass, and 2 lb – 4-wing Salt bush.
- C. Mulch: Mulch shall be a fibrous, wood cellulose product produced for this purpose. It shall be dyed green and shall contain no growth or germination inhibiting substances and shall be manufactured so that when thoroughly mixed with seed, fertilizer, and water, in the proportions indicated it will form a homogenous slurry which is capable of being sprayed. The mulch shall be Sliva Fiber as manufactured by Weyerhaeuser Company; Conwood Fiber as manufactured by Consolidated Wood Conversion Corp.; or equal.

D. Erosion Control Fabric

1. Materials: North American Green, S75 Temporary Erosion Control Blanket, or equal.
2. Anchorage Devices: Six-inch, 11-gauge staples from the manufacturer or staples of the proper length as recommended by the manufacturer for specific soil condition.

E. Manufacturers, or Equal

1. North American Green
2. Mirafi (Ten Cate)
3. Maccaferri

## PART 3- EXECUTION

### 3.01 GENERAL

- A. Weather Conditions: Fertilizing, seeding, or mulching operations will not be permitted when wind velocities exceed 15 miles per hour or when the ground is frozen, unduly wet, or otherwise not in a tillable condition.
- B. Soil Preparation: The ground to be seeded shall be graded in conformance with the Drawings and shall be loose and reasonably free of large rocks, roots, and other material which will interfere with the work.
- C. Method of Application: Fertilizer, seed, and mulch may be applied separately (Dry Method), or they may be mixed together with water and the homogeneous slurry applied by spraying (Hydraulic Method), except that all slopes steeper than 3H:1V shall be stabilized by the Hydraulic Method.

### 3.02 DRY METHOD

- A. Fertilizing: The fertilizer shall be spread uniformly at the rate of 800 lb per acre (approximately 1 lb per 55 square feet). The fertilizer shall be raked in and thoroughly mixed with the soil to a depth of approximately 2-inches prior to the application of seed or mulch.
- B. Seeding: The seed shall be broadcast uniformly at the rate of 16.5 lb per acre. After the seed has been distributed it shall be incorporated into the soil by raking or by other approved methods.

- C. Mulch Application: Mulch shall be applied at the rate of 1,500 lb (air dried weight) per acre.

### 3.03 HYDRAULIC METHOD

- A. The hydraulic method consists of the uniform application by spraying of a homogeneous mixture of water, seed, fertilizer, and mulch. The slurry shall be prepared by mixing the ingredients in the same proportions as indicated above. The slurry shall have the proper consistency to adhere to the earth slopes without lumping or running. Mixing time of materials shall not exceed 45 minutes from the time the seeds come into contact with the water in the mixer to the complete discharge of the slurry onto the slopes, otherwise the batch shall be recharged with seed. The mixture shall be applied using equipment containing a tank having a built-in, continuous agitation and recirculation system, and a discharge system which will allow application of the slurry to the slopes at a continuous and uniform rate. The application rates of the ingredients shall be the same as those specified for the Dry Method. The nozzle shall produce a spray that does not concentrate the slurry nor erode the soil.

### 3.04 EROSION CONTROL BLANKET

#### A. Placement

1. Biodegradable erosion control blanket shall be used on all slopes 4H:1V and steeper.
2. The erosion control shall be spread only on prepared, fertilized and seeded surfaces.
3. On all slopes, the erosion control blanket shall be laid up-and-down the slope in the direction of water flow.
4. Waste of erosion control material shall be minimized by limiting overlaps as specified and by utilizing the full length of the netting at roll ends.

#### B. Anchorage

1. Ends and sides of adjoining pieces of material shall be overlapped 6-inches and 4-inches respectively, and stapled. Six anchors shall be installed across ends. A common row of staples shall be used at side joints. Staple through both blankets, placing staples approximately 6-inches apart.

2. The top edge of the erosion control blanket shall be anchored in a 6-inch deep by 6- inch wide trench. Backfill and compact trench after stapling.
3. Anchorage shall be by means of 9-inch long, 2-legged staples driven vertically and full-length into the ground. The legs shall be spread 3-inches to 4-inches apart at the ground to improve resistance to pull-out. In loose soils the use of 18-inch metal washer pins may be required to properly anchor the blankets.
4. All slopes which are 3:1 or greater shall be stapled with 2 staples per square yard in a triangular pattern. Staples shall be installed per the manufacturer's recommended staple pattern guide.
5. The erosion control blanket shall not be stretched but should be laid loosely over the ground to avoid pulling the blanket downslope.
6. The erosion control blanket shall not be rolled out onto ground containing frost within the 9-inch penetration zone of the anchorage staples. Further, no stapling shall be undertaken while any frost exists within the staple penetration zone.

### 3.05 WATERING

- A. Upon completion of the erosion control seeding, water shall be applied as specified by the seed manufacture to meet germination requirements

### 3.06 MAINTENANCE PRIOR TO FINAL ACCEPTANCE

- A. The CONTRACTOR shall maintain the planted areas in a satisfactory condition until final acceptance of the project. Such maintenance shall include the filling, leveling, and repairing of any washed or eroded areas, as may be necessary, and sufficient watering to maintain the plant materials in a healthy condition. The ENGINEER may require replanting of any areas in which the establishment of the vegetative ground cover does not appear to be developing satisfactorily.

\*\*END OF SECTION\*\*

Navajo Nation  
WESTERN NAVAJO PIPELINE PHASE 1

BC PROJECT NO.: 150360

BODAWAY-GAP WELL, STORAGE TANK AND PIPELINE

DIVISION 3

CONCRETE

03100	Concrete Formwork
03200	Concrete Reinforcement
03300	Cast-In-Place Concrete
03600	Grout

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SECTION 03100

CONCRETE FORMWORK

PART 1 -- GENERAL

1.01 DESCRIPTION

This section specifies formwork requirements for concrete construction.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the documents listed below. They are a part of this section as specified and modified. Where a referenced document cites other standards, such standards are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). 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, regardless of whether the document has been superseded by a version with a later date, has been discontinued or has been replaced.

Reference	Title
ACI 117	Standard Specifications for Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete
ACI 303.1	Standard Specification for Cast-In-Place Architectural Concrete Practice
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures
ACI 347R	Guide to Formwork for Concrete
National Institute of Standards - PS1	Construction and Industrial Plywood

B. DESIGN:

Formwork design requirements shall conform to the following:

1. Formwork, shoring and reshoring shall be designed by a Professional Engineer currently registered in the State of Arizona having a minimum of 3 years' experience in this type of design work.
2. Design and engineering of formwork, shoring and reshoring, as well as its construction, is the sole responsibility of the CONTRACTOR.
3. A procedure and schedule shall be developed for removal of shores (and installation of reshores) and for calculating the loads transferred to the structure during this process.
4. Structural calculations shall be prepared as required to prove that all portions of the structure, in combination with the remaining forming and shoring system, have sufficient strength to safely support their own weight plus the loads placed thereon.
5. When developing procedure, schedule and structural calculations, consideration shall be made regarding the structural system that exists, effects of all imposed loads and the strength of concrete at each stage of construction.

C. DESIGN CRITERIA:

Design of formwork shall conform to the following criteria:

1. Formwork shall be designed for loads, lateral pressures and allowable stresses outlined in ACI 347R and for design considerations, wind loads, allowable stresses and other applicable requirements of the controlling local building code. Where conflicts occur between the above two standards, the more stringent requirements shall govern.
2. Formwork shall be designed to limit maximum deflection of form facing materials reflected in concrete surfaces exposed to view to 1/240 of span between structural members.

1.03 SUBMITTALS

Submittals shall be provided in accordance with Section 01300 and shall include the following information:



1. Manufacturer's product data, installation instructions and acknowledgement that products submitted meet requirements of standards referenced for
  - a. Form materials
  - b. Form release compound.
  - c. Form ties.
2. Formwork designer qualifications.
3. Submit letter of certification stamped by the registered Engineer referenced in paragraph 1.02B.1 that formwork has been designed in accordance with the specifications.
4. If requested, structural analysis and concrete strength data used in planning and implementing form removal and shoring.

## PART 2--PRODUCTS

### 2.01 FORMS

#### A. WOOD FORMS:

Wood forms shall be new and unused exterior grade plywood panels manufactured in accordance with APA (American Plywood Association) and bearing the trademark of that group. Forms for all concrete surfaces exposed to view shall be APA High Density Overlay (HDO) Plyform Class I Exterior 48" X 96" X 3/4" minimum thickness. Forms for other concrete surfaces shall be APA Douglas Fir B-B Plyform Class I Exterior 48" X 96" X 3/4-inch minimum thickness.

When approved by the CONSTRUCTION MANAGER, plywood may be reused.

#### B. METAL FORMS:

Metal forms excluding aluminum may be used. Forms shall be free of rust and straight without dents to provide members of uniform thickness.

#### C. ARCHITECTURAL CONCRETE FORMWORK

1. Form-Facing Panels for As Cast Architectural Concrete Finish:  
Exterior-grade plywood panels, nonabsorptive, that will provide continuous,

true, and smooth architectural concrete surfaces, high-density overlay, Class 1, or better, complying with DOC PS 1.

2. Rustication Strips: Metal, rigid plastic, or dressed wood with sides beveled and back kerfed; nonstaining; in longest practicable lengths. Strips to be installed securely, plumb, straight, and true.
3. Chamfer Strips: Metal, rigid plastic, elastomeric rubber, or dressed wood, 3/4 by 3/4 inch (19 by 19 mm), minimum; nonstaining; in longest practicable lengths. Strips to be installed securely, plumb, straight, and true.

## 2.02 FORM TIES

Form ties shall be commercially fabricated for use in form construction and shall be constructed so that ends or end fasteners can be removed without causing spalling at surfaces of the concrete. Diameter on ends shall be 3/4 inch minimum to 1 inch maximum. Embedded portion of ties shall be not less than 1 1/2 inch from face of concrete after ends have been removed. Ties with integral waterstops shall be provided in all water-retaining structures and in below grade structures exposed to a ground water level above the base slab.

## 2.03 FORM RELEASE COMPOUND

Coat all forming surfaces in contact with concrete using an effective, non-staining, non-residual, water based, bond-breaking form coating unless otherwise noted. Form release agents used in potable water containment structures shall be suitable for use in contact with potable water and shall be non-toxic and free of taste and odor. Form release agent shall not adversely affect concrete surfaces and shall not impair subsequent treatments of concrete surfaces.

## PART 3--EXECUTION

### 3.01 PREPARATION

Preparation shall conform to the following:

1. Surfaces of forms shall be covered with an approved form release compound prior to form installation. Application shall be in accordance with manufacturer's recommendations.
2. Excess form coating material shall not be permitted to stand in puddles in forms nor in contact with hardened concrete against which fresh concrete is to be placed.
3. Surfaces of forms, reinforcing steel and other embedded materials shall be cleaned of any accumulated mortar or grout from previous concreting and of all other foreign material before concrete is placed.

### 3.02 CONSTRUCTION

Formwork construction shall conform to the following:

1. Forms shall be used for all cast-in-place concrete including sides of footings.
2. Forms shall be constructed and placed so that the resulting concrete will be of the shape, lines, dimensions, and appearance indicated on the Drawings. Forms shall be braced or tied together to maintain their position and shape under a load of freshly-placed concrete.
2. Forms shall be sufficiently tight to prevent leakage.
4. Temporary openings shall be provided at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed, and to limit height of free fall of concrete to prevent aggregate segregation.
5. Temporary openings, also called form “windows”, shall be used to limit height of free fall of concrete and to limit the lateral movement of concrete during placement. Openings are required in wall placements greater than 20 feet in height and shall be spaced so that no more than 8 feet of solid form exists between openings measured horizontally and vertically.
6. A 3/4-inch chamfer strip shall be placed in exposed to view corners of the forms to produce a 3/4-inch wide beveled edge.
7. At construction joints, contact surface of form sheathing for flush surfaces exposed to view over hardened concrete in previous placement shall be overlapped by at least 1 inch. Forms against hardened concrete shall be held to prevent offsets or loss of mortar at construction joint and to maintain a true surface. Where possible, juncture of built-in-place wood or metal forms shall be located at architectural lines, control joints or at construction joints.
- .8. Where circular walls are formed, and forms made up of straight sections are proposed for use, straight lengths not exceeding 2 feet wide shall be provided for curved surfaces with a radius of 25 feet to 100 feet. Straight form lengths not exceeding 3 feet wide may be used for curved surfaces with a radius of 100 feet and larger. Formwork shall be braced and tied to maintain correct position and shape of members.
9. Wood forms for wall openings shall be constructed to facilitate loosening, if necessary, to counteract swelling. Formwork shall be anchored to

shores or other supporting surfaces of members so that movement of any part of formwork system is prevented during concrete placement.

10. Runways for moving equipment shall be provided with struts or legs, supported directly on formwork or structural members without resting on reinforcing steel.
11. A positive means of adjustment (wedges or jacks) of shores and struts to take up all settlement during concrete placing operation shall be provided. Forms shall be securely braced against lateral deflection. Wedges used for final adjustment of forms shall be fastened prior to concrete placement in position after final check.
12. Sealer: Penetrating, clear, polyurethane wood form sealer formulated to reduce absorption of bleed water and prevent migration of set-retarding chemicals from wood.
13. Form Joint Sealant: Elastomeric sealant complying with ASTM C 920, Type M or S, Grade NS, that adheres to form joint substrates.
14. Coat contact surfaces of wood rustications and chamfer strips with sealer before placing reinforcement, anchoring devices, and embedded items.
15. Architectural concrete smooth as-cast Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Remove fins and other projections exceeding specified limits on formed-surface irregularities. Do not repair and patch tie holes and defects in as-cast concrete finish without approval of the ENGINEER and Architect. Remove and replace cast-in-place architectural concrete that cannot be repaired. Repair in a manner acceptable to the ENGINEER and Architect.
16. Do not fill rock pockets or honey combing in the exposed -to-public-view surfaces without approval of the ENGINEER and the Architect.

### 3.03 TOLERANCES

Formwork tolerances shall be in accordance with ACI 117 and the following. If a discrepancy is found between the requirements below and ACI 117, the more stringent requirement shall control:

1. Products shall be installed in accordance with manufacturer's written instructions.
2. Surfaces of columns, piers, walls, and risers shall vary from plumb a maximum of 1/2 inch for entire height and 1/4 inch in 10 feet of height. Exposed corner columns, control-joint grooves, and other exposed to view

lines shall vary from plumb a maximum of 1/2 inch for entire length and 1/4 inch in 20 feet of length.

3. Maximum variation from level or from grade shall be 3/4 inch for entire length, 3/8 inch for any bay or 20 foot length, and 1/4 inch in 10 feet of length for slab soffits, ceilings, and beam soffits, measured before removal of supporting shores and shall be 1/2 inch for entire length and 1/4 inch in 20 feet of length for exposed lintels, sills, parapets, horizontal grooves, and other exposed-to-view lines.
4. Maximum variation of linear structure lines from established position in plan and related position of columns, walls, and partitions shall be 3/4 inch for entire length and 3/8 inch for any bay or 20-foot length.
5. Maximum variation in size and location of sleeves, floor openings, and wall openings and variation in horizontal plan location of beam, column and wall centerlines shall be  $\pm 1/2$  inch
6. Maximum variation in cross sectional dimensions of columns and beams and in thickness of slabs and walls shall be  $\pm 3/8$  inch and in concrete plan dimensions for footings and foundations shall be - 1/2 inch + 2 inches.
7. Maximum misplacement or eccentricity of footings and foundations shall be 2 percent of footing width in direction of misplacement, but not more than 2 inches.
8. Specified thickness of footings and foundations may be decreased by up to 5 percent with no maximum increase except that which may interfere with other construction.
9. Maximum step variance in the flight of stairs for Rise is  $\pm 1/8$  inch and for Tread is  $\pm 1/4$  inch and in consecutive steps for Rise is  $\pm 1/16$  inch and for Tread is  $\pm 1/8$  inch.
10. Sufficient control points and benchmarks to be used for reference purposes to check tolerances shall be established and maintained in an undisturbed condition until final completion and acceptance of the work.
11. Regardless of tolerances listed, no portion of a structure shall be allowed to extend beyond the legal boundary of work site.
12. To maintain specified tolerances, formwork shall be cambered to compensate for anticipated deflections in formwork prior to hardening of concrete.
13. For Architectural Concrete limit form work deflection of form-facing panels to not exceed ACI 303.1.

14. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-in-place surfaces.
  - a. Seal form joints and penetrations at form ties with form joint sealant to prevent cement paste leakage.

### 3.04 REMOVAL OF FORMS

Removal of forms shall conform to the following:

1. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads placed thereon.
2. When required for concrete curing in hot weather, required for repair of surface defects or when finishing is required at an early age, forms shall be removed as soon as concrete has hardened sufficiently to resist damage from removal operations or lack of support.
3. Top forms on sloping surfaces of concrete shall be removed as soon as concrete has attained sufficient stiffness to prevent sagging. Any needed repairs or treatment required on such sloping surfaces shall be performed at once, followed by curing specified in Section 03300.
4. Wood forms for wall openings shall be loosened as soon as this can be accomplished without damage to concrete.
5. Formwork for columns, walls, sides of beams, and other parts not supporting weight of concrete may be removed as soon as concrete has hardened sufficiently to resist damage from removal.
6. Where no reshoring is planned, forms and shoring used to support weight of concrete shall be left in place until concrete has attained its specified 28-day compressive strength.
7. When shores and other vertical supports are so arranged that non-load-carrying form facing material may be removed without loosening or disturbing shores and supports, facing material may be removed when concrete has sufficiently hardened to resist damage from removal.

### 3.05 RESHORING

Reshoring shall conform to the following:

1. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads placed thereon.
2. While reshoring is underway, no superimposed dead or live loads shall be permitted on the new construction.
3. During reshoring, concrete in structural members shall not be subjected to combined dead and construction loads in excess of loads that structural members can adequately support.
4. Reshores shall be placed as soon as practicable after stripping operations are complete, but in no case later than the end of working day on which stripping occurs.
5. Reshores shall be placed to carry their required loads without overstressing.
6. Where a reshoring procedure is planned, supporting formwork may be removed when concrete has reached the concrete strength by the formwork ENGINEER's structural calculations.

**\*\*END OF SECTION\*\***

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Concrete Formwork  
03100-10

Bodaway-Gap Contract 2  
Bid Issue



SECTION 03200

CONCRETE REINFORCEMENT

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies reinforcing steel for use in reinforced concrete.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). 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, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ACI 117	Standard Specifications for Tolerances for Concrete Construction and Materials
ACI 315	Details and Detailing of Concrete Reinforcement
ACI 318	Building Code Requirements For Structural Concrete and Commentary
ACI SP-66	ACI Detailing Manual
ASTM A82	Steel Wire, Plain, for Concrete Reinforcement
ASTM A185	Steel Welded Wire, Fabric, Plain for Concrete Reinforcement

Reference	Title
ASTM A615/A615M REV B	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A706/A706M REV B	Low-Alloy Steel Deformed Bars for Concrete Reinforcement
ASTM A775/A775M REV B	Epoxy-Coated Reinforcing Steel Bars
ASTM A884/A884M	Epoxy-Coated Steel Wire and Welded Wire Reinforcement
AWS D1.4	Structural Welding Code--Reinforcing Steel
CRSI-PRB	Recommended Practice for Placing Reinforcing Bars
CRSI-MSP 1	Manual of Standard Practice
FEDSPEC QQ-W-461H	Wire, Steel, Carbon (Round, Bare, and Coated)

**B. SHIPPING, HANDLING AND STORAGE:**

Reinforcing steel shall be shipped to the jobsite with attached plastic or metal tags having permanent mark numbers which match the shop drawing mark numbers. All reinforcing shall be supported and stored above ground. Use only plastic tags secured to the reinforcing steel bars with nylon or plastic tags for epoxy coated reinforcing steel bars.

**C. FABRICATION:**

Reinforcing steel bars shall be fabricated in accordance with ACI 315 and the following tolerances:

1. Sheared lengths shall be within +/- 1 inch.
2. Overall dimensions of stirrups, ties, and spirals shall be within +/- 1/2 inch.
3. All other bends shall be within +0 inch, -1/2 inch
4. Minimum diameter of bends of reinforcing steel bars shall be as indicated in ACI-318 paragraph 7.2.

**1.03 SUBMITTALS**

Submittals shall be provided in accordance with Section 01300 and shall include the following:

1. Mill certificates for all reinforcing.

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2. Manufacturer and type of proprietary reinforcing steel splices. A current ICC Report and manufacturer's literature that contains instructions and recommendations for each type of coupler used shall be submitted.
3. Manufacturer and type of proprietary reinforcing headed bar anchor. A current ICC Report and manufacturer's literature that contains instructions and recommendations for each type of anchor used shall be submitted.
4. Manufacturer and type of reinforcing steel adhesive anchor. A current ICC Report and manufacturer's literature that contains instruction and recommendations for each type of adhesive anchor to be used shall be submitted.
5. Qualifications of welding operators, welding processes and procedures.
6. Reinforcing steel shop drawings showing reinforcing steel bar quantities, sizes, spacing, dimensions, configurations, locations, mark numbers, lap splice lengths and locations, concrete cover and reinforcing steel supports. Reinforcing steel shop drawings shall be of sufficient detail to permit installation of reinforcing steel without reference to the contract drawings. Shop drawings shall not be prepared by reproducing the plans and details indicated on the contract drawings but shall consist of completely redrawn plans and details as necessary to indicate complete fabrication and installation of reinforcing steel, including large scale drawings at joints detailing bar placement in congested areas. Placement drawings shall be in accordance with ACI 315. Reinforcing details shall be in accordance with ACI SP-66.

## PART 2--PRODUCTS

### 2.01 BAR REINFORCEMENT

Reinforcing steel bars shall be deformed billet steel in conformance with ASTM A615, Grade 60. Bars to be welded shall be deformed billet steel conforming to ASTM A706.

Reinforcing steel bars in structural elements designated on the design drawings as "special moment frames" and "special shear walls" shall be ASTM A706. ASTM A615 Grade 60 reinforcement may be used if the following requirements are met:

1. The actual yield strength based on mill tests does not exceed the specified yield strength by more than 18,000 psi.
2. The ratio of the actual tensile strength to the actual yield strength is not less than 1.25.

## 2.02 WIRE FABRIC

Wire fabric shall be welded steel mesh conforming to ASTM A185.

## 2.03 WIRE AND PLAIN BARS

Wire used as reinforcement and bars used as spiral reinforcement in structures shall be cold drawn steel conforming to ASTM A82.

## 2.04 SMOOTH DOWEL BARS

Smooth dowel bars shall conform to ASTM A615, Grade 60, with a metal end cap at the greased or sliding end to allow longitudinal movement.

## 2.05 REINFORCING STEEL MECHANICAL SPLICES

Reinforcing steel mechanical splices shall be a positive connecting threaded type mechanical splice system manufactured by Erico, Inc., Dayton Superior, Williams Form Engineering Company, or approved equal.

Type 1 mechanical splices shall develop in tension or compression a strength of not less than 125 percent of the ASTM specified minimum yield strength of the reinforcement and shall meet all other ACI 318 requirements. Type 1 mechanical splices are typical except for locations noted below where Type 2 mechanical splices are required.

Type 2 mechanical splices shall meet the requirements for a Type 1 mechanical splice, plus develop the ASTM specified tensile strength of the reinforcement. Type 2 mechanical splices shall be provided at locations specifically noted on the design drawings.

## 2.06 TIE WIRE

The wire shall be minimum 16 gage annealed steel conforming to FEDSPEC QQ-W-461H.

## 2.07 BAR SUPPORTS

Bar supports coming into contact with forms shall be CRSI Class 1 plastic protected or Class 2 stainless steel protected and shall be located in accordance with CRSI MSP-1 and placed in accordance with CRSI PRB.

1. Manufactured concrete block supports with embedded tie wires (wire dobies) shall be provided for footing and slabs on grade. Do not use brick, broken concrete masonry units, spalls, rocks, construction debris, or similar material for supporting reinforcing steel.
2. Stainless steel or plastic protected plain steel supports shall be provided for

other work.

## 2.08 REINFORCING STEEL HEADED BAR ANCHORS

Reinforcing steel headed bar anchors shall be a positive connecting taper threaded type bar anchor. The bar end must be taper threaded using the manufacturer's bar threading equipment to ensure proper taper and thread engagement. Bars shall be installed in accordance with manufacturer's recommendations and the associated ICC report. Reinforcing steel headed bar anchors shall be model D6 Lenton Terminator as manufactured by Erico, Inc., or approved equal.

Type 1 mechanical splices shall develop in tension or compression a strength of not less than 125 percent of the ASTM specified minimum yield strength of the reinforcement and shall meet all other ACI 318 requirements. Type 1 mechanical splices are typical except for locations noted below where Type 2 mechanical splices are required.

Type 2 mechanical splices shall meet the requirements for a Type 1 mechanical splice, plus develop the ASTM specified tensile strength of the reinforcement. Type 2 mechanical splices shall be provided at locations specifically noted on the design drawings

## PART 3--EXECUTION

### 3.01 TOLERANCE

Reinforcing steel placement tolerance shall conform to the requirements of ACI 117, ACI 318, and the following:

1. Reinforcing steel bar clear distance to formed surfaces shall be within +/- 1/4 inch of specified clearance and minimum spacing between bars shall be a maximum of 1/4 inch less than specified.
2. Reinforcing steel top bars in slabs and beams shall be placed +/- 3/8 inch of specified depth in members 8 inches deep or less and +/- 1/2 inch of specified depth in members greater than 8 inches deep.
3. Reinforcing steel spacing shall be placed within +/- one bar diameter or +/- 1 inch, whichever is greater.
4. The minimum clear distance between reinforcing steel bars shall be equal to the greater of 1 inch or the reinforcing steel bar diameter for beams, walls and slabs, and the greater of 1 1/2 inches or 1.5 times the reinforcing steel bar diameter for columns.
5. Beam and slab reinforcing steel bars shall be threaded through column

vertical reinforcing steel bars without displacing the column reinforcing steel bars and still maintain clear distances for beam and slab reinforcing steel bars.

### 3.02 CONCRETE COVER

Unless specified otherwise on the Drawings, reinforcing steel bar cover shall conform to the following:

1. Reinforcing steel bar cover shall be 3 inches for concrete cast against earth.
2. Reinforcing steel bar cover shall be 2 inches for reinforcing steel bars for formed concrete surfaces exposed to earth and weather.
3. Reinforcing steel bar cover shall be 2 inches for any formed surfaces exposed to or above any liquid.
4. Reinforcing steel bar cover shall be 1 ½ inches for reinforcing not in the above categories unless noted otherwise on the design drawings.

### 3.03 SPLICING

Reinforcing steel splicing shall conform to the following:

1. Class B splice lengths in accordance with ACI 318, Chapter 12, shall be used for all reinforcing steel bars unless shown otherwise on the drawings.
2. For welded wire fabric the splice lap length measured between the outermost cross wires of each fabric sheet shall not be less than one spacing of cross wires plus 2 inches, nor less than 1.5 times the development length nor less than 6 inches.
3. Splices of reinforcement steel bars not specifically indicated or specified shall be subject to the approval of the ENGINEER. Mechanical proprietary splice connections may be used when approved by the ENGINEER or as indicated on the drawings.
4. Welding of reinforcing steel bars is not allowed unless approved by the ENGINEER.

### 3.04 HEADED BAR ANCHORS

Reinforcing steel headed bar anchors shall be used only at locations shown on the drawings. Installation shall be in strict conformance with manufacturer's recommendations and the associated ICC report.

### 3.05 CLEANING

Reinforcing steel bars at time of concrete placement shall be free of mud, oil, loose rust, or other materials that may affect or reduce bond. Reinforcing steel bars with rust, mill scale or a combination of both may be accepted without cleaning or brushing provided dimensions and weights including heights of deformation on a cleaned sample are not less than required by applicable ASTM standards.

### 3.06 PLACEMENT

Reinforcing steel bar placement shall conform to the following:

1. Uncoated reinforcing steel bars shall be supported and fastened together to prevent displacement by construction loads or concrete placement. For concrete placed on ground, furnish concrete block supports or metal bar supports with non-metallic bottom plates. For concrete placed against forms furnish plastic or plastic coated metal chairs, runners, bolsters, spacers and hangers for the reinforcing steel bar support. Only tips in contact with the forms require a plastic coating.
2. Coated reinforcing steel bars shall be fastened together to prevent displacement. Plastic or nylon ties shall be used to hold the coated reinforcing steel bars rigidly in place. The coated reinforcing steel bars shall be supported with plastic or plastic coated chairs, runners, bolsters, spacers and supports as required.
3. Where parallel horizontal reinforcement in beams is indicated to be placed in two or more layers, reinforcing steel bars in the upper layers shall be placed directly over the reinforcing steel bars in the bottom layer with the clear distance between each layer to be 2 inches unless otherwise noted on the Drawings. Spacer reinforcing steel bars shall be placed at a maximum of 3'-0" on center to maintain the minimum clear spacing between layers.
4. Reinforcement shall be extended to within 2 inches of formed edges and 3 inches of the concrete perimeter when concrete is placed against earth.
5. Reinforcing steel bars shall not be bent after embedding in hardened concrete unless approved by the ENGINEER.
6. Tack welding or bending reinforcing steel bars by means of heat is prohibited.
7. Where required by the contract documents, reinforcing steel bars shall be embedded into the hardened concrete utilizing an adhesive anchoring system

specifically manufactured for that application. Installation shall be per the manufacturer's written instructions.

8. Bars with kinks or with bends not shown shall not be used.
9. Heating or welding bars shall be performed in accordance with AWS D1.4 and shall only be permitted where specified or approved by the ENGINEER. Bars shall not be welded at the bend.

### 3.07 FIELD QUALITY CONTROL

Field quality control shall include the following:

1. The CONSTRUCTION MANAGER shall be notified whenever the specified clearances between the reinforcing steel bars can not be met. The concrete shall not be placed until the CONTRACTOR submits a solution to the congestion problem and it has been approved by the ENGINEER.
2. The reinforcing steel bars may be moved as necessary to avoid other reinforcing steel bars, conduits or other embedded items provided the tolerance does not exceed that specified in Section 3.01. The ENGINEER's approval of the modified reinforcing steel arrangement is required where the specified tolerance is exceeded. No cutting of the reinforcing steel bars shall be done without written approval of the ENGINEER.
3. An independent laboratory shall be employed to review and approve CONTRACTOR welding procedures and qualify welders in accordance with AWS D1.4. The laboratory shall visually inspect each weld for visible defects and conduct non-destructive field testing (radiographic or magnetic particle) on not less than one sample for each 10 welds. If a defective weld is found, the previous 5 welds by the same welder shall also be tested.

**\*\*END OF SECTION\*\***



## SECTION 03300

### CAST-IN-PLACE CONCRETE

#### PART 1--GENERAL

##### 1.01 DESCRIPTION

This section specifies cast-in-place concrete which consists of furnishing all material, mixing and transporting equipment, and performing all labor for the proportioning, mixing, transporting, placing, consolidating, finishing, and curing of concrete in the structure.

##### 1.02 QUALITY ASSURANCE

###### A. QUALITY CONTROL BY OWNER:

Special Inspection of concrete work shall be performed by the Special Inspector under contract with the CONTRACTOR and in conformance with the IBC Chapter 17. Special Inspector(s) and laboratory shall be acceptable to the OWNER in their sole discretion. Special Inspection of concrete is in addition to, but not replacing, other inspections and quality control requirements herein. Where sampling and testing required herein conforms to Special Inspection standards, such sampling and testing need not be duplicated.

All structural concrete work shall receive Special Inspection in accordance with IBC Chapter 17. Structural concrete includes all elements which resist code-defined loads and whose failure would impact life safety. Non-structural site work concrete does not require Special Inspection. Anchor bolts and anchors installed in hardened concrete require Special Inspection.

OWNER approved testing shall be in accordance with Section 01400.

###### B. QUALITY CONTROL BY CONTRACTOR:

Where required to demonstrate conformance with the specified requirements for cast-in-place concrete, the CONTRACTOR shall provide the services of an independent testing laboratory which complies with the requirements of ASTM E329. The testing laboratory shall sample and test concrete materials as specified in paragraphs 03300-2.01, 2.02, and 3.15. Costs of testing laboratory services shall be borne by the CONTRACTOR.

###### C. BASIS FOR QUALITY:

Cast-in-place concrete shall conform to the requirements of ACI 301, except as modified herein.

###### D. REFERENCES:

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This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). 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, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
ACI 117	Tolerances for Concrete Construction and Materials
ACI 211.1	Selecting Proportions for Normal, Heavy Weight and Mass Concrete
ACI 214R	Evaluation of Strength Test Results of Concrete
ACI 301	Structural Concrete for Buildings
ACI 305.1	Specification for Hot Weather Concreting
ACI 306.1	Standard Specification for Cold Weather Concreting
ACI 318-05	Building Code Requirements for Structural Concrete
ACI 350-06	Code Requirements for Environmental Engineering Concrete Structures
ACI 350.1	Tightness Testing of Environmental Engineering Concrete Structures
ASTM C31	Making and Curing Concrete Test Specimens in the Field
ASTM C33	Concrete Aggregates
ASTM C39	Compressive Strength of Cylindrical Concrete Specimens
ASTM C40	Organic Impurities in Fine Aggregate for Concrete
ASTM C42	Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C88	Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C94	Ready-Mixed Concrete
ASTM C117	Materials Finer Than 75- $\mu$ m (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131	Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

Reference	Title
ASTM C136	Sieve Analysis of Fine and Coarse Aggregates
ASTM C142	Clay Lumps and Friable Particles in Aggregates
ASTM C143	Slump of Hydraulic Cement Concrete
ASTM C150	Portland Cement
ASTM C157	Length Change of Hardened Cement Mortar and Concrete
ASTM C172	Sampling Freshly Mixed Concrete
ASTM C192	Making and Curing Concrete Test Specimens in the Laboratory
ASTM C231	Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Air-Entraining Admixtures for Concrete
ASTM C309	Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494	Chemical Admixtures for Concrete
ASTM C595	Blended Hydraulic Cements
ASTM C618	Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C881	Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C989	Slag Cement for use in Concrete and Mortars
ASTM C1059	Latex Agents for Bonding Fresh to Hardened Concrete
ASTM C1260	Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar Bar Method)
ASTM C1602	Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D75	Sampling Aggregates
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM E329	Agencies Engaged in Construction Inspection and/or Testing
CRD-C572	U.S. Corps of Engineer's Specifications for Polyvinylchloride Waterstop
IBC 2021	International Building Code with local amendments

## E. CONCRETE CONFERENCE

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A meeting shall be held to review the main specification requirements and the CONTRACTOR's proposed concrete design mixes and to determine the procedures for producing proper concrete construction. The meeting shall be held no later than 28 days after the Notice to Proceed.

All parties involved in the concrete work shall attend the conference, including the following: CONTRACTOR's representative, testing laboratory representative, concrete subcontractor, concrete supplier, CONSTRUCTION MANAGER, and the ENGINEER.

### 1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

1. Each proposed mix design showing (a) the expected strength at 28 days, (b) corresponding slump before and after the introduction of high-range water-reducing admixtures, (c) water/cement ratios, (d) weights and test results of the ingredients, (e) aggregate gradation, (f) test results of mix design prepared by an independent testing laboratory, and (g) other physical properties necessary to review each mix design for conformance with these specifications. Mix design proposed shall be sealed by a Professional Engineer registered in the state where the project is located.
2. Product literature and technical data for aggregates, cement, and pozzolan.
3. Product literature, technical data and dosage of all proposed admixtures including, but not limited to, air entraining, water reducing and/or retarding admixtures and shrinkage reducing admixtures at liquid containing concrete.
4. Anticipated average delivery time from batch plant to site. If this time exceeds the limit specified in paragraph 3.02, include proposed method to extend set time without deleterious effects on final product. The ENGINEER reserves the right, in their sole discretion, to accept or reject such proposed methods.
5. Curing program description in sufficient detail to demonstrate acceptable strength, finish and crack control as specified.
6. Product literature and technical data for waterstops, curing and sealing compounds, bonding compounds, , epoxy and chemical grout for crack injection, retardant, and trench drains.
7. Samples of concrete floor and slab finishes are specified in paragraph 3.12 E.
8. Concrete delivery truck tickets showing the information listed in ASTM C94, section 14.
9. The CONTRACTOR shall prepare concrete placement drawings. The placement drawings shall include the intended placement sequencing, location of each

placement, the size of the concrete placements, joint locations, embedded items, slab high points and low points, and waterstop locations. Each placement shall also be label with a mix design and the type of finish the concrete surface is to receive.

## PART 2--PRODUCTS

### 2.01 MATERIALS

#### A. CEMENT:

Portland cement shall be ASTM C150, Type II, low alkali, containing less than 0.60 percent alkalis. In addition to standard requirements, cement shall satisfy optional chemical and physical requirements of ASTM C150, Tables 2 and 4, respectively.

If low alkali cement is not available, aggregates shall show an expansion of less than 0.1% when tested in accordance with ASTM C1260 or ASTM C1567 concrete mix test results shall be submitted verifying that the aggregates are not reactive per the criteria in this standard. ASTM C1260 and ASTM C1567 results shall be no older than 1 year.

Portland-pozzolan cement shall be ASTM C595, Type IP (MS), interground, low alkali.

Use cementitious materials that are of the same brand and type and from the same plant of manufacture as the cementitious materials used in the concrete represented by the submitted field test records or used in the trial mixtures. See Section 2.01G.

#### B. GROUND GRANULATED BLAST-FURNACE SLAG:

Ground granulated blast-furnace slag (GGBFS), if used in conjunction with Portland cement, shall be per ASTM C989.

#### C. AGGREGATES:

1. GENERAL: Except as modified herein, fine and coarse aggregates shall conform to ASTM C33. Fine and coarse aggregates shall be regarded as separate ingredients. Aggregates shall be non-reactive and shall be washed before use.

Aggregates shall be checked for alkali-silica reactive constituents per ASTM C1260. Aggregate shall have less than 0.1% expansion when tested in accordance with ASTM C1260. Aggregates having 0.1% or greater expansion when tested in accordance with ASTM C1260 may still be satisfactory provided ASTM C1567 concrete mix test results are submitted and show an expansion of less than 0.1% at 16 days. ASTM C1260 and ASTM C1567 test results shall be no older than 1 year.

Tests for size and grading of fine and coarse aggregates shall be in accordance with ASTM C136. Combined aggregates shall be well and uniformly graded from coarse to fine sizes to

produce a concrete that has optimum workability and consolidation characteristics. The final combined aggregate gradation shall be established during the design mix.

Aggregates used in the concrete shall be obtained from the same sources and have the same size ranges as the aggregates used in the concrete represented by the submitted historical data or trial mixtures. See Section 2.01G.

2. FINE AGGREGATE: Fine aggregate shall be hard, dense, durable particles of either sand or crushed stone regularly graded from coarse to fine. Gradation shall conform to ASTM C33. For classes of concrete which will be used in liquid retaining structures, fine aggregate shall not exceed 40 percent by weight of combined aggregate total, except for concrete with coarse aggregate of less than maximum size 1/2 inch.

Variations from the specified gradations in individual tests will be acceptable if the average of three consecutive tests is within the specified limits and the variation is within the permissible variation listed below:

U.S. standard sieve size	Permissible variation in individual tests, percent
30 and coarser	2
50 and finer	0.5

Other tests shall be in accordance with the following specifications:

Test	Test method	Requirements
Amount of material	ASTM C117	3 percent passing No. 200 sieve maximum by weight
Sand equivalent	ASTM D2419	Minimum 70

3. COARSE AGGREGATE: Coarse aggregate shall be hard, dense and durable gravel or crushed rock free from injurious amounts of soft and friable particles, alkali, and organic matter. Other deleterious substances shall not exceed the limits listed in ASTM C33, Table 3 for Class Designation 5S. Gradation of each coarse aggregate size specified in paragraph 03300-2.02 A shall conform to ASTM C33, Table 2.

Variations from the specified gradations will be acceptable in individual tests if the average of three consecutive tests is within the specified limits.

D. POZZOLAN:

Pozzolan shall be Class F fly ash conforming to ASTM C618. Class C fly ash is not allowed. Pozzolan supplied during the life of the project shall have been formed at the same single source. See Section 2.01G.

The pozzolan color shall not substantially alter the resulting concrete from the normal gray color and appearance.

Use pozzolan materials that are of the same brand and type and from the same plant of manufacture as the materials used in the concrete represented by the submitted field test records or used in the trial mixtures.

E. ADMIXTURES:

1. GENERAL: Admixtures shall be compatible with the concrete and with each other. Calcium chloride or admixtures containing calcium chloride are not acceptable. Admixtures shall be used in accordance with the manufacturer's recommendations and shall be added separately to the concrete mix. The water reducing retarders and admixtures shall reduce the water required by at least 11 percent for a given concrete consistency and shall comply with the water/cement ratio standards of ACI 211.1. Retarder dosage shall result in set time consistent with paragraph 3.02.

2. WATER REDUCING ADMIXTURES: Water reducing admixtures shall conform to ASTM C494, Type A. Acceptable products include: BASF "Pozzolith 322N"; SIKA Chemical Corp. "Plastocrete 161"; Euclid Chemical Co. "Eucon WR91"; or equal.

3. WATER REDUCING AND RETARDING ADMIXTURES: Water reducing and retarding admixtures shall conform to ASTM C494, Type D. Acceptable products include: BASF "Pozzolith 300R"; Sika Chemical Corp. "Plastiment"; Euclid Chemical Co. "Eucon Retarder 75"; or equal.

4. HIGH RANGE WATER REDUCING ADMIXTURES: High range water reducing (superplasticizing) admixtures shall conform to ASTM C494, Type F. Acceptable products include: BASF "Glenium 3000NS"; Sika Chemical Corp. "Sikament FF or 686"; Euclid Chemical Co. "Eucon 37"; W.R. Grace "ADVA 195"; or equal.

5. HIGH RANGE WATER REDUCING AND RETARDING ADMIXTURES: High range water reducing and retarding admixtures shall conform to ASTM C494, Type G. Acceptable products include: W.R. Grace "Daracem 100"; Euclid Chemical Co. "Eucon 537"; or equal.

6. AIR ENTRAINING AGENT: Air entraining agent shall conform to ASTM C260. Acceptable products include: BASF "MB-AE 90"; Sika Chemical Corp. "AEA-15"; Euclid Chemical Co. "AEA-92"; or equal. The air entraining agent added shall produce, in

accordance with ASTM C260, an entrained air content specified in paragraph 03300-2.02 A for each class of concrete.

7. **SHRINKAGE REDUCING ADMIXTURE:** Select shrinkage reducing admixture for compatibility with air entrainment admixture and other ingredients of the concrete mix. Acceptable products include: BASF “Tetraguard AS20” and Grace “Eclipse 4500”.

F. **WATER:**

Water for washing aggregate, for mixing and for curing shall be free from oil and deleterious amounts of acids, alkalis, and organic materials; and shall comply with the requirements of ASTM C1602. Additionally, water used for curing shall not contain an amount of impurities sufficient to discolor the concrete.

G. **CHANGE OF MATERIALS:**

After each concrete mix design is approved by the ENGINEER, no changes of any sort or source will be allowed without prior written approval from the ENGINEER. When brand, type, size, or source of cementitious materials, aggregates, water, ice, or admixtures are proposed to be changed, new field data, data from new trial mixtures, or evidence that indicates that the change will not affect adversely the relevant properties of the concrete shall be submitted for approval by the ENGINEER before use in concrete.

2.02 **CONCRETE CHARACTERISTICS**

A. **MIX PROPORTIONING:**

Concrete shall be normal weight concrete composed of specified cement, pozzolan, admixtures, aggregates and water proportioned and mixed to produce a workable, strong, dense, and impermeable concrete. The CONTRACTOR may substitute interground Portland-pozzolan cement conforming to ASTM C595, containing the specified amount of pozzolan in lieu of Portland cement and pozzolan. Water-cementitious material (w/cm) ratio is based on the combined contents of cement and pozzolan in a given mix proportion.

Concrete shall be provided in accordance with the following:

Concrete class	ASTM coarse aggregate size	Maximum water-cementitious materials (w/cm) ratio	Minimum Cementitious Materials Content (pounds/CY)	Pozzolan, percent by weight of cementitious materials	Air content (percent)	Minimum <sup>a</sup> 28-day compressive strength, psi	Slump Range <sup>e</sup> (inches)
A	467	0.42	515	20-35	4-6	4000 <sup>b</sup>	3-5



Concrete class	ASTM coarse aggregate size	Maximum water-cementitious materials (w/cm) ratio	Minimum Cementitious Materials Content (pounds/CY)	Pozzolan, percent by weight of cementitious materials	Air content (percent)	Minimum <sup>a</sup> 28-day compressive strength, psi	Slump Range <sup>e</sup> (inches)
B	57 or 67	0.45	560	15-20 <sup>d</sup>	4-6	3000	3-5
C	57 or 67	0.40	560	15-20	4-6	4500	3-5
E <sup>c</sup>	57	--	-	15-20 <sup>d</sup>	Not Required	2000	4-8

<sup>a</sup> Compressive strength shall be determined at the end of 28 days based on test cylinders made and tested in accordance with ASTM C39.

<sup>b</sup> Compressive strength of Class A concrete may be determined at 56 days.

<sup>c</sup> Concrete encasement for electrical conduit shall contain 3 pounds of red oxide per sack of cement.

<sup>d</sup> Pozzolan use optional for this class of concrete.

<sup>e</sup> Slump before addition of high range water reducing admixture (superplasticizer). Maximum slump after addition of high range water reducing admixture shall be 8".

**B. USE:**

Concrete shall be provided by class for the corresponding use listed as follows:

Type of use	Class of concrete
Concrete greater than 36 inches thick	A
Non-structural concrete (sidewalks, curbs, pavers, etc.)	B
Typical cast-in-place structural concrete, concrete fill, and Architectural Concrete	C
Pipe bedding and encasement, electrical conduit encasement (duct banks)	E

**C. CONTROL TESTS:**

1. **GENERAL:** Before beginning concrete work, the CONTRACTOR shall determine the proper proportions of materials for each class of concrete. The mix shall consist of specified cement, pozzolan, admixtures, aggregate and water. Methods for selecting and adjusting proportions of the ingredients shall be in accordance with ACI 211.1. Verification of mix characteristics for submittal may be achieved using either the Trial Mix Design method or Field Experience method. Concrete shall not be placed in the field prior to review and acceptance of mix proposed.

2. TRIAL MIX DESIGN: Each class of concrete and/or mix verified by this method shall be manufactured at the batch plant which will supply concrete to the project using materials proposed for the Work and material combinations listed in paragraphs 2.01 and 2.02. Testing, data and reporting shall conform to ACI 318 Section 5.3 and the following:

- (a) Required compressive strength used as the basis for selecting concrete proportions ( $f'_{cr}$ ) shall be the specified concrete strength ( $f'_c$ ) + 1000 psi for specified concrete strengths less than 3,000 psi and  $f'_c$  + 1200 psi for specified concrete strengths between 3000 psi and 5000 psi.
- (b) Make at least three trial different mixtures for each class of concrete qualified by the Trial Mix Design. Each trial mixture shall have a different w/cm ratio or different cementitious materials content that will produce a range of compressive strengths encompassing  $f'_{cr}$ .
- (c) Trial mixtures shall be designed to produce a slump within  $\frac{3}{4}$  in. of the maximum specified and for air-entrained concrete, an air content within 0.5% of the maximum allowable air content.
- (d) For each w/cm ratio or cementitious materials content, at least twelve standard test cylinders shall be cast and cured in accordance with ASTM C192. Four cylinders from each batch shall be tested at age 7 days, 14 days, and 28 days or as required to comply with ACI 318 Section 5.3.
- (e) From results of the cylinder tests, plot a curve showing the relationship between w/cm ratio and compressive strength.
- (f) From the curve of w/cm ratio versus compressive strength, select the w/cm ratio that will produce  $f'_{cr}$ . This is the maximum w/cm ratio that shall be used unless a lower w/cm ratio is specified in paragraph 2.02A.

3. FIELD EXPERIENCE DATA: When sufficient test data for a particular mix design is available which is identical or substantially similar to that proposed for use, CONTRACTOR may substitute use of this data in lieu of a trial mix design. Field data, reports, and analysis shall conform to ACI 318 Section 5.3, except as modified herein. Historical mix design proportions for which data are submitted may vary from the specified mix within the following limits: (a)  $f'_c$  as specified or up to 500 psi above; (b) w/cm ratio as specified or lower; (c) pozzolan content within 5 percent of that specified; (d) maximum coarse aggregate size may not vary smaller, but gradation of coarse aggregate may vary; (e) fine aggregate fraction within +0/ 5 percent of that specified; and (f) slump after introduction of admixtures +0/-1 inch. Use of historical mix design data does not allow modification of the project mix specifications herein without the express review and acceptance of the ENGINEER.

4. SHRINKAGE: Liquid containing structures using Class C-1 concrete are intended to be watertight. When used for liquid containing structures, the CONTRACTOR shall provide test

results for the Class C-1 concrete mix meeting the following requirement: drying shrinkage limit of 0.042 percent in the laboratory at 35 days (7 days moist cure and 28 days drying) as tested by ASTM C157 with the following modifications.

- (a) Wet cure specimens for a period of 7 days (including the period of time the specimens are in the mold). Wet cure may be achieved either through storage in a moist cabinet or room in accordance with ASTM C 511, or through storage in lime saturated water.
- (b) Slump of concrete for testing shall match job requirements and need not be limited to restrictions as stated in ASTM C 157 section 8.4.
- (c) Report results in accordance with ASTM C 157 at 0, 7, 14 & 28 days of drying.

Concrete shall not be placed in the field prior to acceptance of the concrete mix. It is recommended that a shrinkage reducing admixture (see 03300-2.01 E.7) be considered for use in concrete for liquid containing structures using the Class C-1 concrete mix to meet the drying shrinkage limit.

## 2.03 WATERSTOPS

### A. POLYVINYL CHLORIDE (PVC):

PVC waterstops shall be manufactured from virgin polyvinyl chloride conforming to the Corps of Engineers Specification No. CRD-C572. Unless otherwise specified or noted on the drawings, waterstops in construction joints shall be 6-inch flat center/ribbed sides/0.375 inch thick. Acceptable products include: Greenstreak Group, Inc. "Model 679"; Vinylex Waterstops and Accessories "Model R638"; or equal. Waterstops in expansion joints shall be 9 inch center-bulb/ribbed sides/0.375 inch thick. Acceptable products include: Greenstreak Group, Inc. "Model 696"; Vinylex Waterstops and Accessories Model "RLB938"; or equal.

Crosses, tees, and other shapes used for changes of direction, intersections, and transitions shall be molded pieces as recommended by the manufacturer.

## B. EXPANDING (HYDROPHILIC) WATERSTOPS:

Expanding waterstops shall be bentonite-free and made from unvulcanized rubber. Acceptable products include: SIKA "SikaSwell P-2010"; Adeka Corporation "Ultra Seal MC-2010MN"; Greenstreak Group, Inc. "Hydrotite CJ-1020-2K"; or equal. These are allowable for use only where indicated on the drawings or accepted in writing by the ENGINEER. Provide adhesive approved by the waterstop manufacturer where required due to geometry, irregular surface conditions, or as recommended by the manufacturer. The waterstop MUST be placed between two mats or curtains of steel reinforcement. For limited cover applications or where only one mat or curtain of reinforcement is present, use Adeka Corporation "Ultra Seal KBA-1510FP".

## C. INJECTED TUBE WATERSTOPS:

Chemical grout injection tube system, if shown on the Drawings, shall be "Injecto System" by De Neef Construction Chemicals or equal. Equivalent systems shall be submitted to the ENGINEER for review.

### 2.04 SEALANTS AND JOINT FILLERS

Sealants and preformed joint fillers shall be as specified in Sections 07900 and 07905.

### 2.05 BONDING COMPOUNDS

Epoxy resin bonding compounds to be used for wet areas shall conform to ASTM C881 Types IV or V, Class A, B, or C depending on temperature at use, and Grade to suit geometry and installation circumstances. Acceptable products include: BASF "Concresive Paste SPL" or "Concresive 1490", as applicable; Sika Chemical Corporation "Sikadur 35" or Sikadur 32", as applicable; or equal.

Non-epoxy bonding compounds may be used in dry areas for non-structural bonding or as specifically noted on the drawings only and shall conform to ASTM C1059 Type II. Acceptable products include: Edoco "Burke Acrylic Bondcrete"; ChemMasters "Cretelox"; or equal.

Bonding compounds shall be applied in accordance with the manufacturer's instructions.

### 2.06 EPOXY FOR CRACK INJECTION

Epoxy for crack injection shall be a two-component, moisture insensitive, high modulus, injection grade, 100 percent solids, blend of epoxy-resin compounds. The consistency shall be as required to achieve complete penetration in hairline cracks and larger. Material shall conform to ASTM C881 Type 1 Grade 1. Acceptable products include Sika Corporation "Sikadur 52"; Adhesives Technology Corporation "Crackbond SLV302"; or equal. Epoxy grout shall be used for all crack repairs except as noted below for non-structural cracks in liquid-containing concrete. The ENGINEER shall determine whether a crack is classified as structural or non-structural. Structural cracks must be repaired with epoxy.

## 2.07 CHEMICAL GROUT FOR CRACK INJECTION

Chemical (hydrophobic polyurethane) grout shall be used at the ENGINEER's discretion as an alternative to the injection of the epoxy grout for sealing non-structural cracks in structures intended to be watertight. Acceptable products include "Hydro Active Cut" by De Neef Construction Chemicals or SikaFix HH by Sika Corporation, or equal approved by the ENGINEER.

## 2.08 RETARDANT

Retardant for exposing aggregates for unformed surfaces in construction joints shall be Sika "Rugasol-S"; W.R. Grace "Top-Cast"; or equal. Retardant shall be applied in accordance with manufacturer's instructions sufficient to assure a minimum penetration of 1/4 inch.

## 2.10 CURING AND SEALING COMPOUNDS

Curing and sealing compound shall be BASF Sonneborn "Kure-N-Seal 25LV"; Edoco, "Spartan-Cote VOC"; or equal, conforming to ASTM C309.

Curing compound shall be clear and shall be applied in accordance with the manufacturer's instructions, except as otherwise specified. Curing and sealing compound shall be certified compliant with final finish systems.

## PART 3--EXECUTION

### 3.01 GENERAL

This section covers the production of cast-in-place concrete. Included are methods and procedures for obtaining quality concrete through proper handling, placing, finishing, curing, and repair of surface defects.

### 3.02 CONCRETE

Concrete shall be truck-mixed, ready-mixed concrete conforming to the applicable portions of ASTM C94. Materials shall be proportioned by weighing. Pozzolan shall be introduced into the mixer with cement and other components of the concrete mix; pozzolan shall not be introduced into a wet mixer ahead of other materials or with mixing water. Water shall be introduced at the time of charging the mixer; additional water may be introduced within 45 minutes from charging the mixer, provided the specified slump is not exceeded and the maximum total water per the approved mix design is not exceeded. CONTRACTOR shall arrange with the testing laboratory for inspection as required to comply with these specifications.

Concrete shall be delivered to the site and discharge shall be completed within 90 minutes after introduction of water to the mixture. Extension of allowable time beyond this limit requires a CONTRACTOR proposed remedial action plan to be reviewed and accepted by the ENGINEER.

### 3.03 CONVEYING AND PLACING CONCRETE

#### A. CONVEYING CONCRETE:

Concrete shall be conveyed from the mixer to the forms in accordance with ACI 301. Concrete which has segregated in conveying shall be removed from the site of the work.

#### B. PLACING CONCRETE:

1. GENERAL: Concrete shall be placed in accordance with ACI 301. Do not permit concrete to drop freely more than 4-ft.

2. PLACING CONCRETE BY PUMPING: Concrete may be placed by pumping at CONTRACTOR's discretion. Use of pumping shall not, however, be cause to change or relax specified mix design characteristics. Concrete shall possess the specified characteristics at the point of placement.

Slump shall be measured at the hose discharge, except as follows. Initial slump testing in each pour shall occur at both the pumping unit inlet hopper and hose discharge. Slump loss in pumping, measured between the inlet hopper and the hose discharge, shall not exceed 1 inch. After these criteria have been satisfied, slump may be measured at the inlet hopper with allowable slump increased by the earlier measured difference, not to exceed 1 inch.

Air content shall be measured at the hose discharge, except as follows. Initial air content testing shall occur at both the pumping unit inlet hopper and the hose discharge. Loss of air content shall be measured between the inlet hopper and the hose discharge. The air content of the delivered concrete at the inlet hopper shall be increased to provide the specified air content at the hose discharge. After these criteria have been satisfied, air content may be measured at the inlet hopper.

Before starting each pumping operation, the pump and line shall be primed with a cement slurry to lubricate the system. Cement slurry shall be wasted outside the forms. Hose tip shall be equipped with a safety chain for recovery in case of hose blowout during pumping, and in no case shall hose or accessories remain in the freshly placed concrete.

Proper tremie placing techniques and equipment shall be used for all pump placed concrete. Pump discharge system shall remain full of concrete from pump to discharge point at all times. Concrete pumping shall not occur until CONSTRUCTION MANAGER has verified that the proper equipment is available, in particular, the tremie plug. Should the discharge line become open, with significant zones empty of concrete, then the pumping shall cease and the line re-primed with tremie plug installed before continuing the pour.

3. PLACING CONCRETE IN HOT WEATHER: In hot weather (above 80 degrees F), concrete shall be placed in accordance with ACI 305.1.
4. PLACING CONCRETE IN COLD WEATHER: In cold weather (below 45 degrees F), concrete shall be placed in accordance with ACI 306.1.

C. CONSOLIDATING CONCRETE:

Concrete shall be consolidated in accordance with ACI 301. If proper consolidation is not occurring, then concrete placing shall be suspended until proper consolidation can be achieved.

3.04 CURING AND SEALING

A. GENERAL:

Concrete curing shall be completed by water curing or by using a clear membrane curing compound or by a combination of both methods. Repairs or treatment of concrete surfaces shall be coordinated so that interruption of the curing will not be necessary.

Concrete surface temperature shall be maintained between 50 degrees F and 80 degrees F for at least 5 days. Curing concrete in hot weather (above 80 degrees F) shall be in accordance with ACI 305.1. Curing concrete in cold weather (below 45 degrees F) shall be in accordance with ACI 306.1.

B. WATER CURING:

When water curing is used, concrete shall be kept wet continuously for a minimum of 10 days after placement. Absorbent mats or fabric may be used to retain moisture during the curing period.

Unless otherwise specified, water curing shall be used in hot weather for water containment structures. Forms shall be covered and kept moist. The forms shall be loosened as soon as possible without damage to the concrete, and provisions made for curing water to run down inside them. During form removal, care shall be taken to provide wet cover to newly exposed surfaces.

C. CURING COMPOUND:

When curing compound is used, it shall be applied as soon as the concrete has set sufficiently so as not to be marred by the application or immediately following form removal for vertical and other formed surfaces. Preparation of surfaces, application procedures, and installation precautions shall be followed in strict compliance with the manufacturer's instructions. Curing compound shall be applied at twice the manufacturer's recommended dosage rate in two coats applied perpendicular to each other. Use of curing compound for other than liquid containing structures shall be in accordance with the manufacturer's recommendations.

Curing compound shall not be used on concrete surfaces to be coated, waterproofed, moisture-proofed, tiled, roofed, or where other coverings are to be bonded, unless the curing compound is compatible with the final finish covering or it is removed prior to covering.

### 3.05 PROTECTION

Concrete shall be protected from injurious action by sun, rain, flowing water, frost and mechanical injury.

Loading green concrete will not be permitted. Green concrete is defined as concrete with less than 100 percent of the specified strength.

Unless otherwise shown on the Drawings, no backfill shall be placed against concrete walls until the concrete has reached the specified strength and the connecting slabs and beams have been cast and have reached the specified strength.

Arrangements for covering, insulating, and protecting concrete in cold weather shall be in accordance with ACI 306.1.

### 3.06 CONSTRUCTION JOINTS

#### A. GENERAL:

Concrete in each unit of construction shall be placed continuously. Before new concrete is placed on or against concrete which has set, forms shall be retightened and the surface of the set concrete shall be cleaned of foreign matter. Watertight joints shall be provided as specified in paragraph 03300-3.09.

#### B. CONSTRUCTION:

Construction joints shall be formed as specified. A rough surface of exposed concrete aggregates shall be produced using a surface retardant at construction joints, including joints between the slab and topping concrete. The limit of the treated surfaces shall be 1 inch away from the joint edges. Within 24 hours after placing, retarded surface mortar shall be removed either by high pressure water jetting or stiff brushing or combination of both so as to expose coarse aggregates. A rough surface of exposed aggregate may also be produced by sandblasting followed by high pressure water jetting. Sandblasting, if used, shall remove 1/4 inch of laitance film and shall expose coarse aggregate to ensure adequate bond and watertightness at the construction joints.

Reinforcing steel and welded wire fabric shall be continued across construction joints. Waterstops shall be provided in construction joints at locations as specified in paragraph 03300-3.09.



### 3.07 INSERTS AND EMBEDMENTS

#### A. INSERTS:

Where pipes, castings or conduits are to pass through structures, the CONTRACTOR shall place such pipes or castings in the forms before placing the concrete, or he may provide openings in the concrete for subsequent insertion of such pipes, castings or conduits. Such openings shall be provided with waterstops and V-shaped construction joint as shown and shall have a slight flare to facilitate grouting and permit the escape of entrained air during grouting.

Additional reinforcement shall be provided around openings as shown. Grout fill around inserts shall be non-shrink grout as specified in Section 03600.

Horizontal conduits and pipes, where shown in structural slabs and beams, shall be placed between the top and bottom layers of reinforcement. Spacing and size limitations shall conform to ACI 318 Section 6.3 unless specifically approved otherwise by the ENGINEER. Such conduits and pipes shall not run directly beneath a column or, if used, its steel base plate. Pipe, conduit, dowels, and other ferrous items required to be embedded in concrete construction shall be so positioned and supported prior to placement of concrete that there will be a minimum of 2-inches clearance between said items and any part of the concrete reinforcement. The outside diameter of such conduits should not exceed one-fourth the slab or beam thickness. Securing such items in position by welding them to the reinforcement will not be permitted.

#### B. EMBEDMENTS:

Gate frames, gate thimbles, special castings, channels or other miscellaneous metal parts that are to be embedded in the concrete shall be set and secured in the forms prior to concrete placement. Unless otherwise specified, anchor bolts and inserts shall be embedded in concrete as shown. The CONTRACTOR shall provide inserts, anchors or other bolts necessary for the attachment of piping, valves, metal parts and equipment. Nailing blocks, plugs, strips, and the like necessary for the attachment of trim, finish, and similar work shall be provided. Voids in sleeves, inserts and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids. Operators or sleeves for gate or valve stems shall be positioned to clear reinforcing steel, conduit and other embedments, and to align accurately with equipment.

### 3.08 EXPANSION JOINTS

Expansion joints shall be as shown. Reinforcement or other embedded metal items bonded to the concrete shall not extend through expansion joints. Waterstops shall be provided in expansion joints as specified in paragraph 03300-3.09.

### 3.09 WATERSTOPS

Waterstops shall conform to ACI 301. Waterstops shall be securely held in position during placing of concrete. If, after placing concrete, waterstops are materially out of position or shape, the

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surrounding concrete shall be removed, the waterstop reset, and concrete replaced in accordance with paragraph 03300-3.10.

Waterstops shall be provided at the following joints:

1. Expansion joints in structures.
2. Joints in parts of structures exposed to ground or water on one side and occupied by non-submerged equipment or by personnel on the other.
3. Wall and slab joints of tank and channels subject to water pressure. Waterstops shall be provided for the full height of the wall, or as otherwise noted on the drawings.

Field splices shall be heat fused welded butt splices only and shall be acceptable only in straight sections. Lapping of splices or joining by any means other than heat fused welding shall not be allowed.

Hydrophilic waterstops shall be installed according to manufacturer's recommendations. Surfaces of concrete shall be prepared to required level/plumb and smoothness as required by manufacturer. Form and finish concrete placed first with contact surface requirements in mind, or grind surface if necessary. Provide bonding adhesive if required for the particular product, or if surface conditions warrant. Note restrictions on use described in paragraph 03300-2.03 B.

### 3.10 FORMED SURFACE FINISHES

#### A. REPAIR OF SURFACE DEFECTS:

Surface defects, including tie holes, minor honeycombing or otherwise defective concrete shall be repaired in accordance with ACI 301. Areas to be patched shall be cleaned. Minor honeycombed or otherwise defective areas shall be cut out to solid concrete to a depth of at least 1 inch. The edges of the cut shall be perpendicular to the surface of the concrete. Patches on exposed surfaces shall be finished to match the adjoining surfaces after they have set. Patches shall be cured as specified for the concrete. Finished surfaces shall be protected from stains and abrasions. Finishes shall be equal in workmanship, texture, and general appearance to that of the adjacent concrete. Concrete with honeycombing which exposes the reinforcing steel or with defects which affect structural strength shall be corrected.

#### B. FORMED SURFACE FINISHING:

Formed surfaces shall be finished as soon as practicable after form removal and repair of surface defects. Finishes shall be as follows.

1. FINISH A: Finish A shall be a grout-cleaned rubbed finish in accordance with ACI 301 except that ALL FORM FINS AND OTHER PROTRUSIONS SHALL BE COMPLETELY REMOVED TO THE FINAL SURFACE. Surfaces shall be lightly sandblasted prior to sacking. Sandblasting shall occur after the specified curing period. For interior areas not exposed to moisture or weather, water used in the sacking mortar shall be mixed with a PVA bonding compound as recommended by the manufacturer. Finish A shall be provided for uncoated surfaces at surfaces of stair wells; interior surfaces of equipment rooms, galleries and tunnels; operations areas; exposed channels and tank from 1 foot below minimum water surfaces and up; and permanently exposed vertical and sloped surfaces, such as pipe chases. Finish A shall not be provided at concrete surfaces receiving a coating.
2. FINISH B: Finish B shall be a smooth surface with all form fins and other protrusions completely removed to the final surface. Finish B shall be provided for coated surfaces. See specification 09900 for concrete surface coatings and surface preparation, including filling bug holes before coating.
3. FINISH C: Finish C shall be a finish which has surface imperfections less than 3/8 inch in any dimension. Surface imperfections greater than 3/8 inch shall be repaired or removed and the affected areas shall be neatly patched. Finish C or smoother shall be provided for interior surfaces of wet wells, tank and channels from 1 foot below minimum water surfaces and down and otherwise unfinished interior surfaces.
4. FINISH D: Finish D shall be the finish for surfaces which may be left as they come from the forms, except that tie holes shall be plugged and defects greater than 1/2 inch in any dimension shall be repaired.

C. SAMPLES OF FORMED SURFACE FINISH:

A sample concrete panel, 2 feet by 2 feet, representative of formed surface Finish A shall be provided to the CONSTRUCTION MANAGER. The panel shall be representative of the workmanship and finish required, including filling of tie holes. The sample shall be deemed acceptable by the CONSTRUCTION MANAGER prior to the start of such work. The sample shall be on display at the job site, and finished surfaces shall match sample.

3.11 SLAB FINISHES

A. GENERAL:

The finishes specified herein include surface finishes, treatments and toppings for floors and slabs. Dry cement shall not be used on new concrete surfaces to absorb excess moisture. Edges shall be rounded to a radius of 1/2 inch. Joints shall be grooved to a radius and depth of 1/4 inch each. Finishes shall match the sample panels provided under paragraph 03300-3.12E.

Floors shall be sloped to drain uniformly within a room or space. Unless otherwise specified, slope shall be a minimum of 1/8 inch per foot toward nearest drain. Where finish is not specified, floor slabs shall receive steel troweling. Use of floor drains with only locally depressed slabs shall be coordinated with CONSTRUCTION MANAGER if detailed on the drawings, and restricted to locations specifically noted.

**B. FLOAT FINISH:**

Floating shall be performed with a hand or power-driven float in accordance with ACI 301. Begin floating when the bleed water sheen has disappeared and the surface has stiffened sufficiently to permit operation of the specific float apparatus. Floating of any one area shall be the minimum necessary to produce a finish that will meet tolerance requirements of ACI 117 for a conventional surface. Refloat the slab immediately to a uniform texture. Floating shall compact and smooth the surface and close any cracks and checking of surfaces. Float finish shall be applied to surfaces of channel, tank bottom slab, tops of footings, and steps and surfaces to receive roofing and insulation.

**C. STEEL TROWEL FINISH:**

Float the concrete surface and then trowel in accordance with ACI 301. Immediately after final troweling, the surface shall be cured and protected as specified in paragraphs 03300-3.04 and 03300-3.05. Steel trowel finish shall be provided on floors unless specified otherwise.

**D. BROOMED FINISH:**

Immediately after concrete has received a floated finish, give the concrete surface a coarse transverse scored texture by drawing a broom or burlap belt across the surface in accordance with ACI 301. Broomed finish shall be provided for walks, tops of tank, slabs-on-grade exposed to atmosphere, and where otherwise indicated or specified.

**E. SAMPLES OF CONCRETE FLOOR FINISHES:**

A sample concrete panel, 2 feet by 2 feet, representative of each specified finish, shall be provided to the CONSTRUCTION MANAGER. The panels shall be representative of the workmanship and finishes required. Samples shall be approved in field prior to the start of such work.

**3.12 RELATED SURFACES**

**A. FINISHING OF UNFORMED SURFACES:**

1. **RELATED UNFORMED SURFACES:** Tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces shall be struck smooth after concrete is placed and shall be floated to a texture reasonably consistent with that of the adjacent

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formed surfaces. Final treatment of formed surfaces shall continue uniformly across the unformed surfaces.

2. PAVEMENTS AND SIDEWALKS: The surfaces of the concrete shall be screeded to grade and sloped to drain. After screeding, the surface shall receive a broomed finish as specified in paragraph 03300-3.12 D. Edges and expansion joints shall be rounded to a radius of ½ inch. Joints shall be grooved to a radius and depth of 1/4 inch each.

### 3.13 FIELD SAMPLING AND TESTS

#### A. GENERAL:

Field sampling and testing shall be performed by the independent testing laboratory. Samples of aggregates and concrete shall be taken at such times to represent the quality of the materials and work throughout the project. The laboratory shall provide the necessary labor, materials and facilities for sampling the aggregate and for casting, handling and initially storing the concrete samples at the site of work. Aggregates shall be sampled in accordance with paragraph 03300-3.14 B not less than 30 days prior to the use of such aggregates in the work. The minimum number of samples and tests are specified in paragraph 03300-3.14 C.

#### B. SAMPLING:

##### 1. AGGREGATES:

a. GENERAL: Fine and coarse aggregates shall be sampled in accordance with ASTM D75. Samples shall be taken at the discharge gates of the bins feeding the weigh hopper. The CONTRACTOR shall provide safe and suitable facilities for obtaining samples. Samples shall be obtained at the concrete batch plant at the frequency specified in paragraph 03300-3.14 C. Sampling shall be repeated when the source of material is changed or when unacceptable deficiencies or variations from the specified requirements of materials are found in testing. Aggregate samples shall be tagged and their sources identified.

b. COARSE AGGREGATE: A sample weighing between 50 and 60 pounds shall be taken after the batch plant is brought up to full operation. The samples shall be taken so that a uniform cross section, accurately representing the materials on the belt or in the bins, is obtained.

c. FINE AGGREGATE: Samples shall be taken as specified for coarse aggregate. The samples shall be taken for sieve analysis of fine aggregate and specific gravity tests. Samples of sand shall be taken when the sand is moist.

2. CONCRETE: Samples of plastic concrete shall be obtained in accordance with ASTM C172. Samples shall be taken at the hopper of concreting equipment or transit mix truck, except as noted in 03300-3.03B.2

C. TESTING:

1. AGGREGATE: A minimum of one test of coarse aggregate per 400 cubic yards of concrete and a minimum of one test of fine aggregate per 200 cubic yards of concrete used shall be made to confirm continuing conformance with specifications for gradation, cleanliness and sand equivalent. A maximum of one test per day of each aggregate is required. The full test program is required before source changes will be accepted.

2. CONCRETE:

a. STRENGTH TESTS: The strengths specified for the design mix shall be verified by the independent testing laboratory during placement of the concrete. Verification shall be accomplished by testing standard cylinders of concrete samples taken at the job site. Cylinders shall be 4 by 8 inch or 6 x 12 inch.

Standard cylinders shall represent the concrete placed in the forms. One set of six standard 6 x 12 inch (or nine 4 x 8 inch) cylinders shall be cast of each class of concrete for each 100 cubic yards or less or for each 5,000 square feet of surface area placed per day. Casting, handling and curing of cylinders shall be in accordance with ASTM C31. Additional cylinders shall be provided when an error in batching is suspected. For the first 24 hours after casting, the cylinders shall be kept moist in a storage box constructed and located so that its interior air temperature will be between 60 and 80 degrees F. At the end of 24 hours, the cylinders shall be transported to the testing laboratory.

Testing of specimens for compressive strength shall be in accordance with ASTM C39. Tests shall be made at 7 and 28 days from time of casting. Two 6 x 12 inch (or three 4 x 8 inch) test cylinders from each group of six (or nine) shall be tested at the end of 7 days and two 6 x 12 inch (or three 4 x 8 inch) shall be tested at the end of 28 days. The two remaining 6 x 12 inch (or three 4 x 8 inch) cylinders shall be tested at the end of 56 days if the 28-day strength reports below specification. A strength test shall consist of the average strength of two 6 x 12 inch (or three 4 x 8) cylinders cast from material taken from a single load of concrete. If one cylinder shows evidence of low strength due to improper sampling, casting, handling or curing, the result of the remaining cylinders may be used if approved by the CONSTRUCTION MANAGER.

The average of any three consecutive 28-day strength test results of the cylinders representing each class of concrete for each structure shall be equal to or greater than the specified strength and not more than 10 percent of the strength test results shall have values less than the specified 28-day strength for the total job concrete. No individual strength test result shall be less than the specified strength by more than 500 pounds per square inch.

Certified reports of the test results shall be provided directly to the CONSTRUCTION MANAGER. Test reports shall include sufficient information to identify the mix used, the stationing or location of the concrete placement, and the quantity placed. Slump, air content, temperature of concrete, and ambient temperature shall be noted. The 28-day strength test results shall be evaluated in accordance with ACI 214R. Quality control charts showing field test results shall be included with the test results for each class of concrete in each major structure. Charts shall be prepared in

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accordance with ACI 214R. Quality control charts shall be maintained throughout the entire job and shall be available for the CONSTRUCTION MANAGER's inspection at any time.

If the 28-day test results fall below the specified compressive strength for the class of concrete required for any portion of the work, adjustment in the proportions, water content, or both, shall be made as necessary at the CONTRACTOR's expense. Changes and adjustments shall be reported in writing to the CONSTRUCTION MANAGER.

If compressive test results indicate concrete in place may not meet structural requirements, tests shall be made to determine if the structure or portion thereof is structurally sound. Tests may include, but not be limited to, cores in accordance with ASTM C42 and any other analyses or load tests acceptable to the CONSTRUCTION MANAGER. Costs of such tests shall be borne by the CONTRACTOR.

b. TESTS FOR CONSISTENCY OF CONCRETE. The slump shall be as specified when measured in accordance with ASTM C143. Samples for slump determination shall be taken from the concrete during placement. Tests shall be made at the beginning of concrete placement operation and at subsequent intervals to ensure that the specification requirements are met. Slump tests shall also be performed whenever standard cylinders are cast. For pumped concrete, slump shall be measured in accordance with paragraph 3.03B.2.

When high range water reducers are added at the site, slump tests shall be taken before and after addition of high range water reducing admixtures.

c. TESTS FOR TEMPERATURE AND AIR CONTENT: Temperature tests shall be made at frequent intervals during hot or cold weather conditions until satisfactory temperature control is established. Whenever standard cylinders are cast, temperature tests shall be performed.

Air content shall be as specified when measured in accordance with ASTM C231. Air content shall be measured whenever standard cylinders are cast. For pumped concrete, air content shall be measured in accordance with paragraph 3.03B.2.

#### D. FINAL LABORATORY REPORT:

A final report, prepared by the testing laboratory, shall be provided at the completion of all concreting. This report shall summarize the findings concerning concrete used in the project and provide totals of concrete used by class and structure. Final quality control charts for compressive strength tests for classes of concrete specified in each major structure shall be included. The report shall also include the concrete batch plant's coefficient of variation and standard deviation results for each class of concrete.

### 3.14 REPAIR OF DAMAGED CONCRETE, CRACKING:

#### A. ACCEPTANCE OF CONCRETE:

Completed cast-in-place concrete work shall conform to the applicable requirements of ACI 301 and the Contract Documents. Concrete work that fails to meet the requirements of ACI 301 or the Contract Documents shall be repaired as approved by the ENGINEER to bring the concrete into compliance. Concrete that cannot be brought into compliance by approved repair methods will be rejected. Rejected concrete work shall be removed and replaced. Repair methods shall be in accordance with ACI standards and are subject to the approval of the ENGINEER. The cost of repairs and replacement of defective concrete shall be borne by the CONTRACTOR.

#### B. REPAIR METHODS:

Damaged or excessively cracked concrete, as determined by the ENGINEER in their sole discretion, shall be repaired by one of the following methods as approved by the ENGINEER:

1. Repair Method 1: Fill the joint or crack by drilling holes to the affected area, install injection ports and force epoxy or chemical grout (expanding urethane) into the joint under pressure. The material type, whether epoxy or chemical grout shall be approved by the ENGINEER. After injection and curing, ports, sealing mix and surface generally shall be cleaned and worked to match the specified finish.
2. Repair Method 2: Fill cracks with low viscosity epoxy, applied by pouring/flooding crack zone until cracks are filled. Prepare surface, install, and cure according to manufacturer's recommendations. At a minimum, prepare surface to result in a clean, dry surface and with no visible detrimental material in cracks to be filled. Conform to temperature limitations for epoxy to be used. Finish to match adjacent areas.
3. Repair Method 3: Cut a bevel groove 3/8 to 1/2 inch in width and depth, and caulk with sealant in accordance with manufacturer's instructions. This repair method is only to be used where expressly allowed by the ENGINEER. Groove and caulk shall be applied on wet or hydrostatic pressure side of surface where occurs.

#### C. REPAIR METHOD USE:

1. Repair Method 1 shall be used for all cracks in walls, surfaces sloped 1:1 or greater, beams, columns, slabs, overhead surfaces and generally for liquid retaining surfaces. Need for repair depends upon crack width, location, and surface conditions under service conditions. Epoxy grout shall be used for repair of structural cracks and chemical grout (expanding urethane) shall be used for repair of non-structural cracks at liquid-containing structures. The



ENGINEER shall determine whether a crack is classified as structural or non-structural.

2. Repair Method 2 may be utilized in lieu of Method 1 for slabs which receive a raked finish. Method 2 may also be used with CONSTRUCTION MANAGER's approval for exposed troweled and broomed finishes after review of conditions, degree of exposure to public, and proposed repair product and installation. Finish shall substantially match adjacent surfaces.
3. Repair Method 3 shall be limited to dry-surface slabs, walls subject to less than three feet of liquid pressure, or as specifically directed by the ENGINEER. Method 3 is not an equivalent repair method to Methods 1 or 2, which shall be considered the standards.

### 3.15 CLEANUP

Upon completion of the work and prior to final inspection, the CONTRACTOR shall clean all concrete surfaces. The cleaning procedures shall be as follows: After sweeping with an ordinary broom to remove the loose dirt, the surface shall be flushed with clean water. Final scrubbing by hand or machine shall follow.

Floors that have curing and sealing compound shall be cleaned of loose dirt and debris by sweeping with ordinary brooms. They shall then be washed and mopped with clean water. Finally, one additional coat of the same clear curing and sealing compound shall be applied in the same manner as specified.

**\*\*END OF SECTION\*\***

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Cast-In-Place Concrete  
03300-26

Bodaway-Gap Contract 2  
Bid Issue

Navajo Nation  
WESTERN NAVAJO PIPELINE PHASE 1

BC PROJECT NO.: 150360

BODAWAY-GAP WELL, STORAGE TANK AND PIPELINE

DIVISION 5

METALS

05501 Anchors to Concrete and Masonry

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## SECTION 03600

### GROUT

#### PART 1--GENERAL

##### 1.01 DESCRIPTION

This section specifies grout for columns and other structural support bases, equipment bases, crack repair, surface repair and uses other than masonry. Grout for masonry is specified in Section 04200.

##### 1.02 QUALITY ASSURANCE

###### A. QUALITY CONTROL BY OWNER:

The CONTRACTOR will pay and provide special inspection and testing in accordance with Section 01400.

###### B. QUALITY CONTROL BY CONTRACTOR:

If a product other than those listed below is proposed and test data is not available from the supplier to demonstrate equivalence to the specified grout, then to demonstrate equivalence with the grout properties of the specified product, the CONTRACTOR shall provide the services of an independent testing laboratory which complies with the requirements of ASTM E329. The testing laboratory shall sample and test the proposed grout materials. Costs of testing laboratory services shall be borne by the CONTRACTOR.

###### C. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM C230	Standard Specification for Flow Table for Use in Tests of Hydraulic Cement
ASTM C307	Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacing
ASTM C531	Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes
ASTM C579	Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing and Polymer Concretes
ASTM C882	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear
ASTM C942	Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM C1107	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1181	Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts
COE CRD-C611	Flow of Grout for Preplaced Aggregate Concrete
COE CRD-C621	Specification for Nonshrink Grout
IBC	International Building Code, 2012 edition

### 1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

1. Complete product literature and installation instructions for epoxy grout (all uses) and cementitious non-shrink grout.
2. Current ICC Evaluation Report for adhesives used for dowel and anchor setting.
3. Installer certification in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program for installers of horizontal or upwardly inclined adhesive anchors.

### PART 2--PRODUCTS

Grout  
03600-2

Bodaway-Gap Contract 2  
Bid Issue

## 2.01 CEMENTITIOUS NONSHRINK GROUT

Cementitious nonshrink nonmetallic aggregate grout shall be Five Star Products, Inc. Five Star Grout, Master Builders Masterflow 928, Burke Company Non-Ferrous, Non-Shrink Grout, Hi-Flow Grout by Euclid Chemical Company, or equal.

## 2.02 EPOXY GROUT FOR EQUIPMENT MOUNTING

Epoxy grout for equipment mounting shall be a non-cementitious, resin based, multi-component formulation. Epoxy grout shall be flowable, with shrinkage minimized to achieve minimum 98% effective bearing area. Epoxy grout shall be Masterflow 648 CP Plus by Masterbuilders; Sikadur 42 by Sika Corporation; E3-G by Euclid Chemical Company; or equal.

## 2.03 ADHESIVE FOR DOWEL AND ANCHOR SETTING

Adhesive for setting dowels and anchoring connection/base plate bolts shall be an injectable two-component epoxy adhesive. Adhesive shall be approved for the intended use per the product ICC Report.

Adhesive shall be HIT-RE 500-SD by Hilti or approved equal (equivalent product must have ICC approval for use in cracked concrete in areas with high seismic risk).

## 2.04 CONCRETE REPAIR MORTAR

Horizontal Applications: Horizontal repair mortars shall be Emaco S66 CI by BASF, SikaTop 111 Plus by Sika Corp, or approved equal.

Vertical and Overhead Applications: Vertical and overhead repair mortars shall be SikaTop 123 Plus or approved equal.

## PART 3--EXECUTION

### 3.01 CEMENTITIOUS NONSHRINK GROUT

Nonshrink, cementitious, nonmetallic aggregate grout shall be used for column base plates, structural bearing plates, and all locations where the general term "non-shrink grout" is indicated on the drawings. Use of this grout to support the bearing surfaces of machinery shall be as specified in Section 11002 or as detailed on the Drawings for specific locations or pieces of equipment. If guidance is not provided in locations noted above, use of non-shrink grout for equipment mounting shall be limited to equipment less than 25 horsepower or 750 pounds. Grout shall be placed and cured in accordance with manufacturer's instructions.

Nonshrink cementitious grout shall not be used as a surface patch or topping. Nonshrink cementitious grout must be used in confined applications only.

### 3.02 EPOXY GROUT FOR EQUIPMENT MOUNTING

Prepare concrete surfaces of equipment pads as indicated in details on the Drawings and as required by the epoxy grout manufacturer. Epoxy grout for equipment mounting shall be placed and cured in accordance with the requirements of Section 11002, details on the Drawings, and in strict conformance with manufacturer's recommendations.

### 3.03 CONCRETE REPAIR MORTAR

Concrete repair materials and procedures shall be submitted for review to the ENGINEER and shall be accepted prior to commencement of the repair work.

Follow all manufacturer's instructions, including those for minimum and maximum application thickness, surface preparation and curing. Add aggregate as required per manufacturer's recommendations. Any deviations from the manufacturer's instructions shall be submitted for review to the ENGINEER and shall be accepted prior to commencement of the work.

**\*\*END OF SECTION\*\***



SECTION 05501

ANCHORS TO CONCRETE AND MASONRY

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies anchor systems; bolts and all-thread rods used to attach structural elements and equipment to concrete and concrete masonry. Included are cast-in-place and post-installed anchors; adhesive systems, limited use expansion (wedge type) anchors, nuts and washers. Cast-in-place anchor bolts are specified as hot-dip galvanized or Type 316 stainless steel; all-thread rods are Type 316 stainless steel.

1.02 QUALITY ASSURANCE/QUALITY CONTROL

A. QUALITY ASSURANCE BY OWNER:

Special inspection of anchor bolts shall be performed by the Special Inspector paid for by the Contractor and in accordance with IBC Chapter 17.

B. REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ACI 318	Building Code Requirements for Structural Concrete
ASTM A193	Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A194	Carbon and Alloy Steel Nuts for Bolts for High Pressure or High-Temperature Service
ASTM A320	Alloy-Steel Bolting Materials for Low-Temperature Service
ASTM A563	Carbon and Alloy Steel Nuts
ASTM F593	Stainless Steel Bolts, Hex Cap Screws and Studs
ASTM F594	Stainless Steel Nuts
ASTM F844	Washers, Steel, Plain (Flat), Unhardened for General Use

Reference	Title
ASTM F1554	Anchor Bolts, Steel, 36, 55, 105-ksi Yield Strength
IBC 2006	International Building Code with local amendments

### 1.03 SUBMITTALS

Provided the following submittals in accordance with Section 01300:

1. Anchor bolt placement plans.
2. Anchor bolt, nut, and washer material information, including material certifications.
3. Where required here-in or by other sections of the Contract Documents, submit record copy of design calculations and details showing the required diameter, length, embedment, edge distance, confinement, anchor reinforcement, anchor bolt sleeves, connection redesign, and other conditions, stamped and signed by a Professional Engineer currently registered in the state of Arizona. Calculations shall comply with the provisions of ACI 318 Appendix C. Calculations will not be reviewed by the Engineer and calculations will not be returned to the Contractor
4. Product Data:
  - a. ICC Evaluation Service Reports for post-installed adhesive type anchors and expansion (wedge type) anchors when allowed. Products shall be ICC approved for use in cracked concrete.
  - b. Product data indicating load capacity charts/calculations.
  - c. Chemical resistance.
  - d. Temperature limitations.
  - e. Manufacturers written installation instructions.

## PART 2--PRODUCTS

### 2.01 GENERAL

Anchor bolt holes in equipment support frames shall not exceed the bolt diameters by more than 1/4 inch. Minimum anchor bolt diameter shall be 1/2 inch. [Anchor bolts for equipment mounting and vibration isolation systems shall be provided as specified in Sections 11002 and 11021, respectively.]

Tapered washers shall be provided where mating surface is not square with the nut.

When cast-in-place anchors are specifically indicated, post-installed anchors set in holes drilled in the concrete after the concrete is placed will not be permitted unless specifically requested by the Contractor and approved by the Engineer.

## 2.02 MATERIALS

Anchor bolt materials shall be as specified in the following table:

Material	Specification
Stainless Steel Anchor Bolts	ASTM A193 or A320, Type 316
Stainless Steel Threaded Rods	ASTM F593, Type 316
Stainless Steel Nuts and Washers	ASTM A194 Heavy Hex Nuts and Washers (ASTM F594 Heavy Hex Nuts at Adhesive Anchors), Type 316
Carbon Steel Anchor Bolts	ASTM F1554, Grade 36 – Hot Dip Galvanized
High-Strength Carbon Steel Anchor Bolts	ASTM F1554, Grade 55, Weldable per Supplementary Requirement S1 – Hot Dip Galvanized
Carbon Steel Nuts and Washers	ASTM A563 and F844 – Heavy Hex
Concrete Adhesive Anchors	Hilti “HIT-RE 500-SD”, Simpson “SET-XP”, or equal – Type 316 stainless steel
Masonry Adhesive Anchors	Hilti "HIT-HY 150 MAX", Simpson “SET”, or equal – Type 316 stainless steel
Masonry Expansion (wedge) Anchors*	Hilti "KWIK BOLT 3", or equal – Type 316 stainless steel
Concrete Expansion (wedge) Anchors *	Hilti “KWIK BOLT TZ”, or equal, Type 316 stainless steel

\*Post installed anchors shall always be an adhesive type anchor system except when Contractor makes a request for a specific application and Engineer approves.

## 2.03 STAINLESS STEEL FASTENER LUBRICANT (ANTI-SEIZING)

A. Anti-seizing Lubricant for Stainless Steel Threaded Connections:

1. [Suitable for potable water supply.]
2. Formulated to resist washout.

3. Acceptable Manufacturers are Bostik, Saf-T-Eze, or equal.

#### 2.04 ANCHOR BOLT SLEEVES

- A. Provide anchor bolt sleeves as required by equipment manufacturer's design for minor location adjustment.
  1. High density polyethylene plastic of single unit construction with deformed sidewalls such that the concrete and grout lock in place.
  2. The top of the sleeve shall be self-threading to provide adjustment of the threaded anchor bolt projection.
  3. Acceptable Manufacturers are Contec, Wilson, or equal.

#### 2.05 DESIGN

Anchor bolts for equipment shall be designed by the equipment manufacturer to include seismic and wind forces when applicable.

### PART 3--EXECUTION

#### 3.01 GENERAL

- A. Anchor bolts shall be cast- in-place where indicated.
- B. Grouting of anchor bolts using plastic sleeves with non-shrink or epoxy grout, where required by equipment manufacturer's design, shall be in accordance with Section 03600.
- C. The threaded end of anchor bolts and all-thread rod shall be long enough to project through the entire depth of the nut and if too long, shall be cut off at ½-inch beyond top of nut and ground smooth.

#### 3.02 CAST-IN-PLACE ANCHOR BOLTS

Anchor bolts to be embedded in concrete shall be placed accurately and held in correct position using templates while the concrete is placed.

After anchor bolts have been embedded, their threads shall be protected by grease and the nuts run on.

Provide anchor bolts with sufficient length to provide for a minimum 10-inch embedment (below any grout pad) unless noted to be longer based on the equipment manufacturer's design.

### 3.03 ADHESIVE ANCHOR BOLTS

Note that adhesive anchors shall not be substituted for anchor bolts which are specifically indicated to be cast-in-place. Use of adhesive anchors shall be subject to the following conditions:

1. Limit to locations where exposure, on an intermittent or continuous basis, to acid concentrations higher than 10 percent, to chlorine gas, or to machine or diesel oils, is extremely unlikely.
2. Limit to applications where exposure to fire or exposure to concrete or rod temperature above 120 degrees F is extremely unlikely. Overhead applications (such as pipe supports) shall not be allowed.
3. Approval from Engineer for specific application and from supplier of equipment to be anchored, if applicable.
4. Anchor diameter and material shall be per equipment manufacturer's specifications. Anchor shall be threaded or deformed full length of embedment and shall be free of rust, scale, grease, and oils.
5. Embedment depth shall be as specified by the equipment manufacturer (minimum 6 inches) unless noted otherwise.
6. Follow the anchor system manufacturer's written installation instructions.
7. Holes shall have rough surfaces created by using a hammer drill with carbide bit (core drilled holes are not allowed).
8. Holes shall be blown clean with oil-free compressed air and be free of dust or standing water prior to installation.
9. Concrete and air temperature shall be compatible with curing requirements of adhesives per adhesive manufacturer instructions. Anchors shall not be placed in when concrete temperature is below 25 degrees F.
10. Anchors shall be left undisturbed and unloaded for full adhesive curing period which is based on temperature of the concrete.

### 3.04 EXPANSION ANCHORS

Expansion (wedge type) anchors shall not be substituted for cast-in-place anchor bolts or adhesive anchors unless approved by the Engineer for a specific application. Use of expansion anchors shall be subject to conditions 3 through 8 as specified above for adhesive anchors.

Expansion anchors shall not be used in a submerged condition nor in mounting of equipment subject to vibration or cyclic motion.

### 3.05 REINFORCING STEEL CONFLICTS WITH POST-INSTALLED ANCHOR INSTALLATION

- A. When reinforcing steel is encountered in the drill path, slant drill to clear obstruction and provide beveled washer to match angle of anchor. Drill shall not be slanted more than 10 degrees.
- B. Where slanting the drill does not resolve the conflict, notify the Project Representative and resolve the conflict to the satisfaction of the Project Representative in consultation with the Engineer.
- C. Abandoned post-installed anchor holes shall be cleaned and filled with non-shrink grout and struck off flush with adjacent surface.
- D. The costs of determining and executing the resolution shall be borne by the Contractor. The determination and execution of the resolution shall not result in additional cost to the Owner.
- E. Reinforcing steel in masonry shall not be damaged.
- F. In order to avoid or resolve a conflict, locate embedded reinforcing steel using non-destructive methods and/or redesign the attachment.
  - 1. Redesign shall be done by the Contractor's Professional Engineer currently registered in the State of Arizona.
  - 2. Calculations and details for redesign shall be submitted for record purpose.

**\*\*END OF SECTION\*\***

Navajo Nation  
WESTERN NAVAJO PIPELINE PHASE 1

BC PROJECT NO.: 150360

BODAWAY-GAP WELL, STORAGE TANK AND PIPELINE

DIVISION 9

FINISHES

09900	Coating Systems
09901	Coating for Steel Water Storage Reservoir

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## SECTION 09900

### COATING SYSTEMS

#### **PART 1--GENERAL**

##### 1.01 DESCRIPTION

###### A. SCOPE:

This Section 09900 specifies coating systems, surface preparations, and application requirements for coating systems.

###### B. DEFINITIONS:

Specific coating terminology used in this Section 09900 is in accordance with definitions contained in ASTM D16, ASTM D3960, and the following definitions:

1. Abrasive: Material used for blast cleaning, such as sand, grit or shot.
2. Abrasive Blast Cleaning: Cleaning/surface preparation by abrasive propelled at high speed.
3. Anchor Pattern: Profile or texture of prepared surface(s).
4. ANSI: American National Standards Institute.
5. Bug Holes: Small cavities, usually not exceeding 15 mm in diameter, resulting from entrapment of air bubbles in the surface of formed concrete during placement and compaction.
6. Coating/Paint/Lining Thickness: The total thickness of primer, intermediate and/or finish coats.
7. Coating System Applicator (CSA): A generic reference to the specialty subcontractor or subcontractors retained by the Contractor to install the coating systems specified in this Section 09900.
8. Coating System Manufacturer (CSM): Refers to the acceptable coating system manufacturer, abbreviated as the CSM.

9. Coating System Manufacturer's Technical Representative(s) (CTR): Refers to the technical representative(s) of the acceptable Coating System Manufacturer and is abbreviated as CTR.
10. Dew point: Temperature of a given air/water vapor mixture at which condensation starts.
11. Dry Film Thickness (DFT): Depth of cured film, usually expressed in mils (0.001 inch). Use this definition as opposed to existing definition.
12. Drying Time: Time interval between application and curing of material.
13. Dry to Recoat: Time interval between application of material and ability to receive next coat.
14. Dry to Touch: Time interval between application of material and ability to touch lightly without damage.
15. Feather Edging: Reducing the thickness of the edge of paint.
16. Feathering: Operation of tapering off the edge of a point with a comparatively dry brush.
17. Field Coat: The application or the completion of application of the coating system after installation of the surface at the site of the work.
18. Hold Point: A defined point, specified in this Section 09900, at which work shall be halted for inspection.
19. Holiday: a discontinuity, skip, or void in coating or coating system film that exposes the substrate.
20. Honeycomb: Segregated condition of hardened concrete due to non-consolidation.
21. ICRI: International Concrete Repair Institute.
22. Incompatibility: Inability of a coating to perform well over another coating because of bleeding, poor bonding, or lifting of old coating; inability of a coating to perform well on a substrate.
23. Laitance: A layer of weak, non-durable concrete containing cement fines that is brought to the surface through bleed water because of concrete finishing and/or over-finishing.

24. Mil: 0.001 inch.
25. NACE: National Association of Corrosion Engineers.
26. Overspray: Dry spray, particularly such paint that failed to strike the intended surface.
27. Pinhole: A small diameter discontinuity in a coating or coating system film that is typically created by outgassing of air from a void in a concrete substrate resulting in exposure of the substrate or a void between coats.
28. Pot Life: Time interval after mixing of components during which the coating can be satisfactorily applied.
29. Resurfacer/Resurfacing Material: A layer of cementitious and/or resin-base material used to fill or otherwise restore surface continuity to worn or damaged concrete surfaces.
30. Shelf Life: Maximum storage time for which a material may be stored without losing its usefulness.
31. Shop Coat: One or more coats applied in a shop or plant prior to shipment to the site of the work, where the field or finishing coat is applied.
32. Spreading Rate: Area covered by a unit volume of paint at a specific thickness.
33. SSPC: The Society for Protective Coatings.
34. Stripe Coat: A separate coat of paint applied to all weld seams, pits, nuts/bolts/washers and edges by brush. This coat shall not be applied until any previous coat(s) have cured and, once applied, shall be allowed to cure prior to the application of the subsequent coat(s).
35. Surface Saturated Dry (SSD): Refers to concrete surface condition where the surface is saturated (damp) without the presence of standing water.
36. Tie Coat: An intermediate coat used to bond different types of paint coats. Coatings used to improve the adhesion of a succeeding coat.
37. Touch-Up Painting: The application of 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.
38. TPC: Technical Practice Committee.

39. 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 (g/l) or pounds per gallon (lb/gal).
40. Immersion: Refers to a service condition in which the substrate is below the waterline or submerged in water or wastewater at least intermittently if not constantly.
41. Weld Splatter: Beads of metal scattered near seam during welding.
42. Wet Film Thickness (WFT): The primer or coating film's thickness immediately following application. Wet film thickness is measured in mils or thousandths of an inch (0.001 inch) and is abbreviated WFT.

## 1.02 QUALITY ASSURANCE

### A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). 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, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
ANSI/ASC 29.4 Exhaust Systems	Abrasive Blasting Operations – Ventilation and Safe Practice
ANSI/NSF 61	Drinking Water System Components Health Effects
ANSI B74.18	Grading of Certain Abrasive Grain on Coated Abrasive Material
ASTM D16	Standard Terminology for Paint, Related Coatings, Materials, and Applications

Reference	Title
ASTM D2200 (SSPC-VIS1)	Pictorial Surface Preparation Standards for Painting Steel Surfaces
ASTM D3960	Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
ASTM D4262	Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces
ASTM D4263	Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D4414	Standard Practice for Measurement of Wet Film Thickness by Notch Gages
ASTM D4417	Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
ASTM D4541	Standard Test Methods for Pull-Off Strength of Coatings On Metal Substrates Using Portable Adhesion Testers
ASTM D4787	Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates
ASTM D5162	Standard Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates
ASTM D7234	Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Adhesion Testers.
ASTM E337	Standard Test Method for Measuring Humidity With a Psychrometer
ASTM F1869	Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
FS 595b	Federal Standard Colors
ICRI 03732	Guideline for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays
NACE Publication 6D-163	A Manual for Painter Safety
NACE Publication 6F-163	Surface Preparation of Steel or Concrete Tank/Interiors
NACE Publication 6G-164 A	Surface Preparation Abrasives for Industrial Maintenance Painting
NACE Standards	January 1988 Edition of the National Association of Corrosion Engineers, TPC.
NACE Standard RP0188	Standard Recommended Practice – Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates

Reference	Title
NACE Standard RP0288	Standard Recommended Practice, Inspection of Linings on Steel and Concrete
NACE Standard RP0892	Standard Recommended Practice, Linings Over Concrete in Immersion Service
NACE Publication TPC2	Coatings and Linings for Immersion Service
NAPF 500-03	Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings
NAPF 500-03-04	Abrasive Blast Cleaning for Ductile Iron Pipe
NAPF 500-03-05	Abrasive Blast Cleaning for Cast Ductile Iron Fittings
OSHA 1910.144	Safety Color Code for Marking Physical Hazards
OSHA 1915.35	Standards – 29CFR - Painting
SSPC	Paint Application Specification No. 1.
SSPC-AB 1	Mineral and Slag Abrasives
SSPC-PA 1	Shop, Field, and Maintenance Painting of Steel
SSPC-PA 2	Measurement of Dry Coating Thickness with Magnetic Gages
SSPC-PA 9	Measurement of Dry Coating Thickness on Cementitious Substrates Using Ultrasonic Gages
SSPC-PA Guide 1	Guide for Illumination of Industrial Painting Project
SSPC-PA Guide 3	A Guide to Safety in Paint Application
SSPC-PA Guide 6	Guide for Containing Debris Generated During Paint Removal Operations
SSPC-PA Guide 11	Guide for Coating Concrete
SSPC SP1	Solvent Cleaning
SSPC SP2	Hand Tool Cleaning
SSPC SP3	Power Tool Cleaning
SSPC SP5	White Metal Blast Cleaning
SSPC SP6	Commercial Blast Cleaning
SSPC SP7	Brush-Off Blast Cleaning
SSPC SP10	Near-White Blast Cleaning
SSPC SP11	Power Tool Cleaning to Bare Metal

Reference	Title
SSPC SP12	Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultra-High Pressure Water Jetting Prior to Recoating
SSPC SP13	Surface Preparation of Concrete
SSPC-TR2	Wet Abrasive Blast Cleaning
SSPC-TU-3	Overcoating
SSPC-TU-4	Field Methods for Retrieval and Analysis of Soluble Salts on Substrates.
SSPC V2	Systems and Specifications: Steel Structures Painting Manual, Volume 2
SSPC-VIS 1	Visual Standard for Abrasive Blast Cleaned Steel
SSPC-VIS 3	Visual Standard for Power and Hand – Tool Cleaned Steel
SSPC-VIS 4	Visual Standards (Waterjetting)
SSPC-VIS 5	Visual Standards (Wet Abrasive Blast Cleaning)
WPCF Manual of Practice No. 17	Paints and Protective Coatings for Wastewater Treatment Facilities. Guide and Paint Application Specifications.

#### B. STANDARDIZATION:

Materials and supplies provided shall be the standard products of CSMs. Materials in each coating system shall be the products of a single CSM.

The standard products of CSMs other than those specified may be acceptable when it is demonstrated to the Construction Manager that they are equal in composition, durability, usefulness, and convenience for the purpose intended. Requests for consideration of CSMs other than those specified in this Section 09900 will be considered, provided the following minimum conditions are met. Such requests are not a substitution for submittals after the alternative CSMs have been considered and accepted.

1. The proposed coating system shall use an equal or greater number of separate coats to achieve the required total dry film thickness.
2. The proposed coating system shall use coatings of the same generic type as that specified including curing agent type.
3. Requests for consideration of products from CSMs other than those specified in this Section 09900 shall include information listed in paragraph 09900-1.04, Items 1, 2, and 3, demonstrating that the proposed CSM's product is equal to the specified coating system.

4. The Contractor and the proposed alternative CSM shall provide a list of references for the proposed product where the coating of the same generic type has been applied. The reference list shall include the project name, city, state, owner, phone number of owner; coating system reference and number from this Section 09900; type of facility in which it was used, generic type, and year coating was applied.

C. QUALITY CONTROL REQUIREMENTS:

1. The Contractor is responsible for the workmanship and quality of the coating system installation. Inspections by the Construction Manager or the CTR will not relieve or limit the Contractor's responsibilities.
2. The Contractor's methods shall conform to requirements of this specification and the standards referenced in this Section 09900. Changes in the coating system installation requirements will be allowed only with the written acceptance of the Construction Manager before work commences.
3. Only personnel who are trained by the CTR specifically for this contract or who are approved by the CSM specifically for this contract shall be allowed to perform the coating system installation specified in this Section 09900.
4. Contaminated, outdated, diluted materials, and/or materials from previously opened containers shall not be used.
5. For repairs, the Contractor shall provide the same products, or products recommended by the CSM, as used for the original coating.
6. The Contractor shall identify the points of access for inspection by the Owner or the Construction Manager. The Contractor shall provide ventilation, ingress and egress, and other means necessary for the Construction Manager's personnel to access safely the work areas.
7. The Contractor shall conduct the work so that the coating system is installed as specified and shall inspect the work continually to ensure that the coating system is installed as specified. Coating system work that does not conform to the specifications or is otherwise not acceptable shall be corrected as specified.
8. The Contractor shall complete the Coating System Inspection Checklist, Form 09900-A, included in Section 01999, for coating system installations. Follow the sequential steps required for proper coating system installation as specified and as listed in the Coating System



Inspection Checklist. For each portion of the work, install the coating system and complete sign-offs as specified prior to proceeding with the next step. After completing each step as indicated on the Coating System Inspection Checklist, the Contractor shall sign the checklist indicating that the work has been installed and inspected as specified.

9. The Contractor shall provide written daily reports that present, in summary form, test data, work progress, surfaces covered, ambient conditions, quality control inspection test findings, and other information pertinent to the coating system installation.

#### D. INSPECTION AT HOLD POINTS

The Contractor shall conduct inspections at Hold Points during the coating system installation and record the results from those inspections on Form 09900-A. The Contractor shall coordinate such Hold Points with the Construction Manager such that the Construction Manager may observe Contractor's inspections on a scheduled basis. The Contractor shall provide the Construction Manager a minimum of two (2) hours of notice prior to conducting Hold Point Inspections. The Hold Points shall be as follows:

1. Environment and Site Conditions. Prior to commencing an activity associated with coating system installation, the Contractor shall measure, record, and confirm acceptability of ambient air temperature and humidity as well as other conditions such as proper protective measures for surfaces not to be coated and safety requirements for personnel. The acceptability of the weather and/or environmental conditions within the structure shall be determined by the requirements specified by the CSM of the coating system being used.
2. Conditions Prior to Surface Preparation. Prior to commencing surface preparation, the Contractor shall observe, record, and confirm that oil, grease, and/or soluble salts have been eliminated from the surface.
3. Monitoring of Surface Preparation. Spot checking of degree of cleanliness, surface profile, and surface pH testing, where applicable. In addition, the compressed air used for surface preparation or blow down cleaning shall be checked to confirm it is free from oil and moisture.
4. Post Surface Preparation – Upon completion of the surface preparation, the Contractor shall measure and inspect for proper degree of cleanliness and surface profile as specified in this Section 09900 and in the CSM's written instructions.
5. Monitoring of Coatings Application – The Contractor shall inspect, measure, and record the wet film thickness and general film quality (visual

inspection) for lack of runs, sags, pinholes, holidays, etc. as the application work proceeds.

6. Post Application Inspection – The Contractor shall identify defects in application work including pinholes, holidays, excessive runs or sags, inadequate or excessive film thickness and other problems as may be observed.
7. Post Cure Evaluation – The Contractor shall measure and inspect the overall dry film thickness. The Contractor shall conduct a DFT survey, as well as perform adhesion testing, holiday detection, or cure testing as required based on the type of project and the specific requirements in this Section 09900 and/or in the CSM's written instructions.
8. Follow-up to Corrective Actions and Final Inspection. The Contractor shall measure and reinspect corrective coating work performed to repair defects identified at prior Hold Points. This activity also includes final visual inspection along with follow-up tests such as holiday detection, adhesion tests, and DFT surveys.

### 1.03 DELIVERY AND STORAGE

Materials shall be delivered to the job site in their original, unopened containers. Each container shall be properly labeled. Materials shall be handled and stored to prevent damage to or loss of label.

Labels on material containers shall show the following information:

1. Name or title of product.
2. CSM's batch number.
3. CSM's name.
4. Generic type of material.
5. Application and mixing instructions.
6. Hazardous material identification label.
7. Shelf life expiration date.

Materials shall be stored in enclosed structures and shall be protected from weather and excessive heat or cold in accordance with the CSM's recommendations. Flammable materials shall be stored in accordance with state and local requirements.

Containers shall be clearly marked indicating personnel safety hazards associated with the use of or exposure to the materials.

Material Safety Data Sheets (MSDS) for each material shall be provided to the Construction Manager.

The Contractor shall store and dispose of hazardous waste according to federal, state and local requirements. This requirement specifically addresses waste solvents and coatings.

#### 1.04 SUBMITTALS:

Provide in accordance with Section 01300:

1. A copy of this specification section, with addendum updates included, and 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 or those parts which are to be provided by the Contractor or others. 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 shall 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 requested deviations to the specification requirements shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.
2. CSM's current printed recommendations and product data sheets for coating systems including:
  - a. Volatile organic compound (VOC) data
  - b. Surface preparation recommendations.
  - c. Primer type, where required.
  - d. Maximum dry and wet-mil thickness per coat.
  - e. Minimum and maximum curing time between coats, including atmospheric conditions for each.
  - f. Curing time before submergence in liquid.
  - g. Thinner to be used with each coating.
  - h. Ventilation requirements.
  - i. Minimum atmospheric conditions during which the paint shall be applied.
  - j. Allowable application methods.
  - k. Maximum allowable moisture content.
  - l. Maximum shelf life.

3. Affidavits signed and sealed by an officer of the CSM's corporation, attesting to full compliance of each coating system component with current and promulgated federal, state, and local air pollution control regulations and requirements.
4. Material Safety Data Sheets (MSDS) for materials to be delivered to the job site, including coating system materials, solvents, and abrasive blast media.
5. List of cleaning and thinner solutions allowed by the CSMs.
6. Storage requirements including temperature, humidity, and ventilation for Coating System Materials as recommended by the CSMs.
7. CSM's detailed, written instructions for coating system treatment and graphic details for coating system terminations in the structures to be coated including pipe penetrations, metal embedments, gate frames, and other terminations to be determined from the contract drawings. This information shall also include detail treatment for coating system at joints in concrete.
8. The Contractor and CSA shall provide a minimum of five project references each including contact name, address, and telephone number where similar coating work has been performed by their companies in the past five years.

#### 1.05 RESPONSIBILITIES OF THE CTR

The Contractor shall retain or obtain the services of the CTR to be on site to perform the Contractor and/or CSA application training and to routinely inspect and verify in writing that the application personnel have successfully performed surface preparation, filler/surface application, coating system application, and Quality Control Inspection in accordance with this Section 09900 and to warrantable level of quality. This must include checking the required degree of cleanliness, surface pH for concrete substrates, surface profile of substrates, proper mixing of coating materials, application (including checking the wet and dry film thickness of the coating systems), proper cure of the coating systems, and proper treatment of coating systems at terminations, transitions, and joints and cracks in substrates. Refer to Paragraph 1.05 B. for further details on these CTR requirements. This inspection is in addition to the inspection performed by the Contractor in accordance with this Section 09900.

##### A. COATING SYSTEM INSTALLATION TRAINING

1. Provide a minimum of 8 hours of classroom and off site training for application and supervisory personnel (both the Contractor's and CSA's). Provide training to a minimum of two supervisory personnel from the

CSA and one supervisor from the Contractor. Alternatively, the CTR shall provide a written letter from the CSM stating that the application personnel (listed by name) who shall perform coating work are approved by the CSM without further or additional training.

2. One CTR can provide training for up to fourteen application personnel and three supervisory personnel at one time. The training shall include the following as a minimum:
  - a. A detailed explanation of mixing, application, curing, and termination details.
  - b. Hands-on demonstration of how to mix and apply the coating systems.
  - c. A detailed explanation of the ambient condition requirements (temperature and humidity) and surface preparation requirements for application of the coating system as well as a detailed explanation of re-coat times, cure times, and related ambient condition requirements.
  - d. When training is performed, the CTR shall provide a written letter stating that training was satisfactorily completed by the personnel listed by name in the letter.

## B. COATING SYSTEM INSPECTION

While on site to routinely inspect and verify, the CTR shall perform the following activities to confirm acceptability and conformance with the specifications:

1. Inspect ambient conditions during various coating system installation at hold points for conformance with the specified requirements.
2. Inspect the surface preparation of the substrates where the coating system will terminate or will be applied for conformance to the specified application criteria.
3. Inspect preparation and application of coating detail treatment (for example, terminations at joints, metal embedments in concrete, etc.).
4. Inspect application of the filler/surface materials for concrete and masonry substrates.
5. Inspect application of the primers and finish coats including wet and dry film thickness of the coatings.

6. Inspect coating systems for cure.
7. Review adhesion testing of the cured coating systems for conformance to specified criteria.
8. Review coating system continuity testing for conformance to specified criteria.
9. Inspect and record representative localized repairs made to discontinuities identified via continuity testing.
10. Conduct a final review of completed coating system installation for conformance to the specifications.
11. Prepare and submit a site visit report following each site visit that documents the acceptability of the coating work in accordance with the CSM's recommendations.

#### C. FINAL REPORT

Upon completion of coating work for the project, the CTR shall prepare a final report. That report shall summarize daily test data, observations, drawings, and photographs in a report to be submitted in accordance with paragraph 09900-2.02. Include substrate conditions, ambient conditions, and application procedures, observed during the CTR's site visits. Include a statement that the completed work was performed in accordance with the requirements of this Section 09900 and the CSM's recommendations.

## **PART 2--PRODUCTS**

### 2.01 MATERIALS

Notwithstanding the listing of product names in this Section 09900, the Contractor shall provide affidavits, signed and sealed by an officer of the CSM's corporation, attesting to full compliance of each coating system component with current and promulgated federal, state, and local air pollution control regulations and requirements. No coatings shall be applied to a surface until the specified affidavits have been submitted and have been reviewed and accepted. Failure to comply with this requirement shall be cause for rejection and removal of such materials from the site.

The following list specifies the material requirements for coating systems. Coating systems are categorized by generic name followed by an identifying abbreviation. If an abbreviation has a suffix number, it is for identifying subgroups within the coating system. Coating Systems E-5 and E-6 shall be NSF 61 certified.

**All of U.S. Except California**

<b>Coating System</b>	<b>CSM</b>	<b>First Coat(s)</b>		<b>Finish Coat(s)</b>
<b>Epoxy Coatings</b>				
E-1	PPG PMC Carboline International Paint/ICI * Sherwin Williams Tnemec	Amerlock 2/400 Series Carboguard 890 Devran 224 HS Macropoxy 646 Series V69		Amerlock 2/400 Series Carboguard 890 Devran 224 Macropoxy 646 Series V69
E-1-G	PPG PMC Carboline International Paint/ICI * Sherwin Williams Tnemec	Amerlock 2/400 Series Carboguard 894 Devran 223/224HS Macropoxy 646 B67-600 Series V27 or V69		Amerlock 2/400 Series Carboguard 894 Devran 224HS Macropoxy 646 B67-600 Series V69
E-5	PPG PMC Carboline International Paint/ICI Sherwin Williams Tnemec	Amercoat 395FD Carboguard 691 Bar-Rust 233H Macropoxy 646 Series V69		Amercoat 395FD Carboguard 691 Bar-Rust 233H Macropoxy 646 Series V69
<b>Epoxy Polyurethane</b>				
		<b>Primer Coat(s)</b>	<b>Intermediate Coat(s)</b>	
EU-1	PPG PMC Carboline International Paint/ICI Sherwin Williams Tnemec	Amercoat Carbozinc 859 Cathacoat 313 Zinc Clad IV Series 90-97	Amercoat 385 Carboguard 890 Devran 233 or 224HS Macropoxy 646 Series V69	Amercoat 450H Carbothane 134 VOC Devthane 379 Hi Solids Polyurethane Series 1075
<b>Latex Acrylic</b>				
L-1	PPG PMC Carboline International Paint/ICI	Amercoat 148 Carbocrylic 120 UH Gripper 3210		Amercoat 220 Carbocrylic 3359 Dulux Pro 1406

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**All of U.S. Except California**

<b>Coating System</b>	<b>CSM</b>	<b>First Coat(s)</b>	<b>Finish Coat(s)</b>
	Sherwin Williams Tnemec	Loxon Acrylic Primer Series 1028 or 1029	Sher Cryl HPA Series 1028 or 1029
S-3	Tnemec or approved equal	N/A	Series V626 Dur A Pell GS or approved equal

**\*See CSM's Product Data Sheets for acceptable thinners for VOC compliance or do not thin.**

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## 2.02 PRODUCT DATA

1. Prior to application of coatings, submit letter(s) from the CTR(s) identifying the application personnel who have satisfactorily completed training as specified in paragraph 09900-1.05 or a letter from the CSM stating that personnel who shall perform the work are approved by the CSM without need for further or additional training.
2. Submit reports specified in paragraph 09900-1.02 C.10 and 09900-1.05 B.12 when the work is underway.
3. Submit the Coating System Inspection Checklists, using Form 09900-A, included in Section 01999, for the coating work.
4. CTR final report in accordance with paragraph 09900-1.05 C.

## **PART 3--EXECUTION**

### 3.01 COATINGS

#### A. GENERAL:

Coating products shall not be used until the Construction Manager has accepted the affidavits specified in paragraph 09900-1.04 and 2.01, the Construction Manager has inspected the materials, and the CTR has trained the Contractor and CSA in the surface preparation, mixing and application of each coating system.

#### B. SHOP AND FIELD COATS:

1. **SHOP APPLIED PRIME COAT:** Except as otherwise specified, prime coats may be shop-applied or field-applied. Shop-applied primer shall be compatible with the specified coating system and shall be applied at the minimum dry film thickness recommended



by the CSM. Data sheets identifying the shop primer used shall be provided to the on-site coating application personnel. Adhesion tests shall be performed on the shop primer as specified in paragraph 09900-3.01B.3. Damaged, deteriorated and poorly applied shop coatings that do not meet the requirements of this Section 09900 shall be removed and the surfaces recoated. If the shop primer coat meets the requirements of this Section 09900, the field coating may consist of touching up the shop prime coat and then applying the finish coats to achieve the specified film thickness and continuity.

2. FIELD COATS: Field coats shall consist of one or more prime coats and one or more finish coats to build up the coating to the specified dry film thickness. Unless otherwise specified, finish coats shall not be applied until other work in the area is complete and until previous coats have been inspected.

3. ADHESION CONFIRMATION: The Contractor shall perform an adhesion test after proper cure in accordance with ASTM D3359 to demonstrate that (1) the shop applied prime coat adheres to the substrate, and (2) the specified field coatings adhere to the shop coat. Test results showing an adhesion rating of 5A on immersed surfaces and 4A or better on other surfaces shall be considered acceptable for coatings 5 mils or more in thickness (Method A). Test results showing an adhesion rating of 5B on immersed surfaces and 4B or better on other surfaces shall be considered acceptable for coating thicknesses less than 5 mils.

#### C. APPLICATION LOCATION REQUIREMENTS:

1. EQUIPMENT, NONIMMERSED: Items of equipment, or parts of equipment that are not immersed in service, shall be shop primed and then finish coated in the field after installation with the specified or acceptable color. If the shop primer requires topcoating within a specified period, the equipment shall be finish coated in the shop and then touch-up painted after installation. If equipment removal and reinstallation is required for the project, touch-up coating work shall be performed in the field following installation.

2. EQUIPMENT, IMMERSED: Items of equipment, or parts and surfaces of equipment that are immersed when in service, with the exception of pumps and valves, shall have surface preparation and coating work performed in the field. Coating systems applied to immersed equipment shall be pinhole free.

3. STEEL WATER TANKS: The interior surfaces of steel water tanks or reservoirs shall have surface preparation and coating work performed in the field.

D. Erect and maintain protective enclosures as stipulated per SSPC-Guide 6 Guide for Containing Debris Generated During Paint Removal Operations.

## 3.02 PREPARATION

### A. GENERAL:

Surface preparations for each type of surface shall be in accordance with the specific requirements of each coating specification sheet (COATSPEC) and the following. In the event of a conflict, the COATSPEC sheets shall take precedence.

Surfaces to be coated shall be clean and dry. Before applying coating or surface treatments, oil, grease, dirt, rust, loose mill scale, old weathered coatings, and other foreign substances shall be removed. Oil and grease shall be removed before mechanical cleaning is started. Where mechanical cleaning is accomplished by blast cleaning, the abrasive used shall be washed, graded and free from contaminants that might interfere with the adhesion of the coatings. The air used for blast cleaning shall be sufficiently free of oil and moisture so as not to cause detrimental contamination of the surfaces to be coated.

Where deemed necessary by the Owner's representative, a NACE International certified coatings inspector, provided by the Owner, will inspect and approve surfaces to be coated before application of a coating. Surface defects identified by the inspector shall be corrected by the Contractor at no additional cost to the Owner.

Cleaning and painting shall be scheduled so that dust and spray from the cleaning process shall not fall on wet, newly coated surfaces. Hardware, hardware accessories, nameplates, data tags, machined surfaces, sprinkler heads, electrical fixtures, and similar uncoated items which are in contact with coated surfaces shall be removed or masked prior to surface preparation and painting operations. Following completion of coating, removed items shall be reinstalled. Equipment adjacent to walls shall be disconnected and moved to permit cleaning and painting of equipment and walls and, following painting, shall be replaced and reconnected.

### B. BLAST CLEANING:

When abrasive blast cleaning is required to achieve the specified surface preparation the following requirements for blast cleaning materials and equipment shall be met:

1. Used or spent blast abrasive shall not be reused on this project.
2. The compressed air used for blast cleaning shall be filtered and shall contain no condensed water and no oil. Moisture traps shall be cleaned at least once every four hours or more frequently as required to prevent moisture from entering the supply air to the abrasive blasting equipment.
3. Oil separators shall be installed just downstream of compressor discharge valves and at the discharge of the blast pot discharges. These shall be checked on the same frequency as the moisture traps as defined in item 2 above.

4. Regulators, gauges, filters, and separators shall be in use on compressor air lines to blasting nozzles times during this work.
5. An air dryer or desiccant filter drying unit shall be installed which dries the compressed air prior to blast pot connections. This dryer shall be used and maintained for the duration of surface preparation work.
6. The abrasive blast nozzles used shall be of the venturi or other high velocity type supplied with a minimum of 100 psig air pressure and sufficient volume to obtain the blast cleaning production rates and cleanliness/specified.
7. The Contractor shall provide ventilation for airborne particulate evacuation (meeting pertinent safety standards) to optimize visibility for both blast cleaning and inspection of the substrate during surface preparation work.
8. If, between final surface preparation work and coating system application, contamination of prepared and cleaned metallic substrates occurs, or if the prepared substrates' appearance darkens or changes color, recleaning by water blasting, reblasting and abrasive blast cleaning shall be required until the specified degree of cleanliness is reclaimed.
9. The Contractor is responsible for dust control and for protection of mechanical, electrical, and other equipment adjacent to and surrounding the work area.

C. SOLVENT CLEANING:

Any solvent wash, solvent wipe, or cleaner used, including but not limited to those used for surface preparation in accordance with SSPC SP-1 Solvent Cleaning and shall be of the emulsifying type which emits no more than 340 g/l VOCs for AIM regions, 250 g/l for CARB regions and 100 g/l for SCAQMD regions, contains no phosphates, is biodegradable, removes no zinc, and is compatible with the specified primer.

Clean white cloths and clean fluids shall be used in solvent cleaning.

D. METALLIC SURFACES:

Metallic surfaces shall be prepared in accordance with applicable portions of surface preparation specifications of the Society for Protective Coatings (SSPC) specified for each coating system. See Coat Spec for each coating system in this Section 09900. The profile depth of the surface to be coated shall be in accordance with the COATSPEC requirements in this Section measured by Method C of ASTM D4417. Blast particle size shall be selected by the

Contractor to produce the specified surface profile. The solvent in solvent cleaning operations shall be as recommended by the CSM.

Preparation of metallic surfaces shall be based upon comparison with SSPC-VIS1-89 (ASTM D2200), and as described in the Coat Spec for each coating system. If dry abrasive blast cleaning is selected and to facilitate inspection, the Contractor shall, on the first day of cleaning operations, abrasive blast metal panels to the standards specified. Plates shall measure a minimum of 8-1/2 inches by 11 inches. Panels meeting the requirements of the specifications shall be initialed by the Contractor and the Construction Manager and coated with a clear non-yellowing finish. One of these panels shall be prepared for each type of abrasive blasting and shall be used as the comparison standard throughout the project.

Blast cleaning requirements for steel, ductile iron and stainless steel substrates are as follows:

1. Steel piping shall be prepared in accordance with SSPC SP-6 (Commercial Blast Cleaning) and primed before installation. Ductile iron piping surfaces including fittings shall be prepared in accordance with NAPF 500-03, NAPF 500-03-04, and NAPF 500-03-05.
2. Stainless steel surfaces shall be abrasive blast cleaned to leave a clean uniform appearance with a minimum surface profile of 1.5 to 2.5 mils that is uniform.
3. Remove traces of grit, dust, dirt, rust scale, friable material, loose corrosion products or embedded abrasive from substrate by vacuum cleaning prior to coating application.
4. Care must be taken to prevent contamination of the surface after blasting from worker's fingerprints, deleterious substances on workers' clothing, or from atmospheric conditions.
5. Ambient environmental conditions in the enclosure must be constantly monitored and maintained to ensure the degree of cleanliness is held and no "rust back" occurs prior to coating material application.

E. CONCRETE SURFACES:

1. Inspection of concrete surfaces prior to surface preparation and surface preparation of concrete surfaces shall be performed in accordance with SSPC-SP13 (also called NACE 6).
2. Prepare substrate cracks, areas requiring resurfacing and perform detail treatment including but not limited to, terminating edges, per CSM recommendations. This shall precede surface preparation for degree of cleanliness and profile.

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3. The surface profile for prepared concrete surfaces to be coated shall be evaluated by comparing the profile of the prepared concrete with the profile of graded abrasive paper, as described in ANSI B74.18 or by comparing the profile with the ICRI 03732 (surface profile replicas). Surface profile requirements shall be in accordance with the Coat Spec requirements and the CSM's recommendations.
4. Surface cleanliness of prepared concrete substrates shall be inspected after cleaning, preparation, and/or drying, but prior to making repairs or applying a coat in the coating system. If concrete surfaces are repaired, they shall be reinspected for surface cleanliness prior to application of the coating system.
5. Surface preparation of concrete substrates shall be accomplished using methods such as dry abrasive blast cleaning, high, or ultra high-pressure water blast cleaning in accordance with SSPC-SP-13. The selected cleaning method shall produce the requirements set forth below.
  - a. A clean substrate that is free of calcium sulfate, loose coarse or fine aggregate, laitance, loose hydrated cement paste, and otherwise deleterious substances shall be achieved. Blast cleaning and other means necessary shall be used to open up air voids or bugholes to expose their complete perimeter. Leaving shelled over, hidden air voids beneath the exposed concrete surface is not acceptable. Concrete substrate must be dry prior to the application of filler/surface or coating system materials.

Acceptable surface preparation must produce a concrete surface with a minimum pH of 8.0 to be confirmed by surface pH testing. If after surface preparation, the surface pH remains below 8.0, perform additional water blasting, cleaning, or abrasive blast cleaning until additional pH testing indicates an acceptable pH level.
  - b. Following inspection by the Contractor of the concrete surface preparation, thoroughly vacuum clean concrete surfaces to be coated to remove loose dirt, and spent abrasive (if dry blast cleaning is used) leaving a dust free, sound concrete substrate. Debris produced by blast cleaning shall be removed from the structures to be coated and disposed of legally off site by the Contractor.
6. Should abrasive blast cleaning or high or ultrahigh pressure water blasting not remove degraded concrete, chipping or other abrading tools shall be

used to remove the deteriorated concrete until a sound, clean substrate is achieved which is free of calcium sulfate, loose coarse or fine aggregate, laitance, loose hydrated cement paste, and otherwise deleterious substances. Concrete substrates must be dry prior to the application of filler/surfacers or coating system materials.

7. Surface cleanliness of prepared concrete substrates shall be inspected after cleaning, preparation, and/or drying, but prior to application of coating materials. If concrete surfaces are repaired, they shall be reinspected for surface cleanliness and required surface profile prior to application of the coating system.
8. Moisture content of concrete to be coated shall be tested in accordance with ASTM D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method and ASTM F 1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride. The ASTM D4263 plastic sheet test shall be conducted at least once for every 500 sq. ft. of surface area to be coated. The presence of any moisture on plastic sheet following test period constitutes a non-acceptable test. For concrete surfaces to be coated which are on the negative or back side of concrete walls or structures exposed to soils (back filled) or immersed and waterproofed in accordance with Section 07100, perform calcium chloride tests in accordance with ASTM F-1869 once for each 500 sq. ft. of surface area to be coated. Comply with CSM's written recommendations regarding acceptance/non-acceptance of moisture vapor emissions.

F. MASONRY SURFACES:

1. Prepare masonry surfaces such as Concrete Masonry Units (CMU) to remove chalk, loose dirt, dried mortar splatter, dust, peeling, or loose existing coatings, or otherwise deleterious substances to leave a clean, sound substrate.
2. Be certain masonry surfaces are dry prior to coating application. If pressure washing or low-pressure water blast cleaning is used for preparation, allow the masonry to dry for at least 5 days under dry weather conditions or when the minimum ambient temperature is 70 degrees F prior to coating application work.

G. FIBERGLASS REINFORCED PLASTIC (FRP) SURFACES:

Prepare FRP surfaces by sanding to establish uniform surface roughness and to remove gloss from the resin in the FRP. Next, vacuum clean to remove loose FRP dust, dirt, and other materials. Next, solvent clean using clean white rags and allow solvent to evaporate completely before application of coating materials.

## H. EXISTING FACILITIES:

Existing equipment and metalwork shall be coated in accordance with the appropriate coating system specified for new work in paragraph 3.05 COATSPEC.

Modified work shall require the full coating system. Other work shall require cleaning and surface preparation as recommended by the CSM followed by two finish coats of the appropriate system.

Contractor shall demonstrate that the existing coating is compatible with field coating by performing the adhesion test specified in paragraph 09900 – 3.01 B.3. Where unacceptable test results are obtained, the Contractor shall follow manufacturer's written instructions as to the necessity of a tie coat to provide a satisfactory bond between the existing coating and the specified field coating. The difference in cost between the specified coatings and that which is compatible with existing coatings, or work required to remove existing coatings, will be paid for as extra work unless identified in the Scope of Work for the project already."

Abrasive blasting shall be used to clean wall surfaces of existing process channels and tanks to be coated. Surfaces to be coated, or recoated, shall be repaired, cleaned, and finished to the standards as specified herein.

## 3.03 APPLICATION

### A. WORKMANSHIP:

1. Coated surfaces shall be free from runs, drips, ridges, waves, laps, and brush marks. Coats shall be applied to produce an even film of uniform thickness completely coating corners and crevices.
2. The Contractor's equipment shall be designed for application of the materials specified. Compressors shall have suitable traps and filters to remove water and oils from the air. A paper blotter test shall be performed by the Contractor when requested by the Construction Manager to determine if the air is sufficiently free of oil and moisture so as not to produce deteriorating effects on the coating system. The amount of oil and moisture in spray air shall be less than the amount recommended by the CSM. Spray equipment shall be equipped with mechanical agitators, pressure gages, and pressure regulators, and spray nozzles of the proper sizes.
3. Each coat of coating material shall be applied evenly and sharply cut to line. Care shall be exercised to avoid overspraying or spattering paint on surfaces not to be coated. Glass, hardware, floors, roofs, and other

adjacent areas and installations shall be protected by taping, drop cloths, or other suitable measures.

4. Coating applications method shall be conventional or airless spray, brush or roller, or trowel as recommended by CSM.
5. Allow each coat to cure or dry thoroughly, according to CSM's printed instructions, prior to recoating.
6. Vary color for each successive coat for coating systems when possible.
7. When coating complex steel shapes, prior to overall coating system application, stripe coat welds, edges of structural steel shapes, metal cut-outs, pits in steel surfaces, or rough surfaces with the primer coat. This involves applying a separate coat using brushes or rollers to ensure proper coverage. Stripe coat via spray application is not permitted.

**B. COATING PROPERTIES, MIXING AND THINNING:**

Coatings, when applied, shall provide a satisfactory film and smooth even surface. Glossy undercoats shall be lightly sanded to provide a surface suitable for the proper application and adhesion of subsequent coats. Coating materials shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings consisting of two or more components shall be mixed in accordance with the CSM's instructions. Where necessary to suit the conditions of the surface, temperature, weather and method of application, the coating may be thinned as recommended by the CSM immediately prior to use. The volatile organic content (VOC) of the coating as applied shall comply with prevailing air pollution control regulations. Unless otherwise specified, coatings shall not be reduced more than necessary to obtain the proper application characteristics. Thinner shall be as recommended by the CSM.

**C. ATMOSPHERIC CONDITIONS:**

Coatings shall be applied only to surfaces that are dry, and only under conditions of evaporation rather than condensation. Coatings systems shall not be applied during rainy, misty weather, or to surfaces upon which there is frost or moisture condensation. During damp weather, when the temperature of the surface to be coated is within 10 degrees F of the dew point, forced dehumidification equipment may be used to maintain a temperature of minimum 40 degrees F and 10 degrees F above the dew point for the surfaces to be coated, the coated surface, and the atmosphere in contact with the surface. These conditions shall be maintained for a period of at least 8 hours or as recommended by the CSM. Where conditions causing condensation are severe, dehumidification equipment, fans, and/or heaters shall be used inside enclosed areas to maintain the required atmospheric and surface temperature requirements for proper coating application and cure.

**D. CONCRETE SUBSTRATE TEMPERATURES AND DETAIL TREATMENT:**



1. When the surface temperatures of the concrete substrates to be coated are rising or when these substrates are in direct sunlight, outgassing of air from the concrete may result in bubbling, pinhole formations, and/or blistering in the coating system. The application of the filler/surface and the coating system will only be allowed during periods of falling temperature. This will require that application of the filler/surface and coating system shall only occur during the cooler evening hours. Contractor shall include any cost for working outside of normal hours in the bid.

Should bubbles, pinholes, or discontinuities form in the applied coating system material, they shall be repaired as recommended by the CSM. Should pinholes develop in the filler/surfacer material or in the first coat of the coating material, the pinholes shall be repaired in accordance with the CSM's recommendations prior to application of the next coat of material. Whenever pinholes occur, the air void behind or beneath the pinhole shall be opened up completely and then completely filled with the specified filler/surfacer material. Next, the coated area around the pinhole repair shall be abraded and the coating reapplied over that area.

2. Perform application detail work per CSM's current written recommendations and/or drawings.

#### E. PROTECTION OF COATED SURFACES:

Items that have been coated shall not be handled, worked on, or otherwise disturbed, until the coating is completely dry and hard. After delivery at the site, and upon permanent erection or installation, shop-coated metalwork shall be recoated or retouched with specified coating when it is necessary to maintain the integrity of the film.

#### F. METHOD OF COATING APPLICATION:

1. Where two or more coats are required, alternate coats shall contain sufficient compatible color additive to act as indicator of coverage, or the alternate coats shall be of contrasting colors. Color additives shall not contain lead, or lead compounds, which may be destroyed or affected by hydrogen sulfide or other corrosive gas, and/or chromium.
2. Mechanical equipment, on which the equipment manufacturer's coating is acceptable, shall be touch-up primed and coated with two coats of the specified coating system to match the color scheduled. Electrical and instrumentation equipment specified in Divisions 16 and 17 shall be coated as specified in paragraph 09900-3.03 I.

3. Coatings shall not be applied to a surface until it has been prepared as specified. The primer or first coat shall be applied by brush to ferrous surfaces that are not blast-cleaned. Coats for blast-cleaned ferrous surfaces and subsequent coats for nonblast-cleaned ferrous surfaces may be either brush or spray applied. After the prime coat is dry, pinholes and holidays shall be marked, repaired in accordance with CSM's recommendations and retested before succeeding coats are applied. Unless otherwise specified, coats for concrete and masonry shall be brushed, rolled, or troweled.

G. FILM THICKNESS AND CONTINUITY:

1. WFT of the first coat of the coating system and subsequent coats shall be verified by the Contractor, following application of each coat.
2. The surface area covered per gallon of coating for various types of surfaces shall not exceed those recommended by the CSM. The first coat, referred to as the prime coat, on metal surfaces refers to the first full paint coat and not to solvent wash, grease emulsifiers or other pretreatment applications. Coatings shall be applied to the thickness specified, and in accordance with these specifications. Unless otherwise specified, the average total thickness (dry) of a completed protective coating system on exposed metal surfaces shall be not less than 1.25 mils per coat. The minimum thickness at any point shall not deviate more than 25 percent from the required average. Unless otherwise specified, no less than two coats shall be applied.
3. In testing for continuity of coating about welds, projections (such as bolts and nuts), and crevices, the Construction Manager shall determine the minimum conductivity for smooth areas of like coating where the dry-mil thickness has been accepted. This conductivity shall be the minimum required for these rough or irregular areas. Pinholes and holidays shall be recoated to the required coverage.
4. The ability to obtain specified film thickness is generally compromised when brush or roller application methods are used and, therefore, more coats may need to be applied to achieve the specified dry film thickness.
5. For concrete substrates, the Contractor shall apply a complete skim coat of the specified filler/surfacer material over the entire substrate prior to application of the coating system. This material shall be applied such that all open air voids and bugholes in the concrete substrate are completely filled prior to coating application.

#### H. SPECIAL REQUIREMENTS:

Before erection, the Contractor shall apply all but the final finish coat to interior surfaces of roof plates, roof rafters and supports, pipe hangers, piping in contact with hangers, and contact surfaces that are inaccessible after assembly. The final coat shall be applied after erection. Structural friction connections and high tensile bolts and nuts shall be coated after erection. Areas damaged during erection shall be hand-cleaned or power-tool cleaned and recoated with primer coat prior to the application of subsequent coats. Touch-up of surfaces shall be performed after installation. Surfaces to be coated shall be clean and dry at the time of application. Except for those to be filled with grout, the underside of equipment bases and supports that have not been galvanized shall be coated with at least two coats of primer specified for system E-2 prior to setting the equipment in place. Provide coating system terminations at leading edges and transitions to other substrates in accordance with the CSM's recommendations or detail drawings.

#### I. ELECTRICAL AND INSTRUMENTATION EQUIPMENT AND MATERIALS:

Electrical and instrumentation equipment and materials shall be coated by the equipment manufacturer as specified below.

1. **FINISH:** Electrical equipment shall be treated with zinc phosphate, bonderized or otherwise given a rust-preventive treatment. Equipment shall be primed, coated with enamel, and baked. Minimum dry film thickness shall be 3 mils.

Unless otherwise specified, instrumentation panels shall be coated with system E-1 for indoor mounting and system EU-1 for outdoor mounting.

Before final acceptance, the Contractor shall touch up scratches on equipment with identical color coating. Finish shall be smooth, free of runs, and match existing finish. Prior to touching up scratches, Contractor shall fill them with an appropriate filler material approved by the CSM.

2. **COLOR:** Exterior color of electrical equipment shall be FS 26463 (ANSI/NSF 61) light gray. Interior shall be painted FS 27880 white. Nonmetallic electrical enclosures and equipment shall be the equipment manufacturer's standard grey color.

Exterior color of instrumentation panels and cabinets mounted indoors shall be FS 26463 light gray; unless otherwise specified, exterior color for cabinets mounted outdoors shall be FS 27722, white. Cabinet interiors shall be FS 27880, white.

## J. SOLUBLE SALT CONTAMINATION OF METALLIC SUBSTRATES:

Contractor shall test in accordance with SSPC-TU-4 metallic substrates to be coated that have been exposed to seawater or coastal air or to industrial fallout of particulate or other sources of soluble chlorides (such as wastewater exposure). If testing indicates detrimental levels of soluble salts, those in excess of 25 ppm, the Contractor shall clean and prepare these surfaces to remove the soluble salts.

### 3.04 CLEANUP

Upon completion of coating, the Contractor shall remove surplus materials, protective coverings, and accumulated rubbish, and thoroughly clean surfaces and repair overspray or other coating-related damage.

### 3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating systems for different types of surfaces and general service conditions for which these systems are normally applied are specified on the following COATSPEC sheets. Surfaces shall be coated in accordance with the COATSPEC to the system thickness specified. Coating systems shall be as specified in paragraph 09900-3.06, Coating System Schedule. In case of conflict between the schedule and the COATSPECS, the requirements of the schedule shall prevail.

Coating Specification Sheets included in Table 09900A are included this paragraph 09900-3.05.

**Table 09900A Coating Specification Sheets**

Coating System ID	Coating Material	Surface	Service Condition
E-1	Epoxy	Metal	Interior; exterior, covered, not exposed to direct sunlight, non-corrosive exposure.
E-1-G	Epoxy	Galvanized Steel	Interior; exterior, covered non-corrosive exposure. Do not use in immersion service.
E-5 (NSF 61 certified)	Epoxy	Metal	Interior potable water tanks and reservoirs and other metal components in contact with water being treated and stored for potable use.
L-1	Latex	Concrete, masonry, plaster, gypsum board	Interior and Exterior including existing exterior coated concrete.
EU-1	Zinc-epoxy-polyurethane system	Ferrous Metal	Exterior, exposed to direct sunlight, moderately corrosive non-immersed.
S-2	Silane/Siloxane or Blended Sealer	Concrete Floors	Wet, non-immersed, non-corrosive. Interior or exterior for waterproofing.
S-3	RTV Silicone Rubber Based Sealer	Concrete or Masonry Walls	Exterior or Interior – Weathering Exposure, Non-Corrosive.

### 3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	E-1
Coating Material:	Epoxy
Surface:	Metal
Service Condition:	Interior; exterior, covered, not exposed to direct sunlight, non-corrosive exposure.
Surface Preparation:	
General:	Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning surfaces in accordance with SSPC SP-2 (Hand Tool Cleaning). Damaged shop coated areas shall be cleaned in accordance with SSPC SP-5 (White Metal Blast Cleaning) to achieve a uniform surface profile of 2.0 to 2.5 mils and spot primed with the primer specified. Shop epoxy primed surfaces shall require light abrasive and vacuum cleaning blasting prior to receiving finish coats.
Ferrous Metal:	Bare ferrous metal surfaces shall be prepared in accordance with SSPC SP-6 (Commercial Blast Cleaning) to achieve a uniform, surface profile of 2.0 to 2.5 mils.  Ferrous metal with rust bleeding shall be cleaned in accordance with SSPC SP-1 (Solvent Cleaning). Areas of rust penetration shall be spot blasted to SSPC SP-10 (Near White Blast) (to achieve the 2.0- to 2.5-mil surface profile) and spot primed with the specified primer. For ductile iron surfaces, refer to the requirements in paragraph 09900-3.02 D.
Nonferrous and Galvanized Metal:	Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) to achieve uniform, minimum surface profile 1.0 to 1.5 mils.

### 3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification: E-1 (continued)

Application: Field

General: Prime coat may be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.

Ferrous Metal: Prime coats shall be an epoxy primer compatible with the specified finish coats and applied in accordance with the written instructions of the CSM.

Nonferrous and Galvanized Metal: Nonferrous and galvanized metal shall be cleaned prior to the application of the prime coat in accordance with SSPC SP-1 (Solvent Cleaning).

System Thickness: 10 mils dry film.

Coatings:

Primer: One coat at CSM's recommended dry film thickness.

Finish: One or more coats at CSM's recommended dry film thickness per coat to achieve the specified system thickness.

### 3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	E-1-G
Coating Material:	Epoxy
Surface:	Galvanized Steel
Service Condition:	Interior; exterior, covered, non-corrosive exposure. Do not use in immersion service.
Surface Preparation:	
General:	Damaged galvanized steel areas with exposed ferrous metal and/or rusted shall be cleaned in accordance with SSPC SP-5 (White Metal Blast Cleaning) or Power Tool Cleaned to Bare Metal in accordance with SSPC-SP-11 to achieve a uniform 1.0- to 1.5-milprofile and spot primed with the primer specified.
Galvanized Metal:	Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) impart a 1- to 2-milprofile to the galvanized steel surfaces. Where this cannot be performed, prepare by abrading in accordance with SSPC-SP-3, Power Tool Cleaning to impart a 1.0- to 1.5-mil profile uniformly to the galvanized steel surfaces.
Application:	Field
General:	Prime coat may be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.
Galvanized Metal:	Nonferrous and galvanized metal shall be cleaned prior to the application of the prime coat in accordance with SSPC SP-1 (Solvent Cleaning).
System Thickness:	5 to 8 mils dry film.



### 3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification: E-1-G (continued)

Coatings:

Primer: One coat at CSM's recommended dry film thickness.

Finish: One or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.

If the coated galvanized steel is to be exposed to ultraviolet light, apply one polyurethane top coat from coating system EU-1 over the second coat of the two epoxy coats specified.

### 3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	E-5 (NSF 61 certified)
Coating Material:	Epoxy
Surface:	Metal
Service Condition:	Interior potable water tanks and reservoirs and other metal components in contact with water being treated and stored for potable use. Interior potable and non-potable carbon steel piping.
Surface Preparation:	
Ferrous Metal:	<p>Ferrous metal surfaces shall be prepared in accordance with SSPC SP-5 (White Metal Blast Cleaning) to achieve a uniform surface profile of 2.0 to 2.5 mils.</p> <p>Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning surfaces in accordance with SSPC SP-2 (Hand Tool Cleaning) or SSPC-SP-3 (Power Tool Cleaning). Damaged shop coating shall be cleaned in accordance with SSPC SP-5 (White Metal Blast Cleaning) and spot primed with the primer specified. Cleaning shall produce a surface profile of 2.0 to 2.5 mils. Shop epoxy primed surfaces shall require light abrasive blasting or abrading prior to receiving finish coats if the maximum recoat limit has been exceeded for the primer. This cleaning shall produce a uniform surface profile of 1.0 to 1.5 mils in the intact primer.</p>
Nonferrous and Galvanized Metal:	<p>Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) to achieve a 1.0- to 1.5-mil profile that is uniform.</p>
Application:	Field
General:	<p>Prime coat shall be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.</p>
Ferrous Metal:	<p>Prime coat shall be an epoxy primer compatible with the specified finish coats.</p>

### 3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification: E-5 (NSF 61 certified) (continued)

Nonferrous and  
Galvanized Metal:

Nonferrous and galvanized metal above the high water elevation shall be cleaned prior to the application of the prime coat in accordance with SSPC SP-1 (Solvent Cleaning).

System Thickness: 10 mils dry film.

Coatings:

Primer: One coat at the CSM's recommended dry film thickness.

Finish: One or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.

### 3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification: EU-1

Coating Material: Zinc-Epoxy-Polyurethane System

Surface: Ferrous Metal

Service Condition: Exterior, exposed to direct sunlight, moderately corrosive, non-immersed.

#### Surface Preparation:

General: Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning surfaces in accordance with SSPC SP-2 (Hand Tool Cleaning). Damaged shop coated areas shall be cleaned in accordance with SSPC SP-3 (Power Tool Cleaning) and recoated with the primer specified.

Ferrous Metal: Bare ferrous metal surfaces shall be prepared in accordance with SSPC SP-6 (Commercial Blast Cleaning) 2.5 – 3.0. Ductile iron surfaces to be coated shall be abrasive blast cleaned in accordance with paragraph 09900-3.02 D.

Ferrous metal with rust bleeding shall be cleaned in accordance with SSPC-SP-11 (Power Tool Cleaning to Bare Metal). Areas of rust penetration shall be spot blasted to SSPC SP-10 (Near White Blast) and spot primed with the specified primer.

Galvanized Metal: Damaged galvanized steel areas with exposed ferrous metal and/or rusted shall be cleaned in accordance with SSPC SP-5 (White Metal Blast Cleaning) or Power Tool Cleaned to Bare Metal in accordance with SSPC-SP-11 to achieve a uniform 1.0- to 1.5-mil profile and spot primed with the primer specified.

Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) to impart a 1.0- to 2.0-mil profile to the galvanized steel surfaces. Where this cannot be performed, prepare by abrading in accordance with SSPC-SP-3, Power Tool Cleaning to impart a 1.0- to 1.5-mil profile uniformly to the galvanized steel surfaces.

### 3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification: EU-1 (continued)

For EU-1 over galvanized steel, delete the zinc rich primer.

Application: Field

General: Prime coat may be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.

Ferrous Metal: Prime coats shall be a zinc rich epoxy or polyurethane primer compatible for use with urethane finish coats and applied in accordance with written instructions of the CSM or in the case of CARB or SCAQMD applications, prime with specified primer that is not zinc rich. In these cases, only a two-coat system is applied.

System Thickness: 3 to 4 mils of zinc rich primer, one intermediate or primer epoxy coat at 5 to 6 mils and one finish coat of polyurethane at 2 to 3 mils DFT.

Coatings:

Primer: One coat at CSM's recommended dry film thickness.

Intermediate: One coat at CSM's recommended dry film thickness.

Finish: One coat at CSM's recommended dry film thickness per coat to meet the specified system thickness.

### 3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification: L-1

Coating Material: Latex

Surfaces: Concrete, masonry, plaster, gypsum board.

Service Condition: Interior and exterior including existing exterior coated concrete.

#### Surface Preparation:

Concrete: Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content may be tested by the Construction Manager with a Delmhorst Instrument Company moisture detector, or equal. Loose concrete and laitance shall be removed from surfaces, and voids and cracks shall be repaired as specified in Section 03300.

Existing Coated Concrete: Remove all loose coating down to a sound substrate or intact, well-adhered existing coating by scraping or other means. Then, abrade all surfaces to achieve a 0.5- to 1.5-mil uniform profile and vacuum clean to remove all loose dirt, paint chips, and dirt.

Masonry: Masonry surfaces shall be allowed to age for at least 28 days. Holes or other joint defects shall be filled with mortar and repointed. Loose or splattered mortar shall be removed by scraping and chipping. Masonry surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances. Muriatic acid shall not be used. After cleaning, masonry surfaces shall be filled with block filler compatible with the specified primer.

Plaster: Plaster surfaces shall be dry, clean, and free from grit, loose plaster, and surface irregularities. Cracks and holes shall be repaired with acceptable patching materials, keyed to existing surfaces, and sandpapered smooth. Surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances. After cleaning, surfaces shall be sealed with a compatible sealer.

### 3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification: L-1 (continued)

Gypsum Wallboard: Tape joints and spackled nail heads shall be sanded smooth and dusted. Seal with PVA sealer for interior uses only.

Application: Field

Sealer or filler shall dry a minimum of 48 hours prior to primer application.

Drying time between coats shall be as recommended by CSM.

System Thickness: 4 mils dry film.

Coatings:

Primer: One coat at CSM's recommended dry film thickness.

Finish: Two or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.

### 3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	S-2
Coating Material:	Penetrating Water Repellent (Clear and Non-Film Building)
Surface:	Concrete Floors
Service Condition:	Exterior and Interior.
Surface Preparation:	Clean surfaces of all traces of dirt, dust, efflorescence, mold, salt, grease, oil, asphalt, laitance, curing compounds, paint, coatings, and other foreign materials by brush-off blast, water blasting, and/or chemical cleaners or other preparation as approved by the CSM.
Concrete	Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content may be tested by the Construction Manager with a Delmhorst Instrument Company moisture detector, or equal. Loose concrete and laitance shall be removed from surfaces, and voids and cracks shall be repaired as specified in Section 03300
Application:	
General:	Drying time before placing into service shall be as recommended by the CSM for site conditions.
System Coverage:	Follow CSM's recommendations.
Color Selection:	Clear.



### 3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	S-3
Coating Material:	Penetrating Water Repellent (Clear & Non-Film Building)
Surface:	Concrete and Masonry Walls
Service Condition:	Exterior and Interior – For Anti-Graffiti Applications
Surface Preparation:	Clean surfaces of all traces of dirt, dust, efflorescence, mold, salt, grease, oil, asphalt, laitance, curing compounds, paint, coatings, and other foreign materials by brush-off blast, water blasting, and/or chemical cleaners or other preparation as approved by the CSM.
Concrete	Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content may be tested by the Construction Manager with a Delmhorst Instrument Company moisture detector, or equal. Loose concrete and laitance shall be removed from surfaces, and voids and cracks shall be repaired as specified in Section 03300
Masonry:	Masonry surfaces shall be allowed to age for at least 28 days. Holes or other joint defects shall be filled with mortar and repointed. Loose or splattered mortar shall be removed by scraping and chipping. Masonry surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances. Muriatic acid shall not be used.
Application:	
General:	Drying time before placing into service shall be as recommended by the CSM for site conditions.
System Coverage:	Follow CSM's recommendations.
Color Selection:	Clear.

### 3.06 COATING SYSTEMS SCHEDULE (FINISH SCHEDULE)

Specific coating systems, colors, and finishes for rooms, galleries, piping, equipment, and other items that are coated or have other architectural finishes are specified in the following coating system schedule. Unless otherwise specified in the coating system schedule, the word "interior" shall mean the inside of a building or structure, and the word "exterior" shall mean outside exposure to weather elements.

Location Description	Surface	Coating System Identification	Standard Color
A. General: All surfaces not specified by area or structure	1. Structural Steel, Metal Decking, and Galvanized Acoustical Decking	Uncoated or E-1	
	2. Galvanized Metal decking	E-1-G	
	3. Equipment and Metal Appurtenances		
	a. Equipment, non immersed, unless otherwise specified		
	1) Indoors	E-1	FS 25051 Blue
	2) Outdoors	EU-1	FS 20040 Brown
	b. Existing equipment		
	1) Not damaged nor modified by work in this contract	Uncoated	--
	2) Damaged, exposed, or modified by work in this contract		
	a) Indoors	E-1 (see paragraph 09900-3.02)	Match existing color
	b) Outdoors	EU-1 without primer (see paragraph 09900-3.02)	Match existing color
	c. Diffusers and grilles on coated surfaces, unless otherwise specified		
	1) Indoors	E-1	Match background color
	2) Outdoors	EU-1	Match background color
d. Diffusers and grilles on uncoated surfaces, unless otherwise specified			
1) Indoors	E-1	FS 25051 Blue	
2) Outdoors	EU-1	FS 20040 Brown	
e. Electrical switchgear panels, unit substations, motor control centers, power transformers, distribution centers, and relay panels; indoors and outdoors	See paragraph 09900-3.03 I	ANSI 61 Grey (outside)	
		FS 27880 White (inside)	

Location Description	Surface	Coating System Identification	Standard Color
	<p>f. Instrumentation panels, graphic indicating panels, indicating and transmitting field panels, unless otherwise specified</p> <p>1) Indoors</p> <p>2) Outdoors</p> <p>g. Existing electrical and instrumentation panels</p> <p>1) Not damaged by work in this contract</p> <p>2) Damaged or exposed to outside surfaces by work in this contract</p> <p>a) Indoors</p> <p>b) Outdoors</p>	<p>See paragraph 09900-3.03 I</p> <p>See paragraph 09900-3.03 I</p> <p>Uncoated</p> <p>E-1 (see paragraph 09900-3.02 F)</p> <p>EU-1 without primer (see paragraph 09900-3.02 F)</p>	<p>FS 26306 Grey (outside)</p> <p>FS 27880 White (inside)</p> <p>FS 27722 White (outside)</p> <p>FS 27880 White (inside)</p> <p>--</p> <p>FS 26306 Grey</p> <p>FS 26306 Grey (Electrical)</p> <p>FS 27722 White (Instrumentation)</p>
	<p>3. Conduit, Piping and Ductwork</p> <p>a. Ferrous, non-ferrous and galvanized piping, and appurtenant hangers and supports, non-immersed, unless otherwise specified.</p> <p>1) Indoors – noncorrosive</p> <p>2) Outdoors – noncorrosive</p> <p>b.</p> <p>c. Conduit, outlet and junction boxes, lighting transformers, lighting, communication and small power panels, control stations, piping, lagged ductwork, appurtenant hangers, clamps, and supports on coated surfaces, unless otherwise specified.</p> <p>1) Indoors</p> <p>2) Outdoors</p>	<p>E-1</p> <p>EU-1</p> <p>E-1</p> <p>EU-1</p>	<p>FS 25051 Blue</p> <p>FS 20040 Brown</p> <p>Match background color</p> <p>Match background color</p>

Location Description	Surface	Coating System Identification	Standard Color
	<p>d. Conduit, outlets and junction boxes, lighting transformers, lighting, communication and small power panels, control stations, piping, lagged ductwork, appurtenant hangers, clamps and supports on uncoated surfaces, unless otherwise specified</p> <p>1) Indoors</p> <p>2) Outdoors</p> <p>e. Existing conduit, outlet and junction boxes, lighting transformers, lighting communication and small power panels, control stations, piping, lagged ductwork, appurtenant hangers, clamps, and supports</p> <p>1) Not damaged nor modified by work in this contract</p> <p>2) Damaged, exposed, or modified by work in this contract</p> <p>a) Indoors</p> <p>b) Outdoors</p>	<p>E-1</p> <p>EU-1</p> <p>Uncoated</p> <p>E-1 (see paragraph 09900-3.02 F)</p> <p>EU-1 without primer (see paragraph 09900-3.02 F)</p>	<p>FS 25051 Blue</p> <p>FS 20040 Brown</p> <p>--</p> <p>Match existing color</p> <p>Match existing color</p>
	<p>4. Concrete, Grout, Masonry and Plaster</p> <p>a.</p> <p>b. Outside concrete walls below grade common with dry area or room</p> <p>c. Walls and ceilings</p> <p>1) Precast concrete or colored masonry</p> <p>2) Outdoors, unless otherwise specified</p> <p>3) Indoors, unless otherwise specified</p> <p>d. Concrete equipment bases unless otherwise specified</p> <p>e. Floors unless otherwise specified</p> <p>f. Existing coated surfaces.</p>	<p>In accordance with Section 07100)</p> <p>S-3</p> <p>S-3</p> <p>S-3</p> <p>E-4</p> <p>S-2</p> <p>L-1</p>	<p>--</p> <p>--</p> <p>--</p> <p>--</p> <p>Match equipment color</p> <p>Match existing color.</p>
	<p>5. Door and Door Frames</p> <p>a. Doors unless otherwise specified</p> <p>1) Ferrous metal</p> <p>a) Indoors</p> <p>b) Outdoors</p>	<p>E-1</p> <p>EU-1</p>	<p>FS 20040 Brown</p> <p>FS 25051 Blue</p>

Location Description	Surface	Coating System Identification	Standard Color
	<ul style="list-style-type: none"> <li>2) Aluminum</li> <li>3) Other</li> <li>4) Existing               <ul style="list-style-type: none"> <li>a) Not damaged by work in this contract</li> <li>b) Damaged, exposed, or modified by work in this contract                   <ul style="list-style-type: none"> <li>(1) Indoors</li> <li>(2) Outdoors</li> </ul> </li> </ul> </li> <li>b. Door frames unless otherwise specified               <ul style="list-style-type: none"> <li>1) Adjacent wall coated                   <ul style="list-style-type: none"> <li>a) Indoors</li> <li>b) Outdoors</li> </ul> </li> <li>2) Adjacent wall uncoated                   <ul style="list-style-type: none"> <li>a) Indoors</li> <li>b) Outdoors</li> </ul> </li> <li>3) Aluminum</li> <li>4) Existing                   <ul style="list-style-type: none"> <li>a) Not damaged by work in this contract</li> <li>b) Damaged, exposed, or modified by work in this contract                       <ul style="list-style-type: none"> <li>(1) Indoors</li> <li>(2) Outdoors</li> </ul> </li> </ul> </li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Uncoated</li> <li>Plastic laminate</li> <li>Uncoated</li> <li>E-1 (see paragraph 09900-3.02 F)</li> <li>EU-1 (see paragraph 09900-3.02 F)</li> <li>E-1</li> <li>EU-1</li> <li>E-1</li> <li>EU-1</li> <li>Uncoated</li> <li>Uncoated</li> <li>E-1 (see paragraph 09900-3.02 F)</li> <li>EU-1 without primer (see paragraph 09900-3.02 F)</li> </ul>	<ul style="list-style-type: none"> <li>--</li> <li>Formica 947 Brown</li> <li>--</li> <li>Match existing color</li> <li>Match existing color</li> <li>Match wall color</li> <li>Match wall color</li> <li>FS 20040 Brown</li> <li>FS 25051 Blue</li> <li>--</li> <li>--</li> <li>Match existing color</li> <li>Match existing color</li> </ul>
	<ul style="list-style-type: none"> <li>6. Handrails, Gratings, Floor Plates, Manhole Covers, and Hatches               <ul style="list-style-type: none"> <li>a. Unless otherwise specified</li> <li>b. Existing                   <ul style="list-style-type: none"> <li>1) Not damaged by work in this contract</li> <li>2) Damaged, exposed, or modified by work in this contract                       <ul style="list-style-type: none"> <li>a) Indoors</li> </ul> </li> </ul> </li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Uncoated</li> <li>Uncoated</li> <li>E-1 (see paragraph 09900-3.02 F)</li> </ul>	<ul style="list-style-type: none"> <li>--</li> <li>--</li> <li>Match existing color</li> </ul>

Location Description	Surface	Coating System Identification	Standard Color
	b) Outdoors	EU-1 without primer (see paragraph 09900-3.02 F)	Match existing color
	7. Metal Stairs, Ladders, Platforms, and Supports Except Tread and Grating		
	a. Indoors	E-1	FS 25051 Blue
	b. Outdoors	EU-1	FS 20040 Brown
	c. Existing		
	1) Not damaged nor modified by work in this contract	Uncoated	--
	2) Damaged, exposed, or modified by work in this contract		
	a) Indoors	E-1 (see paragraph 09900-3.02 F)	Match existing color
	b) Outdoors	EU-1 without primer (see paragraph 09900-3.02 F)	Match existing color
	8. Aluminum Flashing, Light Standards, Supports, and Louvers		
	Indoors and outdoors, unless otherwise specified	Uncoated	--
	9. Precast Concrete Metalwork		
	Fasteners, anchors, supports, etc.	EU-1	Match wall
	10. Other		
	a. Fire hydrants	EU-1	FS 21302 Red
	b. Flap gates	EA-1	Beige
	c. Aluminum slide gates	Uncoated	--
	d. Sluice gates		
	1) Gate	--	--
	2) Stem, except potable	G	--
	3) Operator		
	a) Indoors	E-2	FS 25051 Blue
	b) Outdoors	EU-1	FS 20040 Brown
	e. Tanks		
	1) Filtration and GAC Vessals		
	a) Inside of tank	E-5	See Note 1
	b) Outside of tank	EU-1	FS 25051 Blue
	2) Potable steel water storage tanks		

Location Description	Surface	Coating System Identification	Standard Color
	a) Inside of tank	E-5	See Note 1
	b) Outside of tank	EU-1	FS 25051 Blue
	3) Fiberglass tank	Uncoated	--
	f.	Uncoated	--
	g. Buried, sleeve-type and flanged pipe, couplings, valves, mechanical and electrical penetrations	M-1 or M-2	Manufacturer's color
K. Administration Building	1. Outdoors		
	a. Equipment on roof	EU-1	FS 25051 Blue
	b. Walls	Uncoated	--
	2. Room 5401 Lobby		
	a. Floor	Epoxy terrazzo	National Mosaic Assoc. Std S109
	b. Base	Epoxy terrazzo	NMAS S109
	c. Plaster walls	L-1	FS 23617 Beige
	d. Steel deck ceiling	L-3	FS 23617 Beige
	e. Steel roof trusses	L-3	FS 23617 Beige
	f. Doors	L-3	FS 20040 Brown
	g. Door frames	L-3	FS 23617 Beige
	3. Room 5402 Clerical Area		
	a. Floor	Epoxy terrazzo	NMAS S109
	b. Base	Epoxy terrazzo	NMAS S109
	c. Plaster walls	L-1	FS 23617 Beige
	d. Steel deck ceiling	L-3	FS 23617 Beige
	e. Steel roof trusses	L-3	FS 23617 Beige
	f. Doors	L-3	FS 20040 Brown
	g. Door frames	L-3	FS 23617 Beige
	h. Filing cabinets	Shop coated	Steelcase Tan

Notes:

1. Owner will select color from coating manufacturer's list of EPA approved colors for potable water.

### 3.07 INSPECTION AND TESTING BY OWNER

- A. Inspection by the Owner or others does not limit the Contractor's or CSA's responsibilities for quality workmanship or quality control as specified or as required by the CSM's instructions. Inspection by the Owner is in addition to any inspection required to be performed by the Contractor.

- B. The Owner may perform, or contract with an inspection agency to perform, quality control inspection and testing of the coating work covered by this Section 09900. These inspections may include the following:
1. Inspect materials upon receipt to ensure that are supplied by the CSM.
  2. Inspect to verify that specified storage conditions for the coating system materials, solvents and abrasives are provided.
  3. Inspect and record findings for the degree of cleanliness of substrates.
  4. Inspect and record the pH of concrete and metal substrates.
  5. Inspect and record substrate profile (anchor pattern).
  6. Measure and record ambient air and substrate temperature.
  7. Measure and record relative humidity.
  8. Check for the presence of substrate moisture in the concrete.
  9. Inspect to verify that correct mixing of coating system materials is performed in accordance with CSM's instructions.
  10. Inspect, confirm, and record that the "pot life" of coating system materials is not exceeded during installation. Inspect to verify that recoat limitations for coating materials are not exceeded.
  11. Perform adhesion testing.
  12. Measure and record the thickness of the coating system.
  13. Inspect to verify proper curing of the coating system in accordance with the CSM's instructions.
  14. Perform holiday or continuity testing for coatings that will be immersed or coatings that will be exposed to aggressively corrosive conditions.

### 3.08 FINAL INSPECTION

- A. Contractor shall conduct a final inspection to determine whether coating system work meets the requirements of the specifications.



- B. The Construction Manager will subsequently conduct a final inspection with the Contractor to determine the work is in conformance with requirements of the contract documents.
- C. Any rework required shall be marked. Such areas shall be recleaned and repaired as specified at no additional cost to the Owner.

**09900-A Coating System Inspection Checklist**

Project Name:			
Owner		Coating System Manufacturer(CSM)	
General Contractor (GC)		Coating System Applicator(CSA)	
Area or Structure		Location within Structure	
Coating System (e.g. E-1)		Coating Type (e.g. Epoxy, etc.)	

Step	Description		Name	Signature	Date
1	Completion of cleaning and substrate decontamination prior to abrasive blast cleaning.	GC QC			
		CSM QC			
		CSA QC			
2	Installation of protective enclosure of structure or area and protection of adjacent surfaces or structures that are not to be coated.	GC QC			
		CSM QC			
		CSA QC			
3	Completion of ambient condition control in structure or building area and acceptance of ventilation methods in structure or Area.	GC QC			
		CSM QC			
		CSA QC			
4	Completion of Surface Preparation for Substrates to Be Coated.	GC QC			
		CSM QC			
		CSA QC			
5	Completion of Primer Application.	GC QC			
		CSM QC			

Step	Description		Name	Signature	Date
		CSA QC			
6	Completion of Concrete Repairs If Required and Related Surface Preparation Rework Prior to Coating System Application.	GC QC			
		CSM QC			
		CSA QC			
7	Completion of Concrete Filler/ Surface Application to Concrete.	GC QC			
		CSM QC			
		CSA QC			
8	Completion of First Finish Coat Application and of Detail Treatment at Transitions or Terminations.	GC QC			
		CSM QC			
		CSA QC			
9	Completion of Second Finish Coat Application and of Detail Treatment at Transitions and Terminations.	GC QC			
		CSM QC			
		CSA QC			
10	Completion of Full and Proper Cure of Coating System.	GC QC			
		CSM QC			
		CSA QC			
11	Completion of Testing of Cured Coating System including Adhesion, Holiday (Continuity) Testing and Dry Film Thickness.	GC QC			
		CSM QC			
		CSA QC			
12	Completion of Localized Repairs	GC QC			

Step	Description		Name	Signature	Date
	to Coating System Following Testing.	CSM QC			
		CSA QC			
13	Final Acceptance of Coating System Installation Including Final Clean-Up Complying with Specification Requirements and the CSM's Quality Requirements.	GC QC			
		CSM QC			
		CSA QC			

\*\*END OF SECTION \*\*

## SECTION 09901

### COATING FOR STEEL WATER STORAGE RESERVOIR

#### PART 1--GENERAL

##### 1.01 DESCRIPTION

###### A. SCOPE:

This section specifies coating systems, surface preparations, and application requirements for coating the new Storage Tank.

###### B. DEFINITIONS:

Specific coating terminology used in this section is in accordance with definitions contained in ASTM D16, ASTM D3960, and the following definitions:

1. Dry Film Thickness (DFT): The thickness of one fully cured continuous application of coating.
2. Field Coat: The application or the completion of application of the coating system after installation of the surface at the site of the work.
3. 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.
4. Volatile Organic 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.
8. 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.

##### 1.02 QUALITY ASSURANCE

###### A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event

of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). 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, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM D16	Standard Definitions of Terms Relating to Paint, Varnish, Lacquer, and Related Products
ASTM D2200 (SSPC-Visl-67T)	Pictorial Surface Preparation Standards for Painting Steel Surfaces
ASTM D3359	Methods for Measuring Adhesion by Tape Test--Method A
ASTM D3960	Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
ASTM D4417	Field Measurement of Surface Profile of Blast Cleaned Steel
AWWA D102	Painting Steel Water-Storage Tanks
NSF 61	Drinking Water System Components Health Effects
SSPC	Steel Structures Painting Council Specifications, Vol. 2

**B. STANDARDIZATION:**

Materials and supplies provided shall be the standard products of manufacturers. Materials in each coating system shall be the products of a single manufacturer.

The standard products of manufacturers other than those specified will be accepted when it is demonstrated to the Construction Manager that they are equal in composition, durability, usefulness, and convenience for the purpose intended. Requests for substitutions will be considered, provided the following minimum conditions are met:

1. The proposed coating system shall use an equal or greater number of separate coats to achieve the required dry film thickness.

2. The proposed coating system shall use coatings of the same generic type as that specified.
3. Requests for substitution shall have directions for application and descriptive literature which includes generic type, percent solids by volume, volatile organic content (grams per liter), and information confirming that the substitution is equal to the specified coating system.
4. The Contractor shall provide a list of references where paint of the same generic type has been applied. The reference list shall give the project name, city, state, owner, phone number of owner, coating system reference and number, and year paint was applied.

#### C. INSPECTION:

The Construction Manager will provide, or arrange to have provided, all coating inspections. Test equipment provided by the Contractor as specified in paragraph 09901-3.04 B will be operated by the Construction Manager.

The Construction Manager will perform inspection on all on-site and off-site phases of the surface preparation, abrasive blast cleaning, and application of the coating systems. Specified and optional tank surfaces to have shop-applied primer will be monitored by off-site inspection. The Contractor shall notify the Construction Manager in sufficient time to schedule inspection during shop priming and shall make the shop priming premises open and available to the Construction Manager for inspection. The Contractor shall pay all costs incurred for off-site inspection.

If shop work is not scheduled on a continuous basis to facilitate scheduling by the Construction Manager, all costs incurred for multiple trips to the shop shall be borne by the Contractor. Actual costs incurred for off-site inspection will be incorporated into a change order and deducted from progress payments due the Contractor.

#### 1.03 DELIVERY AND STORAGE

Materials shall be delivered to the job site in their original, unopened containers. Each container shall bear the manufacturer's name, coating type, batch number, date of manufacture, storage life, and special directions.

Materials shall be stored in enclosed structures and shall be protected from weather and excessive heat or cold. Flammable materials shall be stored in accordance with state and local codes. Materials exceeding storage life recommended by the manufacturer shall be removed from the site.

## 1.04 SPARE SUPPLIES

The Contractor shall provide one unbroken gallon container of each color and type of paint and each type of solvent and thinner required by the specification. These spare paint supplies shall be stored as required in paragraph 09901-1.03 until delivery is requested by the Construction Manager.

## PART 2--PRODUCTS

### 2.01 COATING SYSTEMS

#### A. GENERAL:

All materials of a specified coating system, including primer, intermediate, and finish coats, shall be produced by the same manufacturer. Thinners, cleaners, driers, and other additives shall be as recommended by the coating manufacturer for the particular coating system. Coating systems are defined in specification 09900 Coating Systems.

#### B. OUTSIDE COATING:

1. PRIMER: Exterior primer shall be an epoxy compatible for use with Coating System **EU-1**.

2. FINISH COATING: Exterior finish coating shall be Coating System **EU-1**. The color of the finish coat shall be **Tan**.

#### C. INSIDE COATING:

1. CERTIFICATION: All inside coatings shall be certified in accordance with NSF 61.

2. PRIMER: Inside primer shall be an epoxy compatible for use with Coating System **E-5**.

3. FINISH COATING: Inside finish coat shall be an epoxy white in color, Coating System **E-5**.

### 2.02 PRODUCT DATA

Before materials are delivered to the job site, the Contractor shall provide the following information in accordance with Section 01300:

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1. Manufacturer's standard product data and material safety data sheet for each primer and finish coating.
2. List of materials proposed to be used under this section.
3. Manufacturer's literature and written instructions for surface preparation, mixing, and application of each primer and finish coating.

## PART 3--EXECUTION

### 3.01 COATINGS

#### A. GENERAL:

Coating products shall not be used until the Construction Manager has inspected the materials and the coating manufacturer's technical representative has instructed the Contractor and Construction Manager in the surface preparation, mixing and application of each coating.

At least 14 days prior to the shop or field application of the coating systems on the steel tank, the Contractor shall schedule and arrange a conference with the coating applicator, Construction Manager, tank manufacturer, and the coating manufacturer to coordinate the following:

1. Tank manufacturer's work schedule for inspection coordination.
2. Surface preparation prior to abrasive blast cleaning.
3. Specification compliance of blast abrasives and surface profile.
4. Schedule of blast cleaning and coating application.
5. List of equipment for cleaning and coating applications.
6. Weather limitations for acceptable work.
7. Inspection facilities and test equipment.

#### B. COATING SYSTEMS:

1. **SHOP APPLIED PRIME COAT:** Except as otherwise specified, prime coats may be shop- or field-applied. Shop-applied primer shall be compatible with the specified coating system and shall be applied at the minimum dry film thickness recommended by the

manufacturer. Product data sheets identifying the shop primer used shall be provided to the on-site finish coat applicator. Adhesion tests shall be performed on the shop primer as specified in paragraph 09901-3.02 A. Damaged, deteriorated and poorly applied shop coatings that do not meet the requirements of this section shall be removed and the surfaces recoated. If the shop primer coat meets the requirements of this section, the field coating may consist of touching up the shop primer coat and then applying the finish coats to achieve the specified film thickness and continuity.

2. FIELD COATS: Field coats shall consist of one or more prime coats and one or more finish coats to build up the coating to the specified dry film thickness. Unless otherwise specified, finish coats shall not be applied until other work in the area is complete and until all previous coats have been inspected.

### 3.02 PREPARATION

#### A. GENERAL:

Surfaces to be coated shall be clean and dry. Before applying coating or surface treatments, oil, grease, dirt, rust, loose mill scale, old weathered coatings, and other foreign substances shall be removed except as specified. Oil and grease shall be removed before mechanical cleaning is started. Where mechanical cleaning is accomplished by blast cleaning, the abrasive used shall be washed, graded and free of contaminants which might interfere with the adhesion of the coatings. The Contractor shall examine all surfaces to be coated and shall correct all surface defects before application of any coating.

Clean cloths and clean fluids shall be used in solvent cleaning. Cleaning and painting shall be scheduled so that dust and spray from the cleaning process shall not come in contact with wet, newly painted surfaces.

The Contractor shall perform an adhesion test in accordance with ASTM D3359 to demonstrate that (1) the shop primer adheres to the substrate, and (2) the specified field coatings adhere to the shop primer. Test results showing an adhesion rating of 5A on immersed surfaces and 4A or better on all other surfaces shall be considered acceptable. Where unacceptable test results are obtained, the Contractor shall be responsible for removing and reapplying the specified coatings at no expense to the Owner.

#### B. METALLIC SURFACES:

Metallic surfaces shall be prepared in accordance with applicable portions of surface preparation specifications of the Steel Structures Painting Council (SSPC). Unless otherwise specified, interior ferrous metal surfaces shall be prepared in accordance with SSPC SP 5 (White Metal Blast Cleaning) and exterior ferrous metal surfaces prepared in accordance with SSPC SP 6 (Commercial Blast Cleaning). The profile depth of the surface to be coated shall be 20 to 25 percent of the coating dry film thickness as measured by Method C of ASTM D4417. Blast

particle size shall be selected by the contractor to produce the specified surface profile. The solvent in solvent cleaning operations shall be as recommended by the manufacturer.

Preparation of metallic surfaces shall be based upon comparison with SSPC-Visl-67T (ASTM D2200), and as described herein. To facilitate inspection, the Contractor shall, on the first day of sandblasting operations, sandblast metal panels to the standards specified. Plates shall measure a minimum of 8-1/2 inches by 11 inches. Panels meeting the requirements of the specifications shall be initialed by the Contractor and the Construction Manager and coated with a clear nonyellowing finish. One of these panels shall be prepared for each type of sandblasting and shall be used as the comparison standard throughout the project.

#### C. ABRASIVE BLAST CLEANING:

The specified limitations on the application of coatings also applies to blast cleaning. Blast cleaning shall only be done when conditions permit the immediate subsequent application of coating, and only for the area that can be coated with primer or touch-up coating during the same day. Changed humidity or a delay, such as equipment failure, may cause a cleaned surface to color or slightly oxidize from condensation before the coating can be applied. In the event that a surface colors or becomes moist, it shall be blast cleaned again before applying the coating.

Abrasive blast cleaning shall comply with the following:

1. Dry abrasive blast shall be used for cleaning metal surfaces. Sand used for cleaning shall be washed, uniformly graded, dry, and free of contaminants. Sand containing salt or unwashed beach sand shall not be used. When shop blast cleaning with stationary automatic equipment that recycles the blast particles, new abrasives shall be used in the equipment at the beginning of the blast cleaning operations. Use of abrasives that have become contaminated in automatic equipment is prohibited. When shop or field blast cleaning with hand-held nozzles, blast particles shall not be recycled or reused.
2. After blast cleaning and prior to application of coating, surfaces to be coated shall be dry cleaned by dusting, sweeping, and vacuuming to remove residue from blasting. The blasting and the specified primer or touch-up coating shall be applied within the period of an 8-hour working day. Coating shall not be applied over damp or moist surfaces. Prior to application of primer or touch-up coating, any blast cleaned surface not coated within the 8-hour period shall be recleaned.
3. The area of the work shall be kept in a clean condition and blasting particles shall not be permitted to accumulate and constitute a nuisance or hazard.

The reservoir inlet, outlet, drain, and overflow piping shall be covered, and blasting particles prevented from being blown into the piping.

4. During blast cleaning, caution shall be exercised to prevent damage to adjacent preapplied coatings. Blast cleaning and coating shall be scheduled such that dust, dirt, blast particles, old coatings, rust, mill scale, etc., shall not damage or come in contact with wet or newly coated surfaces. Damaged coatings shall be restored to their specified condition.

### 3.03 APPLICATION

#### A. WORKMANSHIP:

Coated surfaces shall be free from runs, drops, ridges, waves, laps, and brush marks. Coats shall be applied so as to produce an even film of uniform thickness completely coating corners and crevices. Painting shall be done in accordance with the requirements of SSPC Paint Application Specification No. 1.

The Contractor's equipment shall be designed for application of the materials specified. Compressors shall have suitable traps and filters to remove water and oils from the air. Spray equipment shall be equipped with mechanical agitators, pressure gages, and pressure regulators, and spray nozzles of the proper sizes.

Each coat of paint shall be applied evenly and sharply cut to line. Care shall be exercised to avoid overspraying or spattering paint on surfaces not to be coated. Glass, hardware, floors, roofs, and other adjacent areas and installations shall be protected by taping, drop cloths, or other suitable measures.

#### B. PAINT PROPERTIES, MIXING AND THINNING:

Paint, when applied, shall provide a satisfactory film and smooth even surface, and glossy undercoats shall be lightly sanded to provide a surface suitable for the proper application and adhesion of subsequent coats. Paints shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings consisting of two or more components shall be mixed in accordance with the manufacturer's instructions. Where necessary to suit the conditions of the surface, temperature, weather and method of application, the paint may be thinned immediately prior to use. The volatile organic content (VOC) of the coating as applied shall comply with prevailing air pollution control regulations. Unless otherwise specified, paint shall not be thinned more than necessary to obtain the proper application characteristics. Thinner shall be as recommended by the coating manufacturer.

#### C. ATMOSPHERIC CONDITIONS:

Paints shall be applied only to surfaces that are dry, and only under conditions of evaporation rather than condensation. Paint shall not be applied during rainy, misty weather, or to surfaces upon which there is frost or moisture condensation. Coatings shall not be applied when the temperature of the surface to be coated is more than 5 degrees F below the air temperature, or when the surface temperature is over 120 degrees F. During painting, and for a period of at least 8 hours after the paint has been applied, the temperature of the surfaces to be painted, the painted surfaces, and the atmosphere in contact shall be maintained at or above 50 degrees F and at least 10 degrees F above the dew point. Paint, when applied, shall be approximately the same temperature as that of the surface on which it is applied. Fans or heaters shall be used inside enclosed areas where conditions causing condensation exist.

If conditions are adverse as noted above, the application of coating shall be delayed or postponed until conditions are favorable. Dew or moisture condensation should be anticipated and if such conditions are prevalent, coating work shall be delayed until midmorning to be certain that the surfaces are dry. The day's coating shall be completed in time to permit the film sufficient drying time prior to damage by climatic conditions. Climatic conditions will be monitored by the Construction Manager to aid in inspection. If a change in climatic conditions damages a coating application, repair of the damaged coatings to their specified condition shall be made at no additional cost to the Owner.

**D. PROTECTION OF COATED SURFACES:**

Items which have been coated shall not be handled, worked on, or otherwise disturbed, until the paint is completely dry and hard. After delivery to the site and permanent erection or installation, shop-coated metalwork shall be repainted or retouched with specified paint when it is necessary to maintain the integrity of the film.

**E. PROCEDURES:**

1. **GENERAL:** Procedures for application of coatings shall comply with the following:

- a. Coating applicator shall conform to the requirements of SSPC PA-1 and follow the recommendations of the coating manufacturer including the selection of spray equipment, brushes, rollers, cleaners, thinners, mixing, drying time, temperature and humidity of application, and safety precautions.
- b. Coating applicator shall stir, strain, and keep coating materials at a uniform consistency during application. A different shade or tint shall be used on succeeding coating applications to indicate coverage. Finished surfaces shall be free from defects or blemishes.

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- c. If allowed, thinning shall not exceed the maximum allowable amount of thinner per gallon of coating material. Coating materials shall be stirred at all times when adding thinner; flooding the coating material surface with thinner prior to mixing is prohibited. Coating materials shall not be thinned more than is absolutely necessary to obtain the proper application characteristics and to obtain the specified dry-film thicknesses.
- d. Blast cleaned surfaces shall be cleaned as specified in paragraph 09901-3.02 C. Ventilator fans shall be used to clean airborne dust to provide good visibility of working area prior to coating applications. Dust shall be removed from coated surfaces by dusting, sweeping, and vacuuming prior to applying succeeding coats.
- e. Coating applicator shall observe minimum and maximum recoat times between primer and succeeding coating applications to achieve maximum crosslinking of coatings. If the recommended minimum or maximum recoat time is violated, the surface shall be prepared as directed by the coating manufacturer. A second application of the primer or coating shall be applied if the maximum recoat time has been exceeded.
- f. Coating systems shall be applied to the specified minimum dry-film thicknesses as measured from above the peaks of the surface profile. Measurement will be in accordance with SSPC PA-2 and will be corrected for the magnetic effect of the surface profile.
- g. Primer or touch-up coating shall be applied immediately after blast cleaning and before any surface rusting occurs, or any dust, dirt, or any foreign matter has accumulated. Steel surfaces that have surface colored or become moist prior to coating application shall be recleaned by blast cleaning.

2. **SHOP-APPLIED PRIMERS:** Procedures for application of shop-applied primers shall comply with the following:

- a. Blast-cleaned steel surfaces will be tested by the Construction Manager utilizing chemical and/or ultraviolet (black light) tests to detect oil and other contaminants deposited on the surface from abrasive recycling. Tests will be conducted prior to the application of primers. Contaminated surfaces shall be recleaned using new abrasives in the equipment and the surfaces prepared as specified.

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- b. After application of primer to steel surfaces, coating shall be allowed to cure for a minimum of 2 hours before handling, to minimize damage.
- c. When loading for shipment to the project site, spacers and other protective devices shall be used to separate the plates and steel members to prevent damaging the shop-primed surfaces during transit and unloading. If wood spacers are used, wood splinters and particles shall be removed from the shop-primed surfaces after separation. Padded chains or ribbon binders shall be used to secure the loaded steel and minimize damage to the shop-primed surfaces.
- d. Shop-primed steel surfaces shall be completely covered with protective coverings or tarpaulins to prevent deposition of road salts, fuel residue, and other contaminants in transit.
- e. Shop-primed steel plates and members shall be handled with care during unloading and erection operations to minimize damage. Sliding steel across another plate or member, except for fitting plates into final position during roof construction is prohibited. Shop-primed steel shall not be placed or stored on the ground or on top of other steelwork unless ground or steelwork is covered with a protective covering or tarpaulin. Steel above the ground shall be placed upon platforms, skids, or other supports.

3. TOUCH-UP OF SHOP-APPLIED PRIMERS: Touch-up of shop-applied primers after erection shall comply with the following:

- a. After erection, the Construction Manager will inspect all surfaces of the tank to determine surface deficiencies in the shop-applied primers. Contaminants that have accumulated on the surfaces of the shop-applied primers during shipment, storage, and erection shall be removed and corrective action performed as noted.
- b. Coating applicator shall remove oil and grease surface contaminants in accordance with SSPC SP-1. The coating applicator shall use clean rags wetted with a degreasing solution, rinse with clean water, and wipe dry.
- c. Coating applicator shall remove dust, dirt, salts, moisture, chalking primers, or other surface contaminants that will affect the adhesion or durability of the coating system by using a high-pressure water

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blaster or scrubbing all surfaces with a broom or brush wetted with a solution of trisodium phosphate, detergent, and water. Scrubbed surfaces shall be rinsed with clean water.

- d. Loose or peeling primer and other surface contaminants not easily removed by the previous cleaning methods shall be removed in accordance with SSPC SP-7. Care shall be taken that remaining primers are not damaged by the blast-cleaning operation. Remaining primers shall be firmly bonded to the steel surfaces with blast-cleaned edges feathered.
- e. Coating applicator shall remove rust, scaling, or primer damaged by welding or during shipment, storage, and erection in accordance with SSPC SP-10. Care shall be taken that remaining primers are not damaged by the blast cleaning operation. Remaining primers shall be firmly bonded to the steel surfaces with blast-cleaned edges feathered.
- f. Repair procedures used on damaged primer shall protect adjacent primer. Blast cleaning may require the use of lower air pressure, smaller nozzles and abrasive particle sizes, short blast nozzle distance from surface, shielding, and/or masking.
- g. If damage to primer in a specific area exceeds 50 percent of the total surface of that specific area, area shall be cleaned by blasting in accordance with SSPC SP-10 and a second application of the specified primer applied to the total surface of the specific area. Specific areas are defined as follows: underside of roof and support structure, shell interior, roof exterior, and shell exterior.
- h. When primed surfaces have exceeded the manufacturer's recommended recoat time or recoat time when exposed to sunlight, surface shall be blast cleaned in accordance with SSPC SP-10 and a second coat of the specified primer applied.

4. **FIELD-APPLIED INTERIOR PRIMER AND COATING:** Procedures for application of field-applied interior primer and coating shall comply with the following:

- a. Coating applicator shall remove dust from the sandblasted surface and allow ventilator fans to clear airborne dust to provide good visibility of working area. Adequate lights shall be provided.



- b. Dust shall be removed from primer before applying second coat. Total mil thickness shall be verified. Floor shall be coated last.
- c. The coating will be checked with a holiday detector as the work progresses. A final check of the entire coating will be performed when it is complete.

5. EXTERIOR COATING: Procedures for application of exterior coatings shall comply with the following:

- a. Coating applicator shall remove sandblasted dust. Primer shall be applied with rollers that leave a smooth surface or by spraying. Rollers shall be used when wind causes unacceptable drift. The finish coats shall be sprayed except spraying is not allowed when wind or other weather conditions are unfavorable.
- b. The mil thickness and the dryness of each coat shall be verified before overcoating.

6. LIMITATIONS ON COATING APPLICATIONS: Coatings shall not be applied under the following conditions:

- a. When the air and surface temperature are outside the range recommended by the coating manufacturer.
- b. When the ambient temperature is less than 5 degrees F above the dew point.
- c. When the surfaces are wet or moist.
- d. During rain, snow, fog, or mist.
- e. When it is expected that the air temperature will drop below that recommended by the paint manufacturer or will drop to less than 5 degrees F above the dew point within 8 hours after applying the coating.

Coating applicator shall maintain a thermometer in the shade on the project site and keep informed of the dew point and the humidity from the weather bureau.

F. CLEANING AND COATING OF ROOF PLATES AND FRAMING:

Before erection of the roof framing, all sides of the roof framing members and the roof plates that will be in contact with them shall be cleaned and painted with the specified prime coat. After erection, visible scratches and other damaged painted surfaces shall be sandblasted, primer applied to the recleaned areas, then finish coat applied along with other interior surfaces.

G.      UNDERSIDE OF FLAT BOTTOM TANKS:

The underside of flat bottom tanks shall not be coated.

H.      CLEANING AND COATING OF OVERFLOW PIPING WITHIN TANK NO. 2:

The interior and exterior of overflow piping within the tank shall be cleaned and coated as specified for the tank interior.

I.      PAINT THICKNESS AND MINIMUM NUMBER OF COATS:

1.      GENERAL: The number of coats specified shall be applied unless the measured dry-film thickness is less than specified, in which case additional coats shall be applied.

2.      INTERIOR:

Epoxy system	
Primer	5 mils
Finish	<u>5 mils</u>
	10 mils minimum

3.      EXTERIOR:

Urethane system	
Primer	5 mils
Finish	<u>2 mils</u>
	7 mils minimum

3.04 INSPECTION

A.      INSPECTION FACILITIES:

Contractor shall provide the Construction Manager with facilities for inspection consisting of the following:

1. Safety equipment and devices required during abrasive blast cleaning and coating operations. Helmet with continuous fresh air supply shall be provided for observation during cleaning operations.

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2. Illumination and the manpower to move the lights, whenever required by the Construction Manager. Additional lights and supports shall be sufficient to illuminate all areas to be inspected. The Construction Manager will determine the level of illumination required for inspection purposes.
3. Temporary ladders and scaffolding as required to provide access to the locations requested by the Construction Manager.

#### B. INSPECTION AND CHECKING:

The Construction Manager will perform such tests as are required to demonstrate substantial compliance with all phases of the surface preparation, abrasive blast cleaning, and application of the coating systems. Test equipment shall include the following: SSPC surface preparation standards, surface profile comparator, test tape, micrometer, abrasive sieve test, ultraviolet lamp, mirror, certified thickness calibration plates, magnetic-type dry-film thickness gage, nondestructive holiday detector, and nonsudsing-type wetting agent. Equipment will be calibrated by the Construction Manager in the presence of the Contractor to verify its accuracy prior to use. The Contractor shall provide the test equipment.

The Construction Manager shall be notified 5 working days in advance of shop and field operations involving abrasive blast cleaning and coating applications. The Construction Manager will determine the degree and surface profile of the shop and field blast cleaned surface. Additional blast cleaning shall be performed over areas not conforming to the specified surface preparation.

The Construction Manager will inspect each coat of primer, touch-up, intermediate, and finish coating to determine thickness and integrity. Each coating application will be checked and deficiencies marked. After observing specified recoat time, additional coating materials shall be applied over area not having the specified minimum dry-film thickness and areas having any holidays or pinholes. After correction of deficiencies, the Construction Manager will reinspect those areas to determine the acceptability of additional coating. Each coating application shall be 100 percent to the satisfaction of the Construction Manager prior to succeeding coating applications.

#### 3.05 WARRANTY

A first-anniversary warranty inspection of the interior and exterior surfaces of the tank will be conducted during the eleventh month following final acceptance of the work by the Owner to determine whether any repair work is necessary. Inspection shall comply with Section 9 of AWWA-D 102 except as specified. The Owner will establish the inspection date and notify the Contractor. The Owner will drain and wash down the tank. The Contractor shall provide lighting and scaffolding for the tank inspection. Where coatings have peeled off, bubbled, or cracked, and any location where rusting is evident shall be considered to be a failure of the coating system. Repairs at failures shall be performed by removing the deteriorated coating; preparing the surface

by abrasive blast cleaning and applying the same coating systems as specified in this section. Inspection and repairs shall be performed at no cost to the Owner.

**\*\*END OF SECTION\*\***

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BODAWAY-GAP WELL, STORAGE TANK AND PIPELINE

DIVISION 10

SPECIALTIES

10441      Warning Signs

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SECTION 10441

WARNING SIGNS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies informational and accident prevention signs.

1.02 OPERATING AND DESIGN REQUIREMENTS

A. GENERAL:

Accident prevention signs shall conform as to design with OSHA Section 1910.145 of Subpart J, Part 1910, Chapter XVII, Title 29 of the Code of Federal Regulations. Exit signs shall conform with Section 1910.37(g) of the OSHA Safety and Health Standard for General Industry, Article 10, Section 10.113 of the Uniform Fire Code, and where applicable with local fire regulations.

In addition to the signs identified on the schedule in Part 3 of this section, the following shall be provided:

1. "Caution Automatic Equipment May Start At Any Time" signs shall be provided in accordance with paragraph 11000-2.07.

B. DESIGN REQUIREMENTS:

1. SIZE: Sign size shall be as follows:

- A - 14 inch x 20 inch
- B - 10 inch x 14 inch
- C - 7 inch x 10 inch

2. TYPE: The sign type shall be as follows:

Type	Message
I	CAUTION--AUTOMATIC EQUIPMENT MAY START AT ANY TIME
II	DANGER--480 VOLTS
III	DANGER--CHLORINE

Type	Message
IV	NOTICE--UNTREATED WATER
VI	CAUTION--WAIT 5 MINUTES AFTER FAN HAS BEEN SWITCHED ON BEFORE ENTERING BUILDING
VII	DANGER--240 VOLTS
VIII	DANGER--HIGH VOLTAGE
X	DANGER--CONFINED SPACE--HAZARDOUS ATMOSPHERE
XIII	RESTRICTED AREA--AUTHORIZED PERSONNEL ONLY
XVI	LOCK OUT SWITCH BEFORE WORKING ON EQUIPMENT

### 1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

1. Sign manufacturer's product data and cut sheets showing sign materials, sizes, dimensions, fonts, colors, and any other applicable data.

### PART 2--PRODUCTS

#### 2.01 GENERAL

Sign lettering shall be single stroke and shall contrast in color with the background. For those messages for which there are international symbols, the international symbols shall be used. Chain mounted signs shall have lettering on both sides.

#### 2.02 MATERIALS

Signs shall be 0.100-inch thick fiberglass with embedded fadeproof legends.

### PART 3--EXECUTION

Signs shall be distributed as follows:

Location	Number	Size	Message	Mount
Well Pump House No. 3 exterior				
Chlorine Room	1	C	III	Door
Chlorine Room	1	B	VI	Door
Gate	1	C	VIII	Fence

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Location	Number	Size	Message	Mount
Gate	1	C	XIII	Fence
Tank No. 2 site - exterior				
Gate	1	C	VIII	Fence
Gate	1	C	XIII	Fence
All 240 volt electrical equipment	1 each	C	VII	Equipment Door
All 480 volt electrical equipment: SES, Switchboard, Motor Starter, RVSS, Panelboard, etc.	1 each	C	II	Equipment Door
Pipeline Vaults				
Access Hatches and Manhole Entries	2	C	X	Underside of Hatch or Wall near Ladder

\*\*END OF SECTION\*\*

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WESTERN NAVAJO PIPELINE PHASE 1

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BODAWAY-GAP WELL, STORAGE TANK AND PIPELINE

DIVISION 11

EQUIPMENT

11000	General Requirements for Equipment
11727	Chlorine Gas Feed System

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## SECTION 11000

### GENERAL REQUIREMENTS FOR EQUIPMENT

#### PART 1--GENERAL

##### 1.01 DESCRIPTION

###### A. SCOPE:

This section specifies general requirements which are applicable to all mechanical equipment. The CONTRACTOR is responsible for ensuring that all mechanical equipment meets the requirements of this section in addition to the specific requirements of each individual equipment specification section.

###### B. EQUIPMENT LISTS:

Equipment lists, presented in these specifications and as specified on the drawings, are included for the convenience of the CONSTRUCTION MANAGER and CONTRACTOR and are not complete listings of all equipment, devices and material required to be provided under this contract. The CONTRACTOR shall prepare his own material and equipment takeoff lists as necessary to meet the requirements of this project manual.

##### 1.02 QUALITY ASSURANCE

###### A. ARRANGEMENT:

The arrangement of equipment shown on the drawings is based upon information available to the OWNER at the time of design and is not intended to show exact dimensions conforming to a specific manufacturer. The drawings are, in part, diagrammatic, and some features of the illustrated equipment installation may require revision to meet actual submitted equipment installation requirements; these may vary significantly from manufacturer to manufacturer. The contractor shall, in determining the cost of installation, include these differences as part of his bid proposal. Structural supports, foundations, connected piping, valves, and electrical conduit specified may have to be altered to accommodate the equipment provided. No additional payment shall be made for such revisions and alterations.

###### B. REFERENCES:

This section contains references to the documents listed below. They are a part of this section as specified and modified. Where a referenced document cites other standards, such standards are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). 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, regardless of whether the document has been superseded by a version with a later date, has been discontinued or has been replaced.

Reference	Title
ABMA Std 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA Std 11	Load Ratings and Fatigue Life for Roller Bearings
ANSI B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ANSI B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Gray Iron Pipe Flanges and Flanged Fittings, (Classes 25, 125, and 250)
ANSI B18.2.1	Square and Hex Bolts and Screws (Inch Series)
ANSI B18.2.2	Square and Hex Nuts (Inch Series)
ANSI S2.19	Mechanical Vibration – Balance Quality Requirements of Rigid Rotors, Part 1: Determination of Permissible Unbalance, Including Marine Applications

C. UNIT RESPONSIBILITY:

The CONTRACTOR shall cause equipment assemblies made up of two or more components to be provided as a working unit by the unit responsibility manufacturer, where specified. The unit responsibility manufacturer shall coordinate selection, coordinate design, and shall provide all mechanical equipment assembly components such that all equipment components furnished under the specification for the equipment assembly, and all equipment components specified elsewhere but referenced in the equipment assembly specification, is compatible and operates reliably and properly to achieve the specified performance requirements. Unless otherwise specified, the unit responsibility manufacturer shall be the manufacturer of the driven component equipment in the equipment assembly. The unit responsibility manufacturer is designated in the individual equipment specifications found elsewhere in this project manual. Agents, representatives or other entities that are not a direct division of the driven equipment manufacturing corporation shall not be accepted as a substitute for the driven equipment manufacturer in meeting this requirement. The requirement for unit responsibility shall in no way relieve the CONTRACTOR of his responsibility to the OWNER for performance of all systems.

The CONTRACTOR shall ensure that all equipment assemblies provided for the project are products for which unit responsibility has been accepted by the unit responsibility manufacturer(s), where specified. Unit responsibility for related components in a mechanical equipment assembly does not require or obligate the unit responsibility manufacturer to warranty the workmanship or quality of component products not manufactured by them. Where an individual specification requires the CONTRACTOR to furnish a certificate from a unit responsibility manufacturer, such certificate shall conform to the content, form and style of Form 11000-C specified in Section 01999, shall be signed by an officer of the unit responsibility 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.*

D. BALANCE:

Unless specified otherwise, for all machines 10 HP and greater, all rotating elements in motors, pumps, blowers and centrifugal compressors shall be fully assembled, including coupling hubs, before being statically and dynamically balanced. All rotating elements shall be balanced to the following criteria:

$$U_{per} = 6.015 \frac{GW}{N}$$

Where:

- $U_{per}$  = permissible imbalance, ounce-inches, maximum
- $G$  = Balance quality grade, millimeters per second
- $W$  = Weight of the balanced assembly, pounds mass
- $N$  = Maximum operational speed, rpm

Where specified, balancing reports, demonstrating compliance with this requirement, shall be submitted as product data. Equipment balance quality grade shall be  $G 2.5$  ( $G = 2.5$  mm/sec) or better in accordance with ANSI S2.19.

PART 2--PRODUCTS

2.01 FLANGES AND PIPE THREADS

Flanges on equipment and appurtenances provided under this section shall conform in dimensions and drilling to ANSI B16.1, Class 125. Pipe threads shall conform in dimension and limits of size to ANSI B1.1, coarse thread series, Class 2 fit.

Threaded flanges shall have a standard taper pipe thread conforming to ANSI B1.20.1. Unless otherwise specified, flanges shall be flat faced.

Flange assembly bolts shall be heavy pattern, hexagonal head, carbon steel machine bolts with heavy pattern, hot pressed, hexagonal nuts conforming to ANSI B18.2.1 and B18.2.2. Threads shall be Unified Screw Threads, Standard Coarse Thread Series, Class 2A and 2B, ANSI B1.1.

## 2.02 BEARINGS

Unless otherwise specified, equipment bearings shall be oil or grease lubricated, ball or roller type, designed to withstand the stresses of the service specified. Each bearing shall be rated in accordance with the latest revisions of ABMA Methods of Evaluating Load Ratings of Ball and Roller Bearings. Unless otherwise specified, equipment bearings shall have a minimum L-10 rating life of 50,000 hours. The rating life shall be determined using the maximum equipment operating speed.

Grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic alemite type.

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 60 degrees C and shall be equipped with a filler pipe and an external level indicator gage.

All bearings accessible to touch, and located within 7 feet measured vertically from floor or working level or within 15 inches measured horizontally from stairways, ramps, fixed ladders or other access structures, shall either incorporate bearing housings with sufficient cooling to maintain surface temperature at 65 degrees C or less for continuous operation at bearing rated load and a 50 degrees C ambient temperature or shall be provided with appropriate shielding shall be provided that will prevent inadvertent human contact.

## 2.03 V-BELT ASSEMBLIES

Unless otherwise specified, V-belt assemblies shall be Dodge Dyna-V belts with matching Dyna-V sheaves and Dodge Taper-lock bushings, Wood's Ultra V-belts with matching Ultra-V sheaves and Wood's Sure-Grip bushings, or equal.

Sheaves and bushings shall be statically balanced. Additionally, sheaves and bushings which operate at a peripheral speed of more than 5500 feet per minute shall be dynamically balanced. Sheaves shall be separately mounted on their bushings by means of three pull-up grub or cap tightening screws. Bushings shall be key seated to the drive shaft.



Belts shall be selected for not less than 150 percent of rated driver horsepower and, where two sheaves sizes are specified, shall be capable of operating with either set of sheaves. Belts shall be of the antistatic type where explosion proof equipment is specified.

## 2.04 PUMP SHAFT SEALS

### A. GENERAL:

Seals for water and wastewater pump shafts shall be mechanical seals. For industrial wastewater service, or for fluids other than water or municipal wastewater, the recommendations of the seal manufacturer shall be followed for selection of appropriate seals. Unless specified otherwise, stuffing boxes and mechanical seals shall conform to the requirements set forth in this paragraph.

### B. MECHANICAL SEALS:

Unless otherwise specified in the detailed pump specifications, mechanical seals shall be split mechanical seals requiring no field assembly, other than assembly around the shaft and insertion into the pump. They shall be self-aligning, and self-centering, single seals. They shall be of a nondestructive (non-fretting) type requiring no wearing sleeve for the shaft. Shafts for pumps specified with mechanical seals shall be furnished with no reduction in size through the seal area (no shaft sleeve). Where the detailed specifications call for cartridge instead of split seals, all other requirements of this paragraph apply.

Metal parts shall be Type 316 or 316L stainless steel. Springs shall be Hastelloy C, Elgiloy, or other Duplex SS selected for resistance to chloride attack. Rotary faces shall be silicon carbide or chrome oxide. Stationary faces shall be silicon carbide for solids bearing fluid service and carbon for clean water service. Elastomers shall be ethylene propylene or fluorocarbon. Mechanical seals shall be suitable for operation between full vacuum (0 psia) up to 200 percent of the maximum specified operating pressure, but in any event not less than 200 psig.

Seal chambers shall be provided with vented solids removal restriction bushings except for enclosed line shaft pumps where the seal barrier fluid is used for line shaft bearing lubrication. The bushing shall both control the amount of flushing water flow and restrict solids and gas accumulation from the seal face area.

Candidate seals include:

1. Chesterton 442 seals provided with Chesterton/SpiralTrac solids removal restriction bushings Version N or D, as recommended by EnviroSeal engineering Products, Ltd, Nova Scotia, Canada.
2. AESSEAL RDS seals with Cyclops bushing.
3. John Crane 3710 seals with Type 24SL bushing.

Seals on pumps for contaminated water service (sludge, grit, wastewater, scum, reclaimed water, etc.) shall be drilled and tapped for connection of a clean water flushing supply.

Seals for all vertical pumps (whether column or volute type) shall be provided with a second flush connection. Vertical pumps shall have a vent valve attached to the mechanical seal to eliminate air from the seal chamber prior to pump start; start-up procedures shall include venting instructions; and for remotely started pumps, the vent system shall be automated. Where specified in the detailed specifications, permissive confirmation automatic vent systems shall be provided.

#### C. SHAFT PACKING – NOT USED:

Where shaft packing is specified, stuffing boxes shall be tapped to permit introduction of seal liquid and shall hold a minimum of five rows of packing. Stuffing boxes shall be face attached. Stuffing box and shaft shall be suitable for field installation, without machining or other modifications, of the mechanical seal specified in paragraph 11000-2.04.B for the applicable pump and operating conditions.

Unless otherwise specified, lantern rings shall be bronze or Teflon, packing shall be die-molded packing rings of non-asbestos material suitable for the intended service and as recommended by the manufacturer, and glands shall be bronze, two piece split construction. Lantern rings shall be of two-piece construction and shall be provided with tapped holes to facilitate removal. Lantern rings shall be drilled and tapped 1/4 NC-20. The impeller end of the packing on all but line shaft pumps with external source water lubricated bearings shall be fitted with a SpiralTrac, Version P packing protection system as manufactured by EnviroSeal engineering Products, Ltd, Nova Scotia, Canada.

The section of each shaft or impeller hub that extends through or into the stuffing box shall be fitted with a replaceable stainless-steel sleeve with a Brinell hardness of not less than 500. The sleeve shall be held to the shaft to prevent rotation and shall be gasketed to prevent leakage between the shaft and the sleeve. Minimum shaft sleeve thickness shall be 3/8 inch.

#### 2.05 COUPLINGS

Unless otherwise specified in the equipment sections, equipment with a driver greater than 1/2 HP, and where the input shaft of a driven unit is directly connected to the output shaft of the driver, shall have its two shafts connected by a flexible coupling which can accommodate angular misalignment, parallel misalignment and end float, and which cushions shock loads and dampens torsional vibrations. The flexible member shall consist of a tire with synthetic tension members bonded together in rubber. The flexible member shall be attached to flanges by means of clamping rings and cap screws, and the flanges shall be attached to the stub shaft by means of taper lock bushings which shall give the equivalent of a shrunk-on fit. There shall be no metal-to-metal contact between the driver and the driven unit. Each coupling shall be sized and provided as recommended by the coupling manufacturer for the specific application, considering horsepower, speed of rotation, and type of service.

Where torque or horsepower capacities of couplings of the foregoing type is exceeded, Thomas-Rex, Falk Steel Flex, or equal, couplings will be acceptable provided they are sized in accordance with the equipment manufacturer's recommendations and sizing data are submitted. They shall be installed in conformance to the coupling manufacturer's instructions.

## 2.06 GUARDS

Exposed moving parts shall be provided with guards which meet all applicable OSHA requirements. Guards shall be fabricated of 14-gage steel, 1/2-13-15 expanded metal screen to provide visual inspection of moving parts without removal of the guard. Guards shall be galvanized after fabrication and shall be designed to be readily removable to facilitate maintenance of moving parts. Reinforced holes shall be provided. Lube fittings shall be extended through guards.

## 2.07 CAUTION SIGNS

Equipment with guarded moving parts which operates automatically or by remote control shall be identified by signs reading "CAUTION - AUTOMATIC EQUIPMENT MAY START AT ANY TIME". Signs shall be constructed of fiberglass material, minimum 1/8 inch thick, rigid, suitable for post mounting. Letters shall be white on a red background. The sign size and pattern shall be as shown on the drawings. Signs shall be installed near guarded moving parts.

## 2.08 GAGE TAPS, TEST PLUGS AND GAGES

Gage taps shall be provided on the suction and discharge sides of pumps, blowers and compressors. Pressure and vacuum gages shall be provided where specified. Gage taps, test plugs, and gages shall be as specified in Divisions 15 and 17, respectively.

## 2.09 NAMEPLATES

Nameplates shall be provided on each item of equipment and shall contain the specified equipment name or abbreviation and equipment number. Equipment nameplates shall be engraved or stamped stainless steel and fastened to the equipment in an accessible and visible location with stainless steel screws or drive pins.

## 2.10 LUBRICANTS

The CONTRACTOR shall provide for each item of mechanical equipment a supply of the required lubricant adequate to last through the specified commissioning period. Lubricants shall be of the type recommended by the equipment manufacturer and shall be products of the OWNER's current lubricant supplier. The CONTRACTOR shall limit the various types of lubricants by consolidating them, with the equipment manufacturer's approval, into the least number of different types. Not less than 90 days before the date shown in his construction schedule for starting, testing and adjusting equipment (Section 01660), the CONTRACTOR shall provide the OWNER with three copies of a list showing the required lubricants, after consolidation, for each item of

mechanical equipment. The list shall show estimated quantity of lubricant needed for a full year's operation, assuming the equipment will be operating continuously.

#### 2.11 ANCHOR BOLTS

Anchor bolts shall be 316 stainless steel and designed for lateral forces for both pullout and shear in accordance with the provisions of Section 05501. Unless otherwise stated in the individual equipment specifications, anchor bolt materials shall conform to the provisions of Section 05501.

#### 2.12 SPARE PARTS

Spare parts, wherever required by detailed specification sections, shall be stored in accordance with the provisions of this paragraph. Spare parts shall be tagged by project equipment number and identified by part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration, such as ferrous metal items and electrical components, shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with a hinged wooden cover and locking hasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts." A neatly typed inventory of spare parts shall be taped to the underside of the cover.

### PART 3--EXECUTION

Installation of equipment accessories included in this section shall be as recommended by the equipment manufacturer unless otherwise specified in the individual equipment specification section.

**\*\*END OF SECTION\*\***

## SECTION 11727

### CHLORINE GAS FEED SYSTEM

#### PART 1 GENERAL

##### 1.01 DESCRIPTION

###### A. SCOPE:

The chlorination system specified in this section shall be provided by a single supplier or manufacturer.

Provide the provide labor, materials, tools, equipment and services required to furnish, install and test the chlorination system as shown on the Drawings, as specified herein, and as required for a complete functioning system.

###### B. The chlorine gas feed system shall be a vacuum operated type consisting of:

1. Two (2) cylinder-mount standard (non-switchover) vacuum regulators for 150 lb cylinders. (Note – Cylinders are “West Coast”)
2. One (1) automatic switchover module.
3. One (1) injector with ¾” inlet/outlet connections
4. One (1) booster pumps sized appropriately for chlorine feed rates.
5. Pressure gauges for water line to/from booster pumps and to/from injectors.
6. Safety Equipment, Two (2) Self Contained Breathing Apparatuses (SCBAs) with 30 minute air tanks, and SCBA enclosure.
7. One (1) dual cylinder weight scale with 4-20 mA signal output.
8. Chlorine Residual Analyzer system.
9. One (1) Chlorine Gas Leak Detection system.
10. Necessary vacuum & vent tubing, fittings, and wrenches.

###### C. System shall have a maximum capacity of 25 pounds per day (PPD) of gaseous chlorine and sized to feed 10 PPD of chlorine for treatment residual application.

- D. System shall be manually controlled having a feed range of 20:1 and the capability to control within  $\pm 4\%$  of the indicated feed rate.

## 1.02 QUALITY ASSURANCE

### A. REFERENCE STANDARDS:

Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

1. Recommendations of The Chlorine Institute, Inc.
2. Occupational Safety and Health Act
3. Joint Industrial Council
4. Instrumentation, Systems, and Automation Society
5. International Building Code – 2006

### B. MANUFACTURER'S QUALIFICATIONS:

Equipment shall be the standard product in regular production by manufacturers of chlorination equipment and shall essentially duplicate equipment that has been in satisfactory operation in at least five (5) installations for a period of at least five (5) years.

The single supplier or manufacturer of the chlorination system will have to provide certain components, as noted, from other manufacturers in order to meet all the requirements of this Section.

## 1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300.

### A. SHOP DRAWINGS:

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 or those parts which are to be provided by the Contractor or others. 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 Engineer 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 shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.

2. A copy of the contract IHS/NTUA Standard Drawing No. W-15 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "*no changes required*". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
3. Marked product literature for all the devices and components. Include electrical connection diagrams.
4. Equipment wiring diagrams identifying internal and face mounted components and connections to remote equipment.
5. Pump motor data sheets.
6. Shop drawings indicating construction and installation details, a complete detailing of the materials construction and equipment weights.
7. Dimensioned drawings of all equipment and accessories as a complete system including cross-section views.
8. List of spare parts and maintenance items to be provided.

## PART 2 PRODUCTS

### 2.01 VACUUM REGULATORS

- A. The vacuum regulators shall be rated for 200 PPD of chlorine.
- B. They shall be designed to reduce full chlorine gas supply pressure to a vacuum without venting.

- C. A self-aligning yoke designed to Chlorine Institute recommendation per drawing 189 shall be provided as an integral part of the vacuum regulators.
- D. The units shall include a selector knob and icons to indicate the chlorine gas container status. Each regulator shall include easy to read indication of the following positions:
  - 1. Operating
  - 2. Empty
  - 3. Off
- E. An off position shall be provided to isolate the diaphragm and internal components from atmospheric air when the operator changes containers.
- F. Vacuum regulators shall contain internal pressure relief capability.
- G. Vacuum regulators shall not include automatic switchover capability (non-switchover).
- G. The check valve assemblies shall close in the event of leakage past the primary valve.
- H. Vacuum regulators shall be Siemens (Wallace and Tiernan) S10K or approved equal.
- I. Regulators for 150 lb. cylinders shall be cylinder mounted.

## 2.02 AUTOMATIC SWITCHOVER

- A. A remote automatic switchover module shall be furnished to change over to new supply as the on-line supply is depleted.
- B. Switchover shall be equipped with manual release handle for manual switchover.
- C. Switchover shall be non-isolating, such that when the switchover is accomplished gas shall continue to be drawn from the former source until the container is empty.
- D. Switchover shall be wall or panel mounted and have easy to read indication for indication of operation status, including indication of which source is active.
- E. Switchover shall be Siemens (Wallace and Tiernan) Series 55-410 or pre-approved equal.



## 2.03 ROTAMETER

- A. Rotameter shall have needle valve type or v-notch type rate control, with manually adjustment capability.
- B. Rotameter shall be Siemens (Wallace and Tiernan) S10K or approved equal.
- C. Solenoid valves shall be 2-way, direct acting, and shall be suitable for chlorine gas vacuum service. Valves shall be ½-inch and operate at negative pressure and up to 120 degrees F. Unpowered position shall be normally closed. Power requirement shall be 110 VAC.

## 2.04 INJECTORS

- A. The gas feed system shall have one PVC 3/4" fixed throat injectors to generate the operating vacuum for the system.
- B. The injector shall be capable of feeding against a backpressure of 130 PSI with a projected operating pressure of 265 PSI, and a projected flow rate of 3 gpm to provide sufficient vacuum to inject up to 10 PPD chlorine gas. Contractor to verify well production flow rate and backpressure with Engineer during submittal process for selection of injector.
- C. Injector shall include built-in double check valve protection to prevent water from back flooding into the vacuum regulator.
- E. A corp stop type injection quill for diffusing the chlorine solution created in the injector into the water piping, as shown in the project drawings shall also be furnished as a part of this system.
- F. The injector shall be mounted directly on the injection quill. See Contract Drawings Standard Drawing No. W-15.
- G. Injector shall be capable of mounting in either the vertical or horizontal plane.
- H. Injector shall be Siemens (Wallace and Tiernan) S10K 3/4" Standard Injector or approved equal.

## 2.05 CHORINE INJECTOR SOLUTION BOOSTER PUMPS

- A. The chlorine injector solution booster pump shall be Jacuzzi brand or approved equal. Contractor to size booster pump based operating pressure and flow rate required to provide sufficient vacuum for injector.

## 2.06 PRESSURE GAUGES, WATER/SOLUTION SERVICE

- A. The pressure gauges for suction/discharge ends of the injector shall be 2 inch, 270-degree movement and suitable for stem mounting. The pressure gauges shall have a 1/4 inch NPT process connection.

## 2.07 SAFETY EQUIPMENT

An emergency repair “Kit A” for 150 lb chlorine cylinders shall be supplied.

## 2.08 SELF CONTAINED BREATHING APPARATUS (SCBA)

The SCBA shall be an MSA Workmask, or approved equal, suitable for use with chlorine gas, with 30-minute air tank.

## 2.09 SCBA ENCLOSURE

The wall mounted enclosure for the 30 minute SCBA shall be constructed of fiberglass reinforced plastic (FRP).

## 2.10 CHLORINE CYLINDER SCALE

- A. Chlorine cylinder scales shall be the CHLOR-SCALE model 150<sup>®</sup> with TUF-COAT<sup>™</sup> coating and SOLO<sup>®</sup> G2 digital display, as manufactured by Force Flow Equipment or approved equal. A quantity of one set of dual chlorine cylinder scales shall be provided as a part of the chlorination system and shall be of the digital readout/electronic load cell type. Scale platforms shall be constructed of non-corrosive PVC plastic and sized to accept 150 lb. chlorine cylinders up to 10.5 inches in diameter. Platform height shall be no more than 1 5/8 inches higher than height to allow easy handling and unloading of cylinders. Platform scale coating system shall be a minimum dry thickness of 80 mils and be resistant to moisture, chemicals, abrasion, impact and UV light. Full scale accuracy shall be < 1%.
- B. Scale shall be of the single load cell design. Weight shall be transferred via a pivoted platform to a single stainless steel canister load cell of the electronic strain gauge type. Load cell shall be mechanically sealed with o-rings. Potted-type load cells shall not be accepted. Flexible cable shall connect load cell to indicator to allow easy remote installation of the readout. Cable length shall be 10 feet. Cylinder chaining bracket shall be wall mounted and use a double coil chain and a spring loaded snap hook to sure cylinder. Chaining bracket shall have an integral tool rack for storing cylinder change-out tools.
- C. A remote mounted 4½ digit LCD indicator shall be housed in a NEMA 4X, UL approved enclosure. LCD Indicator shall be backlit with .5" characters for ease of readability in low light conditions. To allow indication of net weight, indicator

shall be equipped with a sealed ten-turn knob for tare adjustment. Indicator shall output net weight via a 4-20mA signal for remote monitoring. Indicator shall have two adjustable set points for alarms or liquid level control. Set points shall activate (2) 1/2A dry contact relays. Power: 115 Vac.

- D. Scales shall carry a Full Five (5) Year Factory Warranty. “Limited” Warranties shall be considered unacceptable.

## 2.11 CHLORINE RESIDUAL ANALYZER

### A. GENERAL:

An on-line chlorine analyzer shall be provided to continuously measure free chlorine residual. Each chlorine monitor shall consist of a direct measuring chlorine sensor, flow cell, sensor interconnect cable with quick disconnect plug, and an electronic monitor housed in a NEMA 4X enclosure suitable for wall, pipe, or panel mounting.

Accuracy:  $\pm 0.02$  ppm or 0.5% of full scale. Range 0 – 5.00 ppm.

### B. FREE CHLORINE MONITOR:

Chlorine sensor shall be a direct measuring polarographic sensor utilizing a special polymeric membrane to isolate the sensing electrodes from the sample and eliminate the potential for electrode contamination. The membrane shall allow chlorine to diffuse into the sensor where it shall react with the sensing electrode, generating a signal that is linearly proportional to chlorine concentration.

Chlorine sensor shall be constructed with a quick disconnect receptacle to allow easy sensor servicing or exchange. Chlorine sensor shall be furnished for insertion installation. The sensor assembly shall also contain a precision RTD temperature sensor to continuously measure sample temperature to allow temperature compensation of the measured chlorine value.

### C. CHLORINE INDICATING ANALYZERS:

The chlorine analyzer shall provide an AC powered instrument for operation on 115 VAC single-phase line power. The monitor shall provide two isolated 4-20 mA outputs configurable for chlorine, temperature, pH or PID control. Analog outputs shall be both ground isolated and isolated from each other.

Chlorine analyzers shall also contain two SPDT relays. Relays shall be programmable for either control or alarm function, or relays may be assigned to diagnostic functions for use in indicating trouble conditions at a remote location.

Diagnostic functions shall be incorporated into the transmitter. The 4-20 mA output shall be capable of being assigned to safely rise to 20 mA, fall to 4 mA, or be left alone, during diagnostic failures. Diagnostic error messages shall be displayed in clear language; no confusing error codes shall be displayed.

Provide output hold and output simulate functions to allow for testing or remote receiving devices or to allow maintenance without disturbing control systems.

E. CALIBRATION TOOL:

1. Provide photometer or color disk kit to use in calibration, Hach CN-66F, or equal.

2.12 CHLORINE GAS LEAK DETECTOR

A. SYSTEM PERFORMANCE REQUIREMENTS:

The chlorine gas detection system shall measure and display gas concentration and provide alarms when preset limits are exceeded in Chlorine Room. The system shall consist of a NEMA 4X alarm module and a remote mounted gas sensor/transmitter.

The gas leak detection system shall meet the following performance requirements:

1. Power Supply Module Requirements:
  - a. Input: 115 VAC, 60 Hertz with battery back-up
  - b. Output: Regulated, 13.7 VDC, 1A
2. Operating Temperature Range: -40° to 55° C.
3. Relative Humidity Rating: 0-99% non-condensing.
4. Enclosures (Sensors and Monitor/Transmitter): Corrosion Resistant, NEMA 4X designed for wall mounting, UL approved.
5. Gas Measuring Ranges:
  - a. Standard Range: 0-10 ppm.
6. Accuracy:  $\pm 5\%$  of reading.
7. Repeatability:  $\pm 2\%$  of reading.

B. RECEIVER MODULE:

Receiver module shall provide a high intensity digital LED display of gas concentration, plus alarm indicator LED's for Warning, Alarm, and Trouble. Two programmable alarm setpoints shall be provided for warning personnel of differing levels of leakage. Gas leak alarms shall be indicated by flashing LED indicators on the alarm receiver.

The concentration of the gas shall be displayed directly in PPM units. Three alarm relays shall be provided for external alarming functions. Each alarm relay shall be independently assignable to either the low or the high alarm setpoint, and shall also be programmable for latching and/or fail-safe operation.

Alarm module shall consist of a NEMA 4X enclosure containing one modular receiver, and one power supply. The enclosure shall contain a hinged window to allow access to controls without tools, and shall be suitable for wall or surface mounting.

Each receiver shall provide an isolated 4-20 mA output signal proportional to gas concentration, and shall also contain remote reset input terminals to allow alarm acknowledgment from a remote location.

1. Alarms: Two adjustable concentration alarms, set point adjustable from 5-100%.
2. Alarm indication: High Intensity LED Bars for Warning (low setpoint) and Alarm (high setpoint). Indicators shall operate as follows:
  - a. Warning level indicator shall be non-latching.
  - b. Alarm level indicator shall be latching.
3. Alarm relays: Three assignable alarm relays.
  - a. Functions: Each relay shall be user-assignable for either "alarm" setpoint level (warning or alarm), and shall be configurable for normal/fail-safe, and latching/non-latching, and fast/slow operation.
  - b. Contact Rating: 10A at 120 VAC.
4. Trouble Alarm: Front panel LED indicator and SPDT, factory set for fail-safe operation.
  - a. Functions: Indicates loss of sensor/transmitter input or failure of sensor.
  - b. Contact Rating: 10A at 120 VAC.

5. Gas Alarm Beacon: Red rotating flashing beacon to indicate gas leak mounted outside the building at the entrance door and a warning sign not enter and to call NTUA when Beacon is flashing – indicating a gas leak.

C. POWER SUPPLY:

The power supply in the receiver module shall be a modular design providing DC power to up to two receiver modules. A third DC output shall be provided to float charge a standby battery system to provide battery backup to the entire detection system in the event of power failure. The power supply shall operate from 115 volts AC, without adjustment, and shall also contain a power failure relay for remote power failure indication.

Battery backup module shall be housed in a NEMA 4X enclosure and shall be suitable for operating the detector for at least 4 hours in the event of power outage. Battery backup units shall contain protective circuitry to isolate the battery in the event that battery voltage drops to levels where battery damage might result.

D. ACCEPTABLE PRODUCT:

The chlorine gas detector shall be Siemens (Wallace and Tiernan) or approved equal.

## 2.13 SPARE PARTS

Provide the following spare parts with the chlorine gas feed system:

1. One (1) spare booster pump (for booster pump).
2. One (1) spare educator/injector assembly.
3. One (1) spare pressure gauge (for each pressure range).
4. Three (3) spare solenoid valves.
5. One (1) spare rotameter.
6. One (1) complete set of all special tools required for maintenance of chlorine gas leak detection equipment.

Provide the following for each chlorine sensor provided with chlorine residual analyzer:

1. Ten (10) spare membranes or one spare complete sensor
2. Electrolyte, if applicable
3. Spare parts kit that includes all o-rings and special hardware

## 2.14 PRODUCT DATA

Provide the following in accordance with the requirements of Section 01300.

1. Manufacturer's operation and maintenance information as specified in Section 01730, including:
  - a. Final reviewed submittal.
  - b. Record of Analyzer configuration settings.
2. Installation forms specified in Part 3.
3. Training forms specified in Part 3.
4. Training information as specified in Section 01664

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. The equipment shall be installed per the contract documents and manufacturer's recommendations.
- B. Configure the leak detector leak alarm to be fail-safe and closed under normal conditions.

### 3.02 FIELD SERVICES

- A. A factory trained technician shall provide up to eight on-site hours of start-up and training service for this system. Training shall be per Section 01664.
- A. A factory trained technician shall provide monthly on-site analyzer calibration and chlorinator adjustment service for one year from date of initial service. Service to be scheduled in advance with and witnessed by NTUA Operations personnel.

### 3.02 WARRANTY

- A. In addition to the requirements of General Conditions, the equipment/system warranty, unless otherwise stated, shall be one year from start-up or 18 months after shipment.

**\*\* END OF SECTION\*\***

Chlorine Gas Feed System  
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Bodaway – Gap Contract 2  
Bid Issue

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Chlorine Gas Feed System  
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Bid Issue



Navajo Nation  
WESTERN NAVAJO PIPELINE PHASE 1

BC PROJECT NO.: 150360

BODAWAY-GAP WELL, STORAGE TANK AND PIPELINE

DIVISION 13

SPECIAL CONSTRUCTION

13201      Welded Steel Water Storage Tank

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SECTION 13201

WELDED STEEL WATER STORAGE TANK

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

The Contractor shall be responsible for all labor, materials and equipment necessary for the design, fabrication, construction, painting, and disinfection and testing of a welded steel water storage tank.

Design and construction of the welded steel tank shall conform to all requirements of AWWA D100 Standard for Welded Carbon Steel Tanks for Water Storage, except as modified by the requirements of these Contract Documents.

B. WATER STORAGE TANK NO. 2 DESIGN:

The Water Storage Tank dimensions shall be as required to provide 83,000 gallons of tank operational volume (Low Water Level to High Water Level) with a maximum tank diameter of 30 feet and a maximum height of 16'-0". Unless otherwise specified, the Water Storage Tank shall be a ground (concrete pad)-supported steel tank with a sloped internal concrete floor to the center of the tank. It shall have a self-supported dome room as specified. Design of the tank shall comply with AWWA D100 and Navajo Tribal Utility Authority (NTUA) standards. The effects of an oscillating water surface in the tank shall also be taken into account. The drawings of the steel reservoir are intended to define general dimensional requirements and tank configuration. Inlet, outlet, and overflow configuration shall be as shown in the drawing. The Contractor shall design the reservoir and all required structural supports and stiffeners in accordance with the requirements contained herein. Design calculations shall be provided in sufficient detail to indicate the procedures used, signed by a structural or civil engineer licensed to practice in the State of Arizona. The reservoir shall be anchored to the concrete pad with stainless steel anchor bolts.

C. DESIGN CRITERIA – WATER STORAGE TANK NO. 2:

Diameter 30 feet maximum

Straight Shell Height 16'-3" maximum

Welded Steel Water Storage Tank

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Roof Live Load	15 psf
Roof Snow Load	25 psf
Wind Velocity	125mph
Exposure category	C
Importance factor	1.15
Winter Design Temperature	15 degrees F
Allowable bearing pressure <sup>1</sup>	3,000 psf

Note 1: 1/3 stress increase is allowed for wind and seismic loads.

D. SEISMIC DESIGN:

The Contractor shall design the tank, foundation and accessories in conformance with AWWA D100, Section 13, modified as specified herein with the following data to determine the minimum strength requirements of the tank for seismic design.

- a. Seismic Design Category C .
- b. Seismic Use Group III.
- c. Seismic Importance Factor,  $I_E = 1.50$ .
- d. Site Class . D
- e.  $S_{DS} = 0.343g$  ;  $S_{D1} = 0.158g$
- f. Vertical acceleration: 25 percent of horizontal. Combine with horizontal acceleration. Contractor shall verify.
- g. Freeboard: Contractor to calculate earthquake wave (sloshing) height and adjust height to accommodate design.
- h. Combine hoop stresses by root mean square.
- i. Pressure stability: Do not consider for seismic loading.

E. WIND DESIGN

Design the tank per wind criteria shown on drawing S-001, AWWA D100. Tank shall be designed for maximum wind speed at tank empty condition.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). 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, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AISI	Pocketbook of AISI Standard Steels
ASTM A36/A36M	Structural Steel
ASTM A283/A283M	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes, and Bars
ASTM D1751	Preformed Expansion Joint Filler for Concrete Paving and Structural Construction
AWWA B300	Hypochlorites
AWWA B301	Liquid Chlorine

Reference	Title
AWWA C504	Rubber Seated Butterfly Valves
AWWA C652	Disinfection of Water Storage Facilities
AWWA D100-11	Welded Steel Tanks for Water Storage
UL 96A	Installation Requirements for Lightning Protection Systems, Ninth Edition
NTUA	Navajo Tribal Utility Authority

## 1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

1. **Specification Compliance Statement.** 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 Engineer 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. **Qualifications Statements.** Provide proof of qualifications in the form of copies of licenses, registrations, and certifications as applicable to the profession of the individual or organization. For Contractor, Contractor's tank design engineer, welders, and independent inspection and testing company, provide name, company name, address, and a description of past experience with work like that to be performed under this contract.
3. **List, by product name and number, of standard manufactured items or equipment not fabricated by the tank constructor.**
4. **Product information, including manufacturer's catalogues, technical data, parts lists, materials lists, operation and maintenance manuals, for standard manufactured items or equipment not fabricated by the tank constructor.**
  - a. All tank accessories including access hatches, ladders, vents, hatches, etc.
  - b. Fall protection equipment.
  - c. Piping expansion joints.
    1. Affidavit of compliance with AWWA C221.
  - d. Piping support and seismic restraint system components.
  - e. Electrical system components.
5. **Design Information.** Design drawings and calculations shall provide information needed for fabrication, layout and erection. Design

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calculations shall be in sufficient detail to indicate the procedures used, including the design coefficients, loads and methods. All drawings and calculations shall be sealed by a registered Professional Structural Engineer in the State of Arizona. At a minimum, design drawings shall include the following:

- a. Project location,
- b. Reservoir shape,
- c. Dimensions,
- d. Supports and seismic restraints for the piping,
- e. Locations of all access hatches, doors, and wall penetrations
- f. Location and design of internal ventilation system
- g. Locations and dimensions of all piping and conduits
- h. Electrical and lighting plans
- i. Personnel access door details
- j. Access ladders and fall protection system
- k. Sloped concrete flooring system.
- l. Sacrificial anode cathodic protection system.
- m. Exterior insulation and cladding

At a minimum, design calculations and design standards shall include the following:

- a. Structural calculations for the tank structure and all appurtenances demonstrating compliance with applicable standards
  - b. Component parts and materials of the steel tank and support structure including:
    1. Welded joints,
    2. Accessories,
    3. Piping,
    4. Anti-vortex devices,
    5. Pipe penetrations,
    6. Supports,
    7. Seismic restraints for piping systems,
    8. Pipe connections, and
    9. Electrical lighting and receptacle system.
    10. Sloped concrete flooring system.
    11. Sacrificial anode cathodic protection system.
    12. Exterior insulation and cladding.
6. Schedule of radiographic inspection locations prior to tank construction. A written report of shop and field inspections completed during construction fabrication including weld joint records, radiographic film and test segments shall be delivered to Owner.
7. Construction Schedule: Schedule shall be provided for all component parts, accessories and piping. All components that require extended lead



times shall be identified. At a minimum the schedule shall incorporate the following activities:

- a. Shop fabrication of plate steel components
- b. Shop application of coatings
- c. Foundation construction
- d. Tank and support structure erection
- e. Field coatings
- f. Disinfection and testing
- g. Inspection milestones by tank manufacturer, and Engineer
- h. Weather limitations for field construction

Note that upon construction additional data/inspection information is required for submittal per Section 2.07.

#### 1.04 QUALIFICATION OF MANUFACTURER

The design and construction of the water storage tank shall be completed by a Contractor with a minimum of five years experience with the design and construction of welded steel tanks, depending on the final tank type selected by the Owner. The Contractor must be able to demonstrate experience through the design and construction of at least three similar type and sized water tanks.

#### 1.05 QUALITY CONTROL

- A. **INSPECTION AND TESTING:** Inspection of shop and field welds shall be in accordance with AWWA D100. All inspection shall be performed prior to interior and exterior field painting. Radiographic inspection shall be performed by an independent testing agency with all costs included in the Contractor's bid and paid by the Contractor.

The Owner has the option to provide the services of an Owner's Representative who will review the inspection and testing records and reports, and who may duplicate some of the inspection activities to confirm quality control information. Inspections may be waived only by written notice from the Engineer to the Contractor.

- B. **CONTRACTOR'S ACTIVITIES:** The Contractor will provide the services of an independent commercial inspection and testing company to perform inspections and tests required to demonstrate substantial compliance with specifications for all phases of work, including layout, assembly, welding, erection and water-tightness (leak testing).

1. **WELDING INSPECTION AND TESTING:** Radiographic testing of welds will be used in all cases where feasible. A written report of shop inspections and testing shall be prepared for submittal. The Contractor shall

demonstrate weld quality by obtaining and evaluating radiographs prepared using the X-ray or Gamma Ray method. The basic testing schedule shall be:

- a. Full radiograph of the first 10 feet of each type of joint welded by each welder. Obtain acceptable results before allowing welder to continue work on the project, and submit radiographs and acceptable results to Engineer within 1 week of testing.
  - b. One spot radiograph for:
    1. Each 50 linear feet of shell well subject to primary stress.
    2. Each 100 linear feet of shell well subject to secondary stress.
    3. Thirty percent of weld junctions.
    4. When unacceptable sections of weld are discovered, the Engineer may direct additional radiographs be taken to determine the extent of deficiency and to establish that which joints elsewhere are not deficient. In such situations, additional radiographs will be at no additional compensation.
  - c. Obtain and evaluate radiograph tests uniformly as construction progresses. Review results with the when welding is approximately 25, 50, 75 and 100 percent complete.
  - d. Minimum length of spot radiographs shall be 16 inches.
  - e. Use two penetrometers for each film, placed at end of exposure adjacent and parallel to weld.
  - f. Fluorescent type (calcium tungstate) screens are not acceptable. Use lead screen type.
  - g. Use fine-grain or extra-fine-grain film. Coarse-grain, high-speed film is not acceptable.
  - h. Unsatisfactory radiograph results indicate inferior workmanship that Contractor shall repair at no additional compensation.
  - i. Repaired welds shall be 100 percent radiographed.
  - j. Prepare a shell plate diagram to indicate radiograph locations. Submit diagram and radiograph films to Engineer.
2. **LEAK TESTING:** Leak testing shall occur after completing assembly, welding and erection of the tank and support structure, and before applying field coatings on the tank. If leaks are discovered, Contractor shall complete weld repairs as specified in AWWA D100 (Section 11.11 and 11.12.2), retest, and repeat as necessary until no leakage exists. Repeated leak testing and repairs shall be completed by the Contractor for no additional compensation.
  3. **HYDROSTATIC TESTING:** Hydrostatic leak testing shall be conducted on tank weld joints at and below the operating high water level (HWL).

Hydrostatic leak testing shall conform to the requirements of AWWA D100 (Section 11.12.2), as modified in this section.

- a. The Owner will supply the potable water for one tank fill. Subsequent fills will be purchased from the Owner at a cost of \$2.50 per 1,000 gallons.
  - b. The Contractor shall fill the tank to the overflow level and hold for a minimum of 24 hours before searching for leaks.
  - c. The Contractor shall dispose of leak test water in the evaporation pond adjacent to the site and in accordance with State and local regulations. Chlorine residual in the water shall be completely neutralized prior to discharge.
4. **DISINFECTION:** The contractor shall flush and disinfect the tank and all appurtenances in contact with the stored water in accordance with ANSI/AWWA C-652. Chlorine residual in the water shall be completely neutralized prior to discharge.
5. **DEMONSTRATION:** After all work has been completed, all inspection reports and test data are acceptable, and the tank system is otherwise ready for service, the Contractor shall demonstrate tank operation and performance as follows:
- a. With the water level in the tank at overflow elevation, the Contractor shall operate the treatment system to deliver the design waste washwater (BWW) flow rate specified.
  - b. With the water level in the tank at overflow elevation, the Contractor shall open the sludge lines (S) connected to the tank to demonstrate the hydraulic capacity and mixing of the sludge mixing system.
  - c. With the water level in the tank at overflow elevation, the Owner shall open the reclaim water line (RWR) to demonstrate the hydraulic capacity of the return water piping system.
  - d. With the water level in the tank above the overflow elevation, the Contractor shall demonstrate the hydraulic capacity of the overflow piping (OF) system.
  - e. Demonstrate acceptable access to and operation of all ladders, fall protection equipment, doors, manholes, hatches and covers.
  - f. Satisfactorily operate all mechanical accessories, including valves, vents, doors, etc.

- g. Demonstrate that all instrumentation has been installed, calibrated, and is reading correctly.

#### 1.06 TANK NO. 2 DETAILS

The tank shall be all-welded steel construction. All members of structural steel shall be designed to safely withstand the maximum stresses to which they may be subjected during erection and operation.

- A. Tank Operational Capacity. The operational capacity of the tank, from the lower operation water level (LWL) to the upper operation water level (HWL), shall be 83,000 gallons.
- B. Inlet:
  - 1. Nominal Pipe Size: 10 inch
  - 2. Capacity: 640 gpm
- C. Overflow:
  - 1. Nominal Pipe Size: 10 inch
  - 2. Capacity: 640 gpm
- D. Outlet:
  - 1. Nominal Pipe Size: 10 inch
  - 2. Capacity: 640 gpm
- E. Drain:
  - 1. Nominal Pipe Size: 10 inch
  - 2. Capacity: 640 gpm

#### 1.07 PERMITS AND UTILITIES

Project related permits and licenses required for the construction of the Tank No. 2 and associated work shall be obtained by the Contractor.

The Contractor tank design drawings shall clearly indicate the approximate location of all equipment and material lay down areas. Existing overhead electrical lines, underground utilities and piping are present at the site. Contractor is responsible for protecting existing utilities and relocating utilities if they interfere with the safe construction of the tank and support slab. Contractor shall coordinate all work and any required utility shutdowns with the Owner.

## PART 2--PRODUCTS

### 2.01 GENERAL

Unless otherwise specified, materials and construction shall conform to AWWA D100. Steel plates shall conform to ASTM A283 and structural shapes shall conform to ASTM A36. Submerged bolts shall be Type 304 stainless steel and all other bolts shall be galvanized unless otherwise noted on the drawings.

#### A. LOADS

1. Seismic Loads – All members of structural steel and reinforced concrete shall be designed to safely withstand the maximum stresses to which they may be subjected as a result of seismic action. See Specification 01900 for seismic design parameters.
2. Wind Loads - Wind pressure shall be determined in accordance with AWWA D100.

### 2.02 SHELL

Welded Steel Tank: Shell plates shall be cold rolled to the tank radius prior to the removal of mill scale. Horizontal and vertical joints shall be butt welded on each side with full penetration. If structural bracing of the shell is required, these members shall only be placed on the inside of the shell. Shell plates shall include all vertical plates.

Shell shall be insulated with 2-inches of polyisocyanurate foam with 0.024 inches of standard embossed aluminum cladding.

### 2.03 ROOF, ROOF COLUMNS, RAFTERS, AND GIRDERS

Roof support system members for the welded steel tank shall be provided whose slope and layout facilitates cleaning and preparation for application of protective coatings. Columns shall be circular with section properties not less than those of a 6-inch-diameter standard pipe section. The column baseplate shall not be welded to the floor plates but held in position by angles or other stops welded only to the floor plates at ends of a plate diagonal. Shims shall be provided under baseplate to provide uniform bearing where column baseplate overlaps a lap seam in the floor plates.

### 2.04 ACCESSORIES

#### A. SHELL MANHOLES AND HANDHOLES:

Shell manholes shall be 30 inches in diameter, as indicated on the drawings, and shall be hinged to the shell. Manholes shall be gasketed and watertight.

**B. PIPE CONNECTIONS:**

All pipe and pipe connections shall be constructed to the limits specified. Pipe connections shall be provided per AWWA D100 (Section 13.5). Penetrations of shell shall not be less than 12 inches clear above bottom. Steel pipe supports for piping inside the tank shall be designed and installed per the tank manufacturer's recommendations.

**C. OVERFLOW PIPE:**

The tank shall have an overflow pipe as specified and shown on the drawings. The overflow pipe shall be designed for a flow rate of 660 gallons per minute. Overflow capacity shall be provided with no more than 3 inches of weir crest height.

**D. INTERNAL AND EXTERNAL LADDERS:**

The tank shall have one external ladder meeting the requirements of AWWA D100 or AWWA D103. The external ladder shall be provided with a Saf-T-Climb device as manufactured by North Safety Products, or approved equal. The exterior ladder shall be carbon steel, painted, and provided with a gate with locking mechanism and padlock as shown on the drawings. Ladders shall comply with OSHA and NTUA requirements.

**E. ROOF HATCH:**

The 2' by 2' roof hatch shall be aluminum with steel hinges and locking hasps. The manufacturer shall provide compression spring operators enclosed in telescopic tubes to provide smooth, easy, and controlled cover operation throughout the entire arc of opening and closing. The hatch opening shall have a 4-inch high curb and the hatch cover shall lap the curb by 2 inches. Roof hatch shall be lockable and be provided with an intrusion sensor/alarm to NTUA's SCADA system.

**F. VENT:**

A tank vent shall be provided as shown on the drawings. The vent shall contain removable panels with bronze screen and fiberglass insect mesh.

G. PLATFORM:

The reservoir shall have a landing platform and handrails at the top of the ladder.

H. GAGE BOARD:

The Tank No. 2 shall have a gage board assembly. Gage board assembly shall be a target-reading type liquid level indicator. Gage board assembly shall have an accuracy of plus or minus 1/10 foot.

The indicator shall have an anodized aluminum gage board graduated in feet and tenths and shall extend from the base of the reservoir to the top of the reservoir wall. Gage board shall have black numbers and marks on a white background. The pointer shall be cast iron, colored red, and shall travel in the same direction as the liquid in the reservoir. Pointer shall have two guide wires. Assembly shall have a guided float with two top and bottom anchors, sheave elbows, guides, clamps, and other appurtenances. Sheave anchors shall have a steel housing, adjustable spring rod with cadmium-plated steel spring. Bottom anchor shall be steel. Float and guide wires, pointer guide wires, and wire fasteners shall be 316 stainless steel. Pipe between elbow sheaves and the tank and indicator board shall be 1-1/2-inch galvanized steel. Top of the indicator board shall have an iron cap with a drilled brass bolt guide for guiding the pointer wire. Brackets shall be steel. Indicator shall be equipped with a Type 304 stainless steel pull chain. Gage board shall be Varec 6700 series, or equal.

I. LEVEL INDICATOR TRANSMITTER:

Provide a 6-inch flange connection on top of the tank for a level indicator transmitter for level measurement (level indicator transmitter details specified in 11830). The flange connection shall be a maximum of 6-inches above the tank roof and within access of the platform and walkway.

J. EXPANSION JOINT FILLER:

Reformed expansion joint filler shall be ASTM D1751, nonextruding, resilient bituminous type, except strips utilizing cork shall not be used. Cane or other cellular fibers uniformly saturated with asphalts shall be provided.

K. BITUMINOUS MASTIC:

Bituminous sealant shall consist of Henry's 204 as manufactured by Henry Company, APCO 100, Marvin, or equal.

L. (NOT USED)

M. DAVIT CRANE (NOT USED)

N. SAFETY:

1. GENERAL: Safety devices shall be as specified in AWWA D100 and OSHA.
2. FALL PROTECTION: All ladders shall be equipped with a fall arrest system meeting OSHA regulations. The system shall be supplied complete with rigid metal climbing column, top and bottom mounting brackets, intermediate brackets, sliding clamps, safety harnesses, locking mechanisms, lanyards and accessories for three persons. Wire or cable climbing columns will not be acceptable. The climbing columns shall be constructed of the same material as the ladder. The sliding clamps shall be constructed of stainless steel.
3. RIGGING: Interior and exterior rigging devices shall be provided for painting, inspection and maintaining the structure and accessories. Pipe couplings with plugs in the roof or other similar features shall be furnished to provide means for attaching rigging and gaining access to the tank interior for painting, cleaning and inspection.

B. PROTECTION AND SECURITY:

1. PADLOCKS: The Contractor will provide padlocks (keyed to the Owner's requirements) for all locking hasps.

C. MISCELLANEOUS:

1. IDENTIFICATION PLATE: A tank identification plate shall be mounted near the personnel door on a bracket that projects approximately 1 inch out from the pedestal shell to allow for coating. The identification plate shall be stainless steel and provide information as follows:
  - a. Name of tank contractor/supplier
  - b. NTUA's project or file number
  - c. Tank capacity
  - d. Height to HWL
  - e. Date completed

## 2.05 FOUNDATION

Welded Steel Water Storage Tank  
13201-14

Bodaway-Gap Contract 2  
Bid Issue



The reservoir foundation shall consist of a reinforced concrete pad. Prior to construction, the Contractor shall submit final foundation loads and required tank anchorage criteria for review by the Engineer.

## 2.06 CATHODIC PROTECTION – SACRIFICIAL ANODE SYSTEM

The Contractor shall provide a cathodic protection system including the design, installation, materials, equipment, and testing for a sacrificial anode cathodic protection system to provide corrosion protection for the interior submerged surface of the tank. The design, materials, installation and testing shall conform to AWWA D-106-10.

## 2.07 PRODUCT DATA

The following information shall be provided in accordance with Section 01300:

1. Structural calculations of the reservoir and accessory items as specified in paragraph 13201-1.01 B.1.
2. Welding data tabulation and details of welded joints.
3. Erection drawings.
4. Mill test reports of all steel materials with a certification of which ASTM or other AWWA D100 required specification each meets.
5. Report of initial radiographs and evaluation for each weld as specified in paragraph 13201-3.02 A.
6. Report certifying the inspection per Section 11.2, AWWA D100 at the conclusion of the work.
7. Certificate of compliance with AWWA D100.

## PART 3--EXECUTION

### 3.01 CONSTRUCTION

#### A. GENERAL:

Unless otherwise specified, construction shall conform to AWWA D100.

#### B. ASPHALT-IMPREGNATED SAND CUSHION: (NOT USED)

C. WELDING:

1. Unless otherwise specified, all welding shall comply with AWWA D100.
2. Contractor-certified qualification records of the welders employed for erection shall be reviewed with the Engineer at the start of erection and each time a new welder is employed. The record for each welder shall indicate:
  - a. Date and result of qualification test.
  - b. Contractor conducting tests.
  - c. Identifying mark of welder.
3. All butt joints shall be provided with complete joint penetration welds.
4. Welding is not permitted when the temperature is less than 32 degrees F, nor during rain, snow, high winds, or when ice is on the metal. For plate thicknesses in excess of 1-1/2 inches, preheating is required when the metal temperature is less than 70 degrees F.

D. BOTTOM:

The tank bottom shall be assembled by the lap joint method of construction as specified in AWWA D100 for the welded steel tank.

E. JOINT FILLER, TANK NO. 2 BOTTOM TO CONCRETE FOUNDATION:

As recommended by the tank manufacturer, a preformed expansion joint filler or asphalt impregnated board shall be placed between the concrete foundation and the tank bottom. Expansion joint shall be sealed with bituminous mastic. Material furnished shall comply with ASTM D-994.

F. TANK NO. 2 COATINGS:

1. Welded Steel Tank: The tank shall be prepared and coated as specified in Section 09901. There is to be full containment within the project site of materials used in and resulting from the steel tanks surface preparation and painting.

### 3.02 WELD TESTING

#### A. SPOT RADIOGRAPHS:

1. During erection of the tank shell, spot radiographs in the first 10 feet of joint welded by each welder shall be obtained and evaluated. The radiographs and the evaluation shall be submitted to the Engineer within a week after the employment of each welder on the site.
2. A spot radiograph in each 100 feet of shell weld subject to primary stress, and in each 200 feet of shell weld subject to secondary stress, shall be obtained and evaluated. A record of the extent of repair of defective welds and the spot radiographs of repaired joints shall be maintained for review by the Engineer on the site and included in the report (per AWWA D100) at job conclusion. After acceptance of the structure, the radiographs or sectional segments shall become the property of the Owner.

#### B. VACUUM TEST:

Welded seams of the tank bottom shall be tested for porosity by observation for any bubbles in a soap solution coating with a glass top metal testing box connected to equipment that produces a vacuum of at least 2 psi. Deficient welds shall be corrected.

### 3.03 TEMPORARY CLOSURE OF TANK NO. 2 OPENINGS

Tank openings that are not fitted with valves, hatches, or manhole covers at the completion of erection shall be provided with temporary covers of metal, 10-gage minimum, or plywood, concrete-form quality, cut to fit. Covers shall be installed using three or more bolts. The covers are intended to exclude dust, animals, and intruders before and after painting and after disinfection.

### 3.04 DISINFECTION

The Contractor shall schedule disinfection of the reservoir in coordination with the treatment contractor to coincide with water availability and the preparation for startup of the treatment facility and tank. Disinfection shall not commence until coating is completed, and after the final coat has dried and cured.

The tank shall be disinfected in accordance with AWWA C652 unless otherwise specified. Water for disinfection will be provided by the Owner. The Contractor shall provide chlorine

and the piping, equipment and appurtenances to deliver the water from the point of supply to the tank.

Prior to disinfection, all interior surfaces shall be washed with clean water using a high-pressure water blaster. All water, dirt, and foreign material accumulated in this cleaning operation shall be discharged from the tank in compliance with State and local regulations.

The tank shall be disinfected with chlorine that conforms to AWWA B300 or B301. A chlorine solution having a chlorine content of 300 mg/l to 500 mg/l shall be sprayed on interior surfaces to be in contact with water when the tank is put into service. The used chlorine solution shall not be drained from the tank during the spraying operation. At the completion of disinfection, the tank shall be partially filled with water to a depth of 1 foot and retained for 4 hours minimum. After the 4-hour period, the chlorinated water shall be drained and squeegeed from the tank and the tank rinsed with potable water.

Disposal of chlorinated water may be through the storm drain or other means proposed by the Contractor. All water to be discharged shall be dechlorinated and disposal shall be in accordance with State and local regulations.

### 3.05 TESTING FOR VOLATILE ORGANIC CONSTITUENTS

Following disinfection of the tank, but prior to filling the tank for bacteriological testing, a 5-day soak test shall be completed to determine the presence of any volatile organic chemicals (VOC) at unacceptable concentrations. The test results shall be approved by the Engineer prior to final acceptance of the project by the Owner.

Testing for volatile organic constituents shall be as follows:

1. Contractor shall fill the Tank No. 2 to the overflow level. Potable water for the first test will be provided by the Owner at no cost to the Contractor.
2. Water shall be allowed to stand for a 5-day soaking period.
3. The Contractor will engage the services of a testing laboratory approved by the Owner to perform a total organic scan.
4. The Owner will obtain water samples from the tank in accordance with the latest procedures and forward the samples to the laboratory for analysis.
5. If levels of the volatile organic contaminants exceed the action levels recommended NTUA, Contractor shall drain the tank, cure and force-ventilate the tank for a minimum of 10 days, disinfect, refill, allow to soak,

and retest at his expense. This process shall continue until the sample passes. No compensation for additional testing will be provided.

### 3.06 BACTERIOLOGICAL TESTING

After successful VOC testing, bacteriological tests shall be conducted. The reservoir shall be drained, if directed by the resident project representative, and re-filled to capacity with potable water. Contractor shall dechlorinate water to be disposed as required.

After filling Tank No. 2, but prior to placing tank in service, samples shall be collected by the Owner and delivered to a certified laboratory within 6 hours to obtain a bacteriological quality test to demonstrate the absence of coliform organisms. Initial laboratory testing will be paid by the Owner. If the initial tests fail, water in the tank shall be chlorinated and retested until satisfactory results are obtained. All costs of retesting shall be borne by the Contractor.

### 3.07 GUARANTEE

- A. The Contractor shall guarantee its work for a period of two years from the completion date defined in the contract documents to the extent that it will repair any defects caused by faulty design, workmanship or material furnished under the specifications. If Contractor is not advised of any defects within 30 days of end of guarantee period, guarantee shall be considered fulfilled and complete. Defects caused by damaging service conditions such as electrolytic, chemical, abrasive or other damaging service conditions are not covered by this guarantee.
- B. All guarantees obtained by the Contractor from the manufacturer or installer of paint, equipment or accessories not manufactured by Contractor shall be obtained for the benefit of the Purchaser.
- C. An inspection of the Tank No. 2 system (including coatings) will be conducted during the month prior to final acceptance of the work by the Owner to determine whether any repair work is necessary. The Owner will establish the inspection date and notify the Contractor. The Owner will drain and wash down the tank. The Contractor shall provide lighting and scaffolding for the tank inspection. Cracking, deformation, misalignments, leakage, rusting, or deterioration of concrete or structural metal shall be considered to be a failure of the elevated tank system. Repairs at failures shall be performed by determining and removing the cause of the failure, and by removing and replacing the failed component or, if authorized by the Owner, correcting the failed component in place by modification and/or reinforcement. Inspection and repairs shall be performed at no additional cost to the Owner.

### 3.08 LEAKS

If any leaks are detected (moisture on the outside of the Tank No. 2) during testing, the Contractor shall promptly repair the leaks by cutting out the defective welds, rewelding, and repairing coatings. Coatings shall be repaired to meet all product, application, and testing criteria for the original coatings.

**\*\*END OF SECTION\*\***

Navajo Nation  
WESTERN NAVAJO PIPELINE PHASE 1

BC PROJECT NO.: 150360

BODAWAY-GAP WELL, STORAGE TANK AND PIPELINE

DIVISION 15

MECHANICAL

15050	Piping Systems
15062	Ductile Iron Pipe
15064	Plastic Pipe
15065	HDPE Pipe
15085	Piping Connections
15102	Resilient-Seated Gate Valves
15118	Spring Loaded Swing Check Valves
15125	Steel Pipe Casing
15150	Air Release and Vacuum Valves for Clean Water Service
15184	Manual Valve and Gate Operators and Operator Appurtenances

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## SECTION 15050

### PIPING SYSTEMS

#### PART 1--GENERAL

##### 1.01 DESCRIPTION

###### A. SCOPE:

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 other sections of Division 15. This section shall be used in conjunction with those sections.

###### B. DEFINITIONS:

Pressure terms used in Section 15050 and elsewhere in Division 15 are defined as follows:

1. Maximum: The greatest continuous pressure at which the piping system operates.
2. Test: The hydrostatic pressure used to determine system acceptance.

##### 1.02 QUALITY ASSURANCE

###### A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). 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, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AASHTO M36/M36M	Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts and Underdrains
ANSI A13.1	Scheme for the Identification of Piping Systems
ANSI B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.3	Malleable Iron Threaded Fittings Class 150 and 300
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B16.9	Factory-Made Wrought Steel Buttwelding Fittings
ANSI B16.11	Forged Steel Fittings, Socket Welding and Threaded
ANSI B16.12	Cast Iron Threaded Drainage Fittings
ANSI B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ANSI B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
ANSI B31.1	Power Piping
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Qualifications
ASTM A47	Malleable Iron Castings
ASTM A53	Pipe, Steel, Black and Hot Dipped, Zinc-Coated Welded and Seamless
ASTM A74	Cast Iron Soil Pipe and Fittings
ASTM A105/A105M	Forgings, Carbon Steel, for Piping Components
ASTM A106	Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A197	Cupola Malleable Iron
ASTM A234/A234M	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A312/A312M	Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A403/A403M	Wrought Austenitic Stainless Steel Piping Fittings
ASTM A536	Ductile Iron Castings
ASTM A570/A570M	Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality
ASTM B88	Seamless Copper Water Tube

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15050-2

Reference	Title
ASTM C76	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C296	Asbestos-Cement Pressure Pipe
ASTM C443-REV A	Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
ASTM D2513	Thermoplastic Gas Pressure Pipe, Tubing, and Fittings
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D2996	Filament-Wound Reinforced Thermosetting Resin Pipe
ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3261	Butt Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D4174	Cleaning, Flushing, and Purification of Petroleum Fluid Hydraulic Systems
ASTM D4101	Propylene Plastic Injection and Extrusion Materials
ASTM F441	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
AWWA C105	Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids
AWWA C110	Ductile-Iron and Gray-Iron Fittings, 3 Inch Through 48 Inch, for Water and Other Liquids
AWWA C111	Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings
AWWA C115	Flanged Ductile-Iron and Gray-Iron Pipe with Threaded Flanges
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
AWWA C153	Ductile-Iron Compact Fittings, 3 Inches Through 12 Inches, for Water and Other Liquids

Reference	Title
AWWA C200	Steel Water Pipe 6 Inches and Larger
AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe--4 In. and Larger--Shop Applied
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Services--Sizes 4 In. through 144 In.
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold-Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210	Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipe
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C301	Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids
AWWA C303	Reinforced Concrete Pressure Pipe--Steel Cylinder Type, Pretensioned, for Water and Other Liquids
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C605	Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
AWWA C651	Disinfecting Water Mains
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 12 60 Inches, for Water
AWWA C901	Polyethylene (PE) Pressure Pipe and Tubing, ¾ In. (19 mm) Through 3 In. (76 mm), for Water Services
AWWA C906	Polyethylene (PE) Pressure Pipe and Fittings, 4 In. Through 65 In. (100 mm Through 1,650 mm), for Waterworks
AWWA M11	Steel Pipe--A Guide for Design and Installation
CISPI 301	Specification Data for Hubless Cast Iron Sanitary System with No-Hub Pipe and Fittings
FEDSPEC L-C-530B(1)	Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy
MIL-H-13528B	Hydrochloric Acid, Inhibited, Rust Removing
MIL-STD-810C	Environmental Test Methods

Reference	Title
SAE J1227	Assessing Cleanliness of Hydraulic Fluid Power Components and Systems
UPC	Uniform Plumbing Code
NTUA	Navajo Area Standards & Construction Requirements

**B. FITTINGS AND COUPLING COMPATIBILITY:**

To assure uniformity and compatibility of piping components, fittings and couplings for grooved end piping systems shall be furnished by the same manufacturers.

**1.03 SUBMITTALS**

Submittals and product data for all piping materials shall be provided in accordance with Section 01300.

Piping layout drawings for all piping (including encased and above ground piping) shall be transmitted to the CONSTRUCTION MANAGER a minimum of 2 weeks prior to construction. Drawings shall be original layouts by the CONTRACTOR; photocopies of contract drawings are not acceptable.

**1.04 TEMPORARY ABOVEGROUND POTABLE WATER PIPE (HIGH LINE)**

High line piping shall be provided where water service is to be maintained and as required by the CONSTRUCTION MANAGER. High line piping and appurtenances shall be furnished, installed, disinfected, connected, maintained, and removed by the CONTRACTOR. Bacteriological sampling and testing shall be performed by a certified testing laboratory approved by the Owner. The Contractor shall coordinate highlining activities with the Construction Manager.

**PART 2--PRODUCTS**

**2.01 PIPING MATERIALS**

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 appurtenance specified in other sections of Division 15.

**2.02 PIPING IDENTIFICATION**

**A. PLASTIC CODING MARKERS:**

Plastic markers for coding pipe shall conform to ANSI A13.1 and shall be as manufactured by W. H. Brady Company, Seton Name Plate Corporation, Marking Services Inc., or equal. Markers shall be the mechanically attached type that are easily removable; they shall not be the adhesive applied type. Markers shall consist of pressure sensitive legends applied to plastic backing which is strapped or otherwise mechanically attached to the pipe. Legend and backing shall be resistant to petroleum based oils and grease and shall meet criteria for humidity, solar radiation, rain, salt, fog and leakage fungus, as specified by MIL-STD-810C. Markers shall withstand a continuous operating temperature range of -40 degrees F to 180 degrees F. Plastic coding markers shall not be the individual letter type but shall be manufactured and applied in one continuous length of plastic.

Markers bearing the legends on the background colors specified in the PIPESPEC shall be provided in the following letter heights:

Outside pipe diameter, <sup>a</sup> 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

<sup>a</sup> 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. 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 paragraph 15050-3.06 and shall be inscribed with the word "CAUTION--PIPE BURIED BELOW" and the name of the piping system.

**2.03 VALVES**

Valves of the same size and service shall be provided by a single valve manufacturer. Packing shall be nonasbestos 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. Manual Valve operators are specified in Sections 15184. Motorized Valve operators are specified in Section 11830.

## PART 3--EXECUTION

### 3.01 INSTALLATION

#### A. LOCATION:

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:

Where the size of piping is not specified, the CONTRACTOR shall 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. GENERAL: 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 indicated 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 shall be hot-dip or mechanically galvanized. Unless otherwise specified, existing pipes and supports shall not be used to support new piping.

2. PIPING CONNECTIONS TO MACHINES: Piping at machine connections shall be aligned in all planes to permit insertion of bolts at bolted connections or coupling screwed connections without using jacks, come-a-longs or other mechanical means to align field piping with the connections at the machines. Bolts shall not be forced into mating flange bolt holes and shall be capable being withdrawn using finger pressure alone. The use of 'dutchmen' mitered sections or similar specials to achieve the required alignment with machine connections is strictly prohibited.

#### D. ANCHORAGE FOR BURIED PIPING:

All plugs, caps, tees and bends in buried pressure piping systems shall be anchored by means of reaction backing or restrained joints as specified.

#### E. BEDDING AND BACKFILL:

Bedding and backfill for buried piping shall be as specified in Section 02200 (Earthwork).

## F. EQUIPMENT CONNECTION FITTINGS

Where shown, equipment connection fittings as specified in Section 15085 shall be provided between field piping systems and equipment inlet and outlet connections.

## G. FLEXIBILITY

Pipe couplings or flexible joints shall be provided as specified.

Unless otherwise specified, piping passing from concrete to earth shall be provided with two pipe couplings or flexible joints as specified in Section 15085.

## 3.02 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 plastic markers as specified in paragraph 15050-2.02 A. 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 50-foot centers.

### B. MAGNETIC TRACER TAPE:

Polyethylene magnetic tracer tape shall be buried 12 to 18 inches below ground and shall be above and parallel to buried nonferrous, plastic and reinforced thermosetting resin pipelines. For pipelines buried 8 feet or greater below final grade, the CONTRACTOR shall provide a second line of tape 2.5 feet above and parallel to the buried pipe.

## 3.03 VALVE IDENTIFICATION

Stainless steel tags bearing the specified valve number stamped in 1/4-inch high letters shall be installed on valve flanges in a position visible from floor level. Flangeless valves 8 inches in diameter and larger shall have tags attached to the valve body by self-tapping corrosion resistant metal screws. Flangeless valves 6 inches in diameter and smaller shall have tags attached to the valve stem by stainless steel wire. Wire shall be 0.063 inch minimum.

## 3.04 TESTING

### A. GENERAL:

Upon completion of piping, but prior to application of insulation on exposed piping, the CONTRACTOR shall test the piping systems. Pressures, media and test durations shall be as specified in Paragraph 3.09 of the Navajo Area Standards & Construction Requirements (See



Appendix G) and paragraph 3.06 15050. 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, the CONTRACTOR shall notify the CONSTRUCTION MANAGER 24 hours prior to each test.

Unless otherwise specified, testing, as specified herein, shall include existing piping systems which connect with new pipe 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.

Where testing existing chlorine systems to the nearest isolation valve, CONTRACTOR shall 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 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. CONTRACTOR shall be responsible for all damage to the existing system as a result of this work.

B. GAS, AIR, AND VAPOR SYSTEMS: (NOT USED)

C. LIQUID SYSTEMS:

Leakage shall be zero at the specified test pressure throughout the specified duration for the following systems: exposed piping, buried insulated piping, and buried or exposed piping carrying liquid chemicals. Testing procedures for chlorine systems are specified in paragraph 15050-3.04 D. 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.

D. CHLORINE SYSTEMS:

1. GENERAL: Chlorine systems include chlorine in gaseous and liquid phase under positive and negative pressure. After cleaning, as specified in paragraph 15050-3.05 E, the system shall be pressure tested. Pressure gages, relief valves, automatic control valves, and other components which may be damaged or exceeded by test pressures shall be removed and openings shall be blocked off prior to testing. The Contractor shall not attempt to repair leaks until all pressure has dissipated from the system. The system shall be repaired and retested as necessary until a successful test (zero leakage) is achieved.

For evaporator-supplied systems, Contractor shall disconnect the vent from the discharge side of the pressure relief valve of each evaporator, plug the resultant opening, inspect and secure all joints, close all valves which discharge to atmosphere, and open all in-line valves. Contractor shall open the valve in the bypass line around the pressure reducing valve on the downstream side of each evaporator to provide a through path around this valve. System piping shall then be tested to 150

psig. After testing, Contractor shall replace all equipment previously removed and close all in-line valves. Contractor shall reconnect the vent line to the downstream side of the pressure relief valve of each evaporator and close the valve in the bypass line around the pressure reducing valve on the downstream side of each evaporator.

Steel pipelines shall be hydrostatically tested. However, if drying after hydrostatic testing is impractical or cannot be accomplished, the Contractor may test steel lines with nitrogen gas or dry air providing he takes the necessary safety precautions to safeguard personnel and minimize the risk incurred when performing such a test at high pressures. All PVC pipelines shall be hydrostatically tested. Testing PVC lines with nitrogen or air is not permitted.

2. **HYDROSTATIC TESTING:** Steel piping lines and PVC solution lines hydrostatically tested shall be tested to 150 psig. PVC vacuum lines shall be hydrostatically tested to 50 psig. After testing, all moisture absorbing gaskets and valve packing shall be replaced.

3. **DRYING:** Chlorine and sulfur dioxide piping systems shall be dried prior to placing in service. Even if water has not been purposely introduced into the system for hydrostatic testing or cleaning, drying is still required because moisture may enter the system from the atmosphere or other sources.

For steel pipe, drying shall be accomplished by passing steam through the lines from the high end of the system until the lines are thoroughly heated. While steaming, the Contractor shall allow condensate and foreign matter to drain out. The steam supply shall then be disconnected and all pockets and low spots in the line drained. While the line is still warm, dry oil-free air having a dew point of -40 degrees F, or below, shall be blown through the line until the exiting air dew point is the same as the supply air. Valves shall be fixed in the half-open position during drying. Valves removed temporarily from the system during drying operations must be free of moisture before being recoupled to the system piping.

Drying of PVC pipe applies solely to vacuum lines and consists of draining and removing all water and moisture from the system. After draining the line, the Contractor shall first pig the pipe to remove excess water. The Contractor shall then air dry the system in accordance with the requirements for steel pipe. PVC pipe shall not be steamed.

4. **NITROGEN OR AIR PRESSURE TESTING:** The Contractor may use nitrogen gas or oil-free dry air to test steel lines. Testing consists of gradually introducing nitrogen gas or dry air up to 50 psig and maintaining this pressure while testing the line for leaks with soapy water. When the system is free from leaks at this pressure, the test pressure shall then be increased in increments of 50 psig up to a maximum of 150 psig. At each stepped increase in pressure, the Contractor shall check for leaks and take corrective action as necessary. When the system is free from leaks at the final test pressure, the system shall then be depressurized, the test source disconnected, and the system capped to prevent the entrance of water.

For testing with nitrogen gas, the Contractor shall use cylinders of dry high purity nitrogen gas, nitrogen handling cylinder mounted pressure regulator 0 to 300 psig, and necessary fittings and

adapters to complete connection between the source and system header. Pressure regulator shall be self-relieving type which vents to the atmosphere and include a throttling valve.

For testing with air, the Contractor shall provide oil-free air with a relative humidity of zero. All fittings, adapters, and accessories, pressure regulator and throttling valve shall be suitable for pressure testing with air and rated for 300 psig service.

5. SERVICE GAS TESTING: Immediately after the chlorine system has been dried and pressure tested, the service gas shall be gradually introduced and the entire system tested for leaks. Time shall be allowed for the complete replacement of air from the piping with service gas.

The Contractor shall use a liquid ammonia solution or chlorine gas detector to detect for chlorine leaks. The Contractor shall spray the solution at the pipe connections and shall not squirt the liquid on the pipe or fittings. In the event leaks are detected in the piping or the equipment, they shall not be repaired until all gas has been purged from the line. The reaction of the two substances produces a dense white cloud. Upon completion of repairs, the Contractor shall repeat the cleaning and drying process described in paragraphs 15050-3.04 D and 3.05 E and retest the lines with service gas.

E. HYDRAULIC AND LUBE OIL SYSTEMS: (NOT USED)

F. DRAINS:

Drain systems, other than pumped drain systems, shall be tested in accordance with UPC and the local governing agency.

G. GRAVITY SEWER LINES: NOT USED

### 3.05 CLEANING AND FLUSHING

A. GENERAL:

Piping systems shall be cleaned following completion of testing and prior to connection to operating, control, regulating or instrumentation equipment. The CONTRACTOR may, at his option, clean and test sections of 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:

Upon completion of the cleaning, the CONTRACTOR shall 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 – 1	1/16
1-1/4 – 3	1/4
3-1/2 – 6	1/2
Over 6	1

The CONTRACTOR shall 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. The CONTRACTOR shall 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: NOT USED

D. LIQUID SYSTEMS:

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. Liquid chlorine lines shall be cleaned in accordance with paragraph 15050-3.05 E.

E. CHLORINE SYSTEMS:

1. GENERAL: All portions of the system shall be cleaned free of oil and grease.

2. STEEL PIPE: All pipe threads shall be washed clean and free from cutting oil. The inside of all pipe sections and fittings shall be cleaned of any pipe dope, oil and grease by drawing a cloth wetted with solvent through each assembly. Valves shall be dismantled, thoroughly cleaned with solvents, and repacked, if necessary. Contractor shall cap or plug all open ends at the end of each work day.

Contractor shall use trichloroethylene. The Contractor shall at all times exercise caution to minimize solvent exposure and shall be responsible for its proper handling and disposal. Solvents containing hydrocarbons or alcohols are unacceptable.

3. PVC PIPE: All solution lines shall be cleaned using water only. Vacuum lines shall be cleaned with a detergent and water and thoroughly rinsed to remove all vestiges of

detergent. All lines shall be further purged of water by passing a cleaning ball or swab through the lines as specified in paragraph 15050-3.05 A.

F. STEAM SYSTEMS: (NOT USED)

G. HYDRAULIC AND FLUID POWER OIL SYSTEMS: (NOT USED)

H. POTABLE WATER SYSTEMS:

Potable water piping systems shall be flushed, tested and disinfected in accordance with NTUA requirements as specified in. Furnish test equipment, chemicals for chlorination, temporary valves, bulkheads and other water equipment control equipment and materials required. A Water Use Permit is required to obtain water for flushing. Coordinate water use permit with Navajo Nation Department Of Water Resources (DWR) Technical, Construction and Operations Branch (TCOB) and NTUA – See Water Use Permit Application in Appendix G.

Indiscriminate onsite disposal or discharge of chlorinated water to sewer systems, storm drains, drainage courses or surface waters is prohibited.

Pipes, fittings, valves and all other components incorporated into tie-ins and connections with the existing system shall be spray disinfected or swabbed with a liquid chlorine solution in accordance with Hydrostatic Pressure Testing and Disinfecting of Water Mains (see Appendix G) and AWWA C651 and as specified herein. Upon connection to the main, the line shall be flushed as directed by the CONSTRUCTION MANAGER. Disinfection by this method is generally limited to assemblies of 20' or less in length. Alternate methods such as "pre-disinfection" prior to installation in accordance with AWWA C651 may be required at the discretion of the CONSTRUCTION MANAGER.

### 3.06 PIPING SPECIFICATION SHEETS (PIPESPEC)

Piping and valves for groupings of similar plant processes or types of service lines are specified on individual piping specification sheets (PIPESPECS). Piping services are grouped according to the chemical and physical properties of the fluid conveyed and/or by the temperature or pressure requirements. Each grouping of services (PIPESPEC) is identified by a piping system number. Piping services specified in the PIPESPECS are designated by service symbols as shown in Table A. Table A also indicates the system number, fluid category, and pipe marker background color of each service.



### 3.06 PIPING SPECIFICATION SHEETS--PIPESPEC

Piping System: 7 (continued)

PVC; ASTM D1784, Class 12454 B, NSF certified, ASTM D1785, Sch. 80. Ref. spec Section 15064.  
Conn; plain end; solvent weld.  
Ftgs; PVC, Sch. 80, socket type.

Valves:

Ball; Jamesbury Fig. 351, Nibco T-580, or equal.  
Globe; Crane 7TF or 17TF, Lunkenheimer 123 or 214, or equal.  
Ball; PVC, true union, socket type, Chemtrol Tru Block TU Series, Asahi/ America Duo Bloc TU Series, GSR TU Series, or equal, with PTFE seats and Viton O-rings.  
Diaphragm; PVC body, PTFE diaphragm, Chemtrol Series PD, Posacon 677, Asahi/ America, or equal.

Gate; Resilient Seated

(4" and larger)  
Pipe:

Ductile iron; AWWA C151 with NSF Compliant lining and coating. Polyethylene encasement per ANSI/AWWA A21.5/C105.

Conn; Restrained mechanical joint pipe. Flanged adapters for valves.

Ftgs; ductile iron;restrained mechanical joint, coating, lining, and ends to match pipe.

(3" and larger)  
Valves:

Altitude Valve; Ref. spec Section 15147.

3.06 PIPING SPECIFICATION SHEETS--PIPESPEC

Piping System: 7 (continued)

Buried Pipe and Valves:

(See drawings for pipe size and valve type.)

(3" and smaller)

Pipe:

HDPE; per AWWA C901

(2-1/2" and smaller)

Valves:

(4" to 12")

Pipe:

PVC; per AWWA C900, DR as specified. Ref. spec Section 15064.

Restrained push-on rubber gasket joint. Flanged adapters for valves and fittings.

Ftgs; ductile iron; coating, lining and ends to match pipe.

Ductile iron; AWWA C151 with NSF Compliant lining and coating.. Polyethylene encasement per ANSI/AWWA A21.5/C105. Ref. spec Section 15062.

Conn; Restrained mechanical joint pipe. Flanged adapters for valves.

Ftgs; ductile iron; restrained mechanical joint, coating, lining, and ends to match pipe.

Valves:

Gate; Resilient Seated. ref. spec Section 15102, with extension stem and valve box.



### 3.06 PIPING SPECIFICATION SHEETS--PIPESPEC

Piping System: 7 (continued)

Encased Pipe:

(See drawings for pipe size and location.)

(4" and larger)

Pipe: Steel; ASTM A283, Grade D. Ref spec Section 15125

Remarks:

1. Combination air valve shall be provided at the high points and drains provided at the low points of each reach of pipeline.
2. Sleeves shall be installed of proper size for all pipes passing through walls as shown on the drawings. Where indicated on the drawings, or required for liquid or gas-tightness, the pipe shall be sealed with mechanical seal by Link Seal as manufactured by Thunderline Corp., Wayne, Michigan, or equal.
3. All pipe and appurtenances connected to equipment shall be supported in such a manner as to prevent any strain being imposed on the equipment.
4. System 7 piping installed in areas and locations subject to freezing (including ceiling areas which are not heated) shall be insulated.
5. Water lines installed over suspended or other type ceilings shall be insulated for condensation control.
6. Systems shall be disinfected per NTUA Testing and Disinfecting Water Mains – See Appendix G.
7. Tape shall be spirally wrapped with a 55 percent overlap and sufficient tension and pressure to provide continuous adhesion without stretching the tape. Edges of tape must be continuously smoothed and sealed by hand during wrapping. On vertical application, contractor shall begin at bottom and proceed upward creating a weather board overlap.

Smooth contours shall have a minimum thickness of 50 mils while nuts, bolts, and sharp projections shall be 100 mils.

3.06 PIPING SPECIFICATION SHEETS--PIPESPEC

Piping Symbol/Service: System--12  
TD--Tank Drain

Test Requirements:

Medium: Water; ref. spec paragraph 15050-3.04 C.  
Pressure: 125 psig  
Duration: 120 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder  
Push-on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:

(See drawings for pipe size and valve type)

(2" and smaller)

Pipe:

Valves: None

(2 1/2" thru 10")

Pipe:

Steel; ASTM A53 ERW, Grade B, black, no lining. Ref. spec Section 15061.

Conn; butt weld, grooved mech pipe coupling or flanged.

Ftgs; malleable iron, ductile iron, or steel per spec Section 15061; ends to match pipe.

Valves: None

Buried and Encased Pipe and Valves:

(See drawings for pipe size and valve type. Omit coating on encased pipe.)

(4" thru 12")

Pipe:

Ductile iron; AWWA C151. Ref. spec Section 15062.

Conn; grooved end or restrained push-on rubber gasket joint. Flanged adapters for valves.

Ftgs; ductile iron, per spec Section 15062; coating, lining and ends to match pipe.

HDPE; per AWWA C906

Steel; per AWWA C200

3.06 PIPING SPECIFICATION SHEETS--PIPESPEC

Piping System: 12 (continued)

Valves: None

Remarks:

1. Manual air vents shall be provided at the high points and drains provided at the low points of each reach of pipeline.
2. Valves for tank drain lines shall be provided where indicated on the drawings.
3. Testing for tank drain shall be in accordance with the Uniform Plumbing Code as applicable.

3.06 PIPING SPECIFICATION SHEETS--PIPESPEC

Piping Symbol/Service: CLS--Chlorine Solution System--19

Test Requirements:

Medium: Water; ref. spec paragraph 15050-3.04 C.  
Pressure: 300 psig  
Duration: 120 minutes

Gasket Requirements:

Flange: PTFE bonded EPDM, full-face gaskets, ANSI B16.1.  
Push-on/Mech Cpl: N/A

Exposed Pipe and Valves:

(See drawings for pipe size and valve type)

(All sizes)

Pipe: CPVC; Sch 80 (valves and fittings to match) NSF certified, Pipe and fittings exposed to sunlight shall be painted. Ref. spec Section 15064.  
Conn; plain end, solvent weld, flanged for valves 3 inch and larger.  
Ftgs; PVC, Sch. 80, solvent weld.

(4" and less)

Valves: Ball; Sch 80 CPVC Chemtrol Tru Bloc TU Series, Asahi/America Duo Bloc TU Series, GSR TU Series, or equal, with PTFE seats and EPDM 0-rings.  
Diaphragm; CPVC body, Chemtrol Series PD, Posacon 677, Asahi/America, or equal with EPDM or PTFE diaphragm.  
Ball check; CPVC body, Chemtrol Series BC, Asahi/America, or equal with EPDM or PTFE seats/seals.

Remarks:

1. Valves shall be provided with certification for use with chlorine by the Chlorine Institute, Inc.
2. Valves shall be cleaned for chlorine service by the valve manufacturer prior to delivery to the job site.
3. Following test completion, piping, valves, and fittings shall be dried as specified in paragraph 15050-3.04 D.
4. Sleeves shall be installed of proper size for all pipes passing through walls as shown on the drawings. Where indicated on the drawings, or required for liquid or gas-tightness, the pipe shall be sealed with mechanical seal by Link Seal as manufactured by Thunderline Corp., Wayne, Michigan, or equal.

3.06 PIPING SPECIFICATION SHEETS--PIPESPEC

Piping System: 19 (continued)

5. All pipe and appurtenances connected to equipment shall be supported in such a manner as to prevent any strain being imposed on the equipment.
6. All pipe, valves, fittings and appurtenances for this system shall be rated for continuous service at 250 psi, minimum.

### 3.06 PIPING SPECIFICATION SHEETS--PIPESPEC

Piping Symbol/Service: CLG--Chlorine Gas System--20

#### Test Requirements:

Medium: Ref. spec paragraph 15050-3.04 D.  
Pressure: 150 psig  
Duration: 120 minutes

#### Gasket Requirements:

Flange: Gylon gasketing, Garlock Style 3500 or 3510  
Push-on/Mech Cpl: N/A

#### Exposed Pipe and Valves:

(See drawings for pipe size and valve type)

(1-1/2" and smaller)

Pipe: Steel; ASTM A106, seamless, Grade B, black, Sch. 80, no lining, pickled.  
Conn; socket weld; forged steel, Class 3000, ANSI B16.5, flanged for valves. Ref. spec Section 15085.  
Ftgs; forged steel, ASTM A105, ANSI B16.11, pressure Class 3000, pickled, ends to match pipe.

Valves: Ball; Jamesbury 530S-C31-2271MT, ITT Cam-Tite 3058-2-4, or equal.

#### Remarks:

1. The cleaning (pickling) solution used shall comply with Mil-H-13528B. Immediately following pickling and rinsing procedures, steel pipe and fittings shall be coated inside and outside with a rust and corrosion preventative system, and the ends sealed to prevent the entry of dirt. Corrosion preventive coating shall not interfere with cleaning operations specified in paragraph 15050-3.05 E.
2. Valves shall be provided with certification for use with chlorine by the Chlorine Institute, Inc.
3. Valves shall be cleaned for chlorine service by the valve manufacturer prior to delivery to the job site.
4. Following test completion, piping, valves, and fittings shall be dried as specified in paragraph 15050-3.04 D.

### 3.06 PIPING SPECIFICATION SHEETS--PIPESPEC

Piping Symbol/Service: CLV--Chlorine Vacuum System--21

#### Test Requirements:

Medium: Water; ref. spec paragraph 15050-3.04 D.  
Pressure: 50 psig  
Duration: 1440 minutes

#### Gasket Requirements:

Flange: PTFE bonded EPDM, full-face gaskets, ANSI B16.1.  
Push-on/Mech Cpl: N/A

#### Exposed Pipe and Valves:

(See drawings for pipe size and valve type)

(All sizes)

Pipe: PVC; ASTM D1784, Class 12454-B, NSF certified, ASTM D1785, Sch. 80. Piping and fittings exposed to sunlight shall be painted. Ref. spec Section 15064.  
Conn; plain end, solvent weld, flanged for valves 3 inches and larger.  
Ftgs; PVC, Sch. 80, solvent weld.

Valves: Ball; PVC, Asahi/America Duo Bloc TU Series, Chemtrol Tru Bloc TU Series, GSR TU Series, or equal, with PTFE seats and Viton O-rings.

#### Remarks:

1. Valves shall be provided with certification for use with chlorine by the Chlorine Institute, Inc.
2. Valves shall be cleaned for chlorine service by the valve manufacturer prior to delivery to the job site.
3. Following test completion, piping, valves, and fittings shall be dried as specified in paragraph 15050-3.04 D.

3.06 PIPING SPECIFICATION SHEETS--PIPESPEC

Piping Symbol/Service: D--Drain System--24  
STD--Storm Drain  
V--Vent

Test Requirements:  
Medium: In accordance with Section 712, Uniform Plumbing Code.  
Pressure: In accordance with Section 712, Uniform Plumbing Code.  
Duration: In accordance with Section 712, Uniform Plumbing Code.

Gasket Requirements:  
Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder  
Push-on/Mech Cpl: Nitrile or neoprene

Exposed Pipe and Valves:  
(See drawings for pipe size.)

(3" and smaller)  
Pipe: None  
Valves: None

(4" thru 12")  
Pipe: None  
Valves: None

Buried and Encased Pipe and Valves Under and 5 Feet Outside Building  
(See drawings for pipe size.)

(12" and smaller)  
Pipe: None  
Valves: None

Buried and Encased Pipe and Valves Beyond 5 Feet Outside Building  
(See drawings for pipe size.)

(3" and smaller)  
Pipe: HPDE; per AWWA C901



Valves: None

Remarks:

None.

3.07 DISINFECTION OF PIPING

A. GENERAL

Upon completion of pressure testing all piping will be disinfected as specified in Paragraph 3.10 of the Navajo Area Standards & Construction Requirements (See Appendix G).

**\*\*END OF SECTION\*\***

SECTION 15062  
DUCTILE IRON PIPE

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies ductile iron pipe, ductile fittings and gaskets.

B. DEFINITION:

Where cast iron pipe is specified, the term and symbol shall mean ductile iron pipe.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). 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, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI A21.14	Ductile-Iron Fittings 3 In. Through 24 In., for Gas
ANSI A21.52	Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand Lined Molds for Gas
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.5	Pipe Flanges and Flanged Fittings
ASTM A716	Ductile-Iron Culvert Pipe

Reference	Title
ASTM C150	Portland Cement
AWWA C104 (ANSI A21.4)	Cement-Mortar Lining for Ductile- Iron and Gray-Iron Pipe and Fittings for Water
AWWA C110 (ANSI A21.10)	Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In., for Water and Other Liquids
AWWA C111 (ANSI A21.11)	Rubber-Gasket Joints for Ductile- Iron and Gray-Iron Pressure Pipe and Fittings
AWWA C115 (ANSI A21.15)	Flanged Ductile-Iron and Gray-Iron Pipe With Threaded Flanges
AWWA C150 (ANSI A21.50)	Thickness Design of Ductile-Iron Pipe
AWWA C151 (ANSI A21.51)	Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
AWWA C153 (ANSI A21.53)	Ductile-Iron Compact Fittings, 3 In. Through 12 In. for Water and Other Liquids
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C606	Grooved and Shouldered Type Joints
NTUA	Navajo Area Standards & Construction Requirements

### 1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

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. A check mark 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. Shop fabrication drawings showing details of materials, piping, fittings, couplings, dielectric connections, joint locations and details, types and locations of supports.
3. CONTRACTOR's layout drawings as specified in paragraph 15050-1.03.
4. Certifications specified in the following documents:
  - ANSI A21.14, paragraph 14-4.2
  - ANSI A21.52, paragraph 52-4.2
  - ASTM A716, paragraph 4.2
  - AWWA C110, paragraph 10-5.3
  - AWWA C111, paragraph 11-7.1
  - AWWA C115, paragraph 15-4.2
  - AWWA C151, paragraph 51-5.2
  - AWWA C153, paragraph 53-6.3
  - AWWA C606, paragraph 4.1.1.1
5. Other data necessary to show conformance of the complete piping system to these specifications.

## PART 2--PRODUCTS

### 2.01 GENERAL

Pipe design, materials and manufacture shall comply with the following documents:

Item	Document
Thickness design	AWWA C150
Manufacturing requirements	
Water or other liquid	AWWA C151
Gas	ANSI A21.52
Gravity service pipe	ASTM A716
Joints	
Rubber gasket	AWWA C111
Threaded flange	AWWA C115

Item	Document
Fittings	
Water or other liquid	AWWA C110/AWWA C153
Gas	ANSI A21.14
Cement mortar lining	AWWA C104

## 2.02 PIPE

Unless otherwise specified, ductile iron pipe shall be Class 50 and have nominal laying lengths of 18 or 20 feet. For grooved-end pipe, wall thickness shall be minimum Class 53 except where the specified pressure requires heavier pipe.

## 2.03 GASKETS

Unless otherwise specified, gasket stock shall be a synthetic rubber 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, in addition, comply with AWWA C111 for push-on and mechanical joints and with AWWA C606 for grooved end joints.

## 2.04 FITTINGS

Unless otherwise specified, fittings shall conform to AWWA C110. Ends shall be flanged, restrained mechanical joint, restrained push-on, or grooved to suit the conditions specified. The AWWA C153 compact ductile iron fittings in sizes 3 through 12 inches are an acceptable substitute for standard fittings unless otherwise specified. Long-radius elbows shall be provided where specified. Grooved end fittings shall comply with paragraph 15050-1.02 B.

## 2.05 JOINTS

### A. UNRESTRAINED JOINTS:

1. **PUSH-ON JOINTS:** Unrestrained joints, where specified, shall be the rubber ring compression, push-on type joint suitable for buried service. Unrestrained joints shall be the Fastite Joint as manufactured by American Cast Iron Pipe Company, the Tyton Joint as manufactured by U.S. Pipe, or equal. This joint is not permitted on fittings or specials, unless otherwise specified. Unless otherwise specified, joints shall have an allowable deflection up to 5 degrees at specified pressures. Joint assembly and field cut joints shall be made in strict conformance with AWWA C600 and manufacturer's recommendations.

2. **MECHANICAL JOINTS:** Where specified, mechanical joints for above or below ground service shall meet the requirements of ANSI/AWWA A21.10/C110 and

ANSI/AWWA A21.11/C111. Gaskets and bolts and nuts shall comply with paragraphs 15062-2.03 and 2.05 D, respectively.

**B. RESTRAINED JOINTS:**

1. **GENERAL:** Unless otherwise specified, restrained joints are required for all exposed and buried piping. Unless otherwise specified, restrained joints shall be flanged or grooved end for exposed service and restrained push-on for buried service.

2. **PUSH-ON JOINTS:** Restrained push-on joints shall be as specified in paragraph 15062-2.05 A.1., modified for restraint. Joints shall be the Flex-Ring or Lok-Ring Joint as manufactured by American Cast Iron Pipe Company, TR Flex Joint as manufactured by US Pipe, or equal. Restrained 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 CONSTRUCTION MANAGER.

3. **FLANGE ASSEMBLIES:** Unless otherwise specified, flanges shall be ductile iron and shall be threaded-on flanges conforming to ANSI/AWWA A21.15/C115 or cast-on flanges conforming to ANSI/AWWA A21.10/C110. Flanges shall be adequate for 250 psi working pressure. Bolt circle and bolt holes shall match those of ANSI B16.1, Class 125 flanges and ANSI B16.5, Class 150 flanges. Where specified, flanges shall be threaded-on or cast-on flanges conforming to ANSI B16.1, Class 250.

Unless otherwise specified, bolts and nuts for flange assemblies shall conform with paragraph 15085-2.01 C. Gaskets shall be as specified in paragraph 15085-2.01 B.

4. **MECHANICAL JOINTS:** Where specified, restrained mechanical joints shall be the positive restraint type. Mechanical joints with retainer glands are not acceptable.

Locked mechanical hydrant tees, bends and adapters are an acceptable substitute for anchoring fire hydrants and valves to the pipe main.

**C. BALL AND SOCKET FLEXIBLE JOINT PIPE:**

Ball and socket flexible joint pipe shall be the boltless type and shall allow a maximum joint deflection of 15 degrees. Each joint shall be provided with a retainer lock to prevent rotation after assembly. Joints shall be the Flex-Lok Joint as manufactured by American Cast Iron Pipe Company, USIflex as manufactured by U.S. Pipe, or equal.

**D. BOLTS AND NUTS:**

Corrosion-resistant bolts and nuts for use with ductile iron joints shall be high-strength, low-alloy steel as specified in ANSI/AWWA C111/A21.11.

**2.06 PIPE COATING**

Unless otherwise specified, pipe and fittings shall be coated with asphaltic material as specified in AWWA C151.

## 2.07 PIPE LINING

### A. ASPHALTIC LINING:

Unless otherwise specified, pipe and fittings shall be lined with asphaltic material as specified in AWWA C151.

### B. CEMENT MORTAR LINING:

Where specified, interior surfaces of pipe and fittings shall be cement mortar lined in accordance with AWWA C104. Cement shall be ASTM C150, Type II or V, low alkali, containing less than 0.60 percent alkalis.

### C. GLASS LINING: (NOT USED)

## PART 3--EXECUTION

### 3.01 INSTALLATION

#### A. GENERAL:

Piping runs specified on the drawings shall be followed as closely as possible. Proposed deviations shall be submitted in accordance with Section 01300.

Pipe shall be installed in accordance with AWWA C600.

Connections to existing structures and manholes shall be made so that the finished work will conform as nearly as practicable to the requirements specified for the new manholes, including necessary concrete work, cutting and shaping. Concrete mortar shaping within any structure and manhole shall be as specified.

#### B. INSULATING SECTIONS:

Where a metallic nonferrous pipe or appurtenance is connected to ferrous pipe or appurtenance, an insulating section shall be provided as specified in paragraph 15085-3.05.

#### C. ANCHORAGE:

Anchorage shall be provided as specified. Calculations and drawings for proposed alternative anchorage shall be submitted in accordance with Section 01300.

### 3.02 ACCEPTANCE TESTING

Hydrostatic pressure tests shall be conducted in accordance with AWWA C600, Paragraph 3.09 of the Navajo Area Standards & Construction Requirements (See Appendix G), and at test pressures listed in Section 15050.

The CONTRACTOR shall conduct the tests in the presence of the CONSTRUCTION MANAGER.

**\*\*END OF SECTION\*\***



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Bodaway-Gap Contract 2  
Bid Issue

SECTION 15064

PLASTIC PIPE

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies polyvinylchloride, chlorinated polyvinylchloride, polyethylene, and polypropylene pipe and fittings. High density polyethylene (HDPE) piping for trenchless installation shall be per specification Section 15065.

The Contractor shall provide all necessary labor, materials, appurtenances, equipment, and services for a complete, in-place pipeline.

B. PIPE DESIGNATIONS:

For use in the Piping System Specification Sheets (PIPESPEC) in Section 15050 and in this section, the following plastic pipe designations are defined:

Designation	Definition
PVC	Polyvinylchloride
CPVC	Chlorinated polyvinylchloride
PE	Polyethylene
PP	Polypropylene

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). 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, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
ASTM D2464	Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM D2657	Heat-Joining Polyolefin Pipe and Fittings
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D4101	Propylene Plastic Injection and Extrusion Materials
ASTM F402	Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings
ASTM F437	Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F438	Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F439	Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F441	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe

Reference	Title
ASTM F493	Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
AWWA C110	Ductile-Iron and Gray-Iron Fittings
AWWA C111	Rubber-Gasket Joints for Ductile-Iron
AWWA C115	Flanged Ductile-Iron Pipe With Ductile-Iron
AWWA C116	Protective Fusion-Bonded Epoxy Coatings
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast
AWWA C153	Mechanical Joint Ductile Iron Fittings
AWWA C210	Liquid-Epoxy Coatings and Linings for Steel Water Pipe and Fittings
AWWA C605	Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings
AWWA M23	PVC Pipe Design and Installation
NTUA	Navajo Area Standards & Construction Requirements

**B. MANUFACTURER INSPECTION AND TESTS:**

1. Unless otherwise specified, all pipe manufacturing materials, pipe and fittings provided shall be tested in accordance with the applicable referenced standards.
  - a. Perform material tests at no additional cost to the Owner.
  - b. In addition to those tests specifically required, Construction Manager may request additional samples of any material for testing by Construction Manager. Additional samples and testing shall be furnished at no additional cost to Owner.
2. Like pipe and fittings provided shall be furnished by a single manufacturer.

**1.03 SUBMITTALS**

The following information shall be provided in accordance with Section 01300:

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

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marked to indicate requested deviations from specification requirements. A check mark 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. Shop fabrication drawings showing details of materials, piping, fittings, couplings, mechanical restraint devices, dielectric connections, joint locations and details, types and locations of supports.
3. CONTRACTOR's layout drawings as specified in paragraph 15050-1.03. Contractor shall provide restraint calculations including required length for mechanical restraint, placement and/or sizing of thrust blocks, based on provided layout and Section 3.03. Calculations shall be stamped by a Registered Professional Engineer in the State of Arizona.
4. Manufacturer's certificates of compliance with the specified standards.
5. Procedures for safe handling, transport and storage of HDPE piping, including maximum pipe stacking height to maintain the round pipe shape.
6. Other data necessary to show conformance of the complete piping system to these specifications.

## PART 2--PRODUCTS

### 2.01 PVC PIPE

#### A. PRESSURE PIPE:

PVC material for pipe and fittings shall conform to ASTM D1784, Class 12454-B with an established hydrostatic design basis (HDB) equal to or greater than 4000 psi at 73.4 degrees F.

Pressure pipe for water lines 4 through 60-inches shall be manufactured in accordance with AWWA C900. Minimum Dimension ratio shall be as specified on the plans. Where not specified on plans, use DR18.

Where specified, pipe and fittings shall be in accordance with ASTM D1785 or shall conform to ASTM D2241 for standard dimension ratios: 160 psi pipe--SDR 26; 200 psi pipe--SDR 21; 250 psi--SDR 17. Pressure rating for pipe shall be in excess of test pressure specified in Section 15050. Neoprene gaskets with push-on joints shall conform to ASTM F477.

Where specified, Schedule 80 PVC socket type fittings shall conform to ASTM D2467. Schedule 40 PVC fittings shall conform to ASTM D2466. PVC solvent weld cement for socket connections shall meet the requirements of ASTM D2564. Schedule 80 PVC threaded fittings shall conform to ASTM D2464. Fittings for gasketed pipe shall be ductile iron or steel push-on IPS-sized pressure fittings rated for use with the specified class of PVC pipe. Unless otherwise specified, fittings shall be lined and coated in accordance with Section 15061 or Section 15062 as applicable.

**B. NONPRESSURE PIPE:**

1. GRAVITY SEWER PIPE: PVC material for sewer pipe and fittings shall conform to Class 12454-B, as defined in ASTM D1784. Pipe and fittings shall meet the requirements of ASTM D3034 for SDR 35. Neoprene gaskets with push-on joints shall conform to ASTM F477.
  
3. DRAIN, WASTE AND VENT PIPE: PVC material for drain waste and vent (DWV) pipe and fittings shall conform to Class 12454-B, ASTM D1784. Pipe and fittings shall conform to ASTM D2665. Unless otherwise specified, connections shall be solvent weld. Connections to traps, closet flanges, and nonplastic pipe shall be with approved adapter type fittings designed for intended use. Solvent weld cement for socket connections shall meet requirements of ASTM D2564.

**C. FITTINGS FOR PVC PRESSURE PIPE**

Fittings for PVC water lines shall be ductile-iron conforming to AWWA C110 or AWWA C153 with a minimum rated working pressure greater or equal to the provided pressure pipe. The fittings shall have restrained mechanical or push on joints manufactured specifically for the PVC pipe to be used with the fitting. Fittings with repaired defects are not acceptable and will be rejected.

Bolts and nuts for mechanical joints, or flanged ends will be of high strength corrosion resistant low-alloy steel and shall conform to AWWA C111. Flange bolts and nuts for above ground installation shall conform to Appendix A of AWWA C115. Flange bolts and nuts for below ground installation shall be 316 stainless steel. All fittings shall be fusion bonded epoxy lined and coated and lined unless stainless steel is used.

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Couplings shall meet the requirements of AWWA C900 as applicable, and be suitable for the working pressure. Deflection shall not exceed 50% of the manufacturer's written maximum recommendation unless otherwise specified.

## 2.02 CPVC PIPE

CPVC material for pipe and fittings shall conform to ASTM D1784, Class 23447-B. Pipe and fittings shall be in accordance with ASTM F441. Neoprene gaskets with push-on joints shall conform to ASTM F477.

Schedule 80 CPVC socket type fittings shall conform to ASTM F439. Schedule 40 CPVC socket type fittings shall conform to ASTM F438. CPVC solvent weld cement for socket connections shall meet the requirements of ASTM F493. Schedule 80 CPVC threaded type fittings shall conform to ASTM F437.

## 2.03 PE PIPE

PE pipe shall meet the requirements of ASTM D1248, Type III, Grade P 34, Class C, 100 psi or as specified in Section 15050, whichever is higher. Fittings shall be of the same material, molded socket fusion for sizes 4 inch diameter and smaller and molded or fabricated butt fusion for sizes 6 inch and larger. Fittings shall be 125 psi or as specified in Section 15050, whichever is higher. Heat fusion welding shall be in conformance with ASTM D2657.

## 2.04 PP PIPE

### A. PRESSURE PIPE:

PP pipe and fittings shall be formulated of polypropylene conforming to ASTM D4101, SDR 11, butt fusion type. Pipe shall be 150 psi rated in all sizes. Heat fusion welding shall be in conformance with manufacturer's recommendation.

### B. DRAIN, WASTE AND VENT PIPE:

PP drain, waste and vent (DWV) pipe and fittings shall be made from flame retardant, Schedule 40, polypropylene (PPFR) plastic as defined in ASTM D4101. Pipe and fittings used for buried piping and in concealed locations shall be joined by electrical fusion coils energized by a variable low-voltage power supply to completely fuse the interface between the pipe and socket and form a completely homogenous structure. Unless otherwise specified, mechanical joint fittings may be used under bench or in exposed locations where future disassembly is desired. The mechanical method shall be in conformance with the manufacturer's recommendation.

## PART 3--EXECUTION

### 3.01 STORAGE AND HANDLING

Pipe shall be stored and handled in accordance with AWWA M23 and the manufacturer's recommendations. PVC pipe that has been gouged, scratched, or otherwise damaged shall be subject to rejection at the discretion of the Construction Manager. Rejected pipe shall be removed from the site and replaced at no additional cost to the Owner.

Cover stored PVC pipe with an opaque material to protect it from the sun's ultraviolet radiation. PVC pipe that has been subjected to excess ultraviolet radiation as identified by color fading or chalking shall not be used. The determination as to the acceptability of PVC pipe shall rest solely with the Construction Manager.

PVC pipe that has been contaminated in any way with petroleum products (on the inside or outside of the pipe) shall not be used.

### 3.02 INSTALLATION

PVC pipe 3 inches in diameter and smaller shall be joined by means of socket fittings and solvent welding in conformance with ASTM F402. Solvent-cemented joints shall be made in strict compliance with the manufacturer's/supplier's instructions and recommended procedures. Unless otherwise specified, PVC pipe 4 inches in diameter and greater shall be joined by means of gasketed push-on joints and steel or ductile iron push-on or mechanical joint fittings. Fittings that are not plastic or stainless steel shall be lined and coated. Linings shall meet or exceed AWWA C-116 or AWWA C-210 and fully compliant with NSF requirements for potable water service, Ceramapure PL90 ceramic epoxy, or equal. Coatings shall be asphaltic material as specified in AWWA C151. Unless otherwise specified, PVC and CPVC piping exposed to sunlight shall be painted with an approved Latex coatings Tnemec Series 1028 or 1029, Sherwin Williams, Sher Cryl HPA, or equal.

Connections to different types of pipe shall be by means of flanges, specified adapters or transition fittings. Where sleeve type couplings are used, both shall be uniformly torqued in accordance with pipe manufacturer's recommendation. Foreign material shall be removed from the pipe interior prior to assembly.

Unless otherwise specified, PE pipe and fittings 4 inch diameter and smaller shall be joined by means of thermal socket fusion and pipe 6 inch and larger by thermal butt fusion. Butt-fusion joining of the pipes and fittings shall be performed with special joining equipment in accordance with procedures recommended by pipe manufacturer. Tensile strength at yield of butt-fusion joints shall not be less than pipe. Flanged adapters shall be provided for connection to valves and where specified.

### 3.03 SUPPORTS, THRUST AND ANCHOR BOLTS

All plugs, caps, tees and horizontal and vertical alignment changes greater than or equal to 11 ¼ degrees and as specified in buried pressure piping systems shall be anchored by means of reaction backing thrust blocks or mechanically restrained joints.



Concrete support blocks shall be provided for all ductile-iron fittings and valves to prevent the fitting or valve weight from being carried by the PVC pipe.

#### 3.04 TESTING

Testing of plastic piping shall be conducted in accordance with AWWA C605, Paragraph 3.09 of the Navajo Area Standards & Construction Requirements (See Appendix G), and at test pressures listed in Section 15050.

**\*\*END OF SECTION\*\***

SECTION 15065

HIGH DENSITY POLYETHYLENE (HDPE) PIPE

PART 1 -- GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies high density polyethylene (HDPE) pipe for piping 2 inches to 10 inches in nominal diameter.

B. CHARACTERISTICS:

Provided HDPE pipe shall conform to the following minimum requirements:

Dimension Ratio (DR)	17
Material Designation	PE-4710
Pipe Sizing System per AWWA C906 & ASTM F714	DPS
Pressure Class in accordance with AWWA C906	125 psig

C. REFERENCES:

The publications listed below form part of this specification to the extent referenced and are referred to in the text by the basic designation only. References shall be made to the latest edition of said standards unless otherwise called for.

References	Title
AWWA C901	Polyethylene (PE) Pressure Pipe and Tubing, ¾ In. (19 mm) Through 3 In. (76 mm), for Water Services
ANSI/AWWA C906	Polyethylene (PE) Pressure Pipe and Fittings, 4 In. Through 65 In. (100 mm Through 1,650 mm), for Waterworks
ASTM D2321	Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D2657	Heat Joining Polyolefin Pipe and Fittings
ASTM D3350	Polyethylene Plastics Pipe and Fittings Material
PPI TR 31	Underground Installation of Polyolefin Piping

## 1.02 QUALITY ASSURANCE

### A. INSPECTION AND TESTING:

All HDPE materials, pipe and fittings shall be inspected and tested in accordance with the requirements of AWWA C906.

### B. AFFIDAVIT OF COMPLIANCE:

The manufacturer shall furnish an affidavit of compliance conforming to the requirements of AWWA C906, Section 1.5, affirming that the piping components comply with the requirements of AWWA C906 and this section.

## 1.03 SUBMITTALS

Submittals shall be in accordance with Section 01300.

Submit the following prior to commencement of the Work:

- A. 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.
- B. Detail drawings which show the type and location of all fittings, joints, and connections to other pipe materials.
- C. Design calculations demonstrating that the pipe is capable of sustaining service conditions and the maximum loads to be imposed during installation. For HDPE installed by directional drilling, this submittal may be made as part of Section 02160 Horizontal Directional Drilling.

- D. Affidavit of Compliance specified in paragraph 15065 1.02 C.
- E. A report containing a copy of all manufacturer's test results for all tests conducted in accordance with paragraph 15065-1.02 B.

#### 1.04 DESIGN REQUIREMENTS

The design and layout of pipe shall meet the service and installation conditions and the criteria specified in this Section and as shown on the Plans are the responsibility of the Contractor. This design shall be performed by or under the supervision of a Professional Engineer licensed by the State of Arizona. The Contractor shall submit design calculations for pipe with wall thickness and pressure class demonstrating that the pipe is capable of sustaining the maximum stresses to be imposed during installation and service.

The calculations shall take into account ground loads, live loads such as traffic and railroad, and any other installation loads which may be reasonably anticipated.

### PART 2 -- PRODUCTS

#### 2.01 GENERAL

HDPE materials, pipe and fittings shall be manufactured, marked, inspected, sampled and tested in accordance with the requirements of AWWA C906 and this section.

The color of the pipe shall be black with a blue stripe designating potable water.

#### 2.02 MATERIALS

HDPE piping components shall as a minimum be manufactured from materials that meet or exceed the requirements of the Plastic Piping Institute designation PE 4710 and that conform to the requirements of ASTM D3350 for a cell classification of PE 445474C.

#### 2.03 PIPE

Pipe shall have the nominal pipe diameter shown, with the inside diameter based on the DR and pipe sizing system shown. Dimensions and tolerances shall be as specified in AWWA C906.

#### 2.04 FITTINGS

Fittings shall meet the pressure requirements of the specified pipe. Fittings shall conform to the applicable requirements of AWWA C906 for the joining methods specified in paragraph 15065-3.02 B.

Increase wall thickness to next nominal pressure rating/next lower DR for mitered bends. Mitered bends shall be segmented according to the following table:

High Density Polyethylene (HDPE) Pipe  
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Degree of bend	Minimum number of miter segments
45 or less	2
Greater than 45	4

#### 2.05 FLANGE ENDS:

Flange End assemblies shall consist of HDPE stub end flange adapter and back up ring.

Furnish beveled flange adapters for disk clearance on connections to butterfly valves.

Stub end flange adapters shall be furnished with concentric ring convolutions on the flange face and radiuses or chamfered outer diameter transition from pipe wall to stub end.

Back up ring shall be ductile iron encapsulated in polypropylene for non corrosive applications or 316L stainless steel for corrosive applications as called for on the Plans. Drilled for ANSI B 16.5, Class 150 or AWWA C207. Flange ring bore shall be chamfered or radiuses to match transition on stub end flange adapter. Improved Piping products - PPDI, or approved equal.

#### 2.06. BOLTS:

Bolts and nuts for buried mechanical joining components such as flanges shall be made of noncorrosive, high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any protective coating.

Flange assembly bolts shall be ANSI B18.2.1 standard square or hexagon head bolts with ANSI B18.2.2 standard hexagon nuts. Threads shall be ANSI B1.1, standard coarse thread series; bolts shall be Class 2A, nuts shall be Class 2B. Bolt length shall conform to ANSI B16.5.

### PART 3 -- EXECUTION

#### 3.01 PIPE HANDLING AND STORAGE

The Contractor shall use care in handling and storage of the pipe. Pipe shall be stored on clean, level ground to prevent undue scratching or gouging of the pipe. If the pipe must be stacked for storage, such stacking shall be done in accordance with the pipe manufacturer's recommendations. The handling of the pipe shall be done in such a manner that it is not damaged by dragging over sharp objects or cut by chokers or lifting equipment.

Sections of pipe with cuts, gouges, or scratches on the outside diameter (OD) surface that exceed 10-percent of the wall thickness of the pipe shall be removed completely and the ends of

the pipeline rejoined. The inside diameter (ID) surface shall be free of cuts, gouges, and/or scratches.

### 3.02 INSTALLATION

#### A. GENERAL:

Unless otherwise specified, the piping system shall be installed in accordance with ASTM D2321, ASTM F1962, AWWA C906 and the manufacturer's recommendations.

#### B. JOINING:

Pipe and fittings shall be joined into continuous lengths on the job site above ground. Unless otherwise specified, joining shall be by the butt-fusion method performed in accordance with the pipe manufacturer's recommendations and ASTM D2657. Socket fusion, extrusion welding and hot gas welding shall not be used.

The pipe supplier shall be consulted to obtain machinery and expertise for the joining by butt-fusion of HDPE pipe and fittings. No pipe or fittings shall be joined by fusion by any of the Contractor's personnel unless they are adequately trained and qualified in the techniques involved. Butt fusion joining shall yield a joint strength equal to or greater than the tensile strength of the pipe.

Flanged joining, or other mechanical joining methods specified, may be used to make connections to differing piping materials, to equipment, valves and other appurtenances, and where specified.

Internal beads formed at joints during butt fusion shall be removed from pipes that convey solids-bearing liquids. Joints shall be debanded on all buried pipes where the beading interferes with the deflection testing specified in paragraph 15065-3.03.C

#### C. INSTALLATION:

Horizontal directional drilling shall be per Section 02160. Trench excavation and backfill where required shall be per Section 02200.

#### D. LOCATION AND ALIGNMENT:

Pipe and fittings shall be placed in the trench with the invert conforming to the elevations, slopes, and alignments shown.

#### E. BEDDING AND BACKFILL:

Materials used for bedding and backfill shall be as specified in Section 02200 and as shown.

Place materials by methods that will not disturb or damage the pipe. All HDPE pipe shall be at the temperature of the surrounding soil at the time it is backfilled and compacted. Work in and tamp the bedding material in the area under the pipe and up to the spring line before placing and compacting the remainder of the embedment. Blocking under the pipe shall not be permitted.

Use compaction equipment and techniques that are compatible with materials specified and location in the trench. Before using heavy compaction or construction equipment directly over the pipe, place sufficient backfill to prevent damage, excessive deflections, or other disturbances of the pipe.

### 3.03 TESTING

#### A. HYDROSTATIC PRESSURE TESTING:

HDPE piping systems shall be fully pressure tested prior to placing the line into service. Water shall be the test medium for hydrostatically testing the pipe. Test procedures shall be conducted in accordance with Paragraph 3.09 of the Navajo Area Standards & Construction Requirements (See Appendix G), and at test pressures listed in Section 15050 and the following. In case of conflict, the following procedures shall apply.

Cover the pipe at intervals and/or at curves if necessary to hold the pipe in place during testing. Connections shall be left exposed for visual leak inspection.

After all free air is removed from the test section, the pressure in the pipe shall be raised at a steady rate to the required pressure. The pressure in the section shall be measured at the lowest point of the test section. Test pressure shall be as specified in Section 15050. The initial pressure shall be applied and allowed to stand without makeup pressure for 2-3 hours to allow for diametric expansion or pipe stretching to stabilize. After the equilibrium period, the test section shall be returned to the required test pressure and held for 3 hours. Amounts of makeup water allowable for expansion during the pressure test shall be as listed in the Plastic Pipe Institute Technical Report TR 31-88. No visual leaks or pressure drops shall be observed during the final test period.

#### B. DEFLECTION TESTING:

1. GENERAL: Deflection testing shall be performed on the entire length of installed pipe no sooner than 30 days after completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads. Deflection of pipe and fittings in the installed pipeline under external loads shall not exceed the maximum deflection specified in paragraph 15065-1.01 B. Either of the following devices and procedures may be used to measure deflection.

2. **PULL-THROUGH DEFLECTION TESTING:** The Contractor shall determine whether the allowable deflection has been exceeded by use of a pull-through device.

a. **PULL-THROUGH DEVICE:** This device shall be a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Circular sections shall be so spaced on the shaft that distance from external faces of front and back sections will equal or exceed diameter of the circular section. Pull-through device may also be of a design promulgated by the Uni-Bell Plastic Pipe Association, provided that the device meets the applicable requirements specified in this paragraph, including those for diameter of the device. Ball, cylinder, or circular sections shall conform to the following:

- (1) A diameter, or minor diameter as applicable, equal to the average inside diameter of the pipe minus the dimension equivalent of the maximum installed deflection specified in paragraph 15065-1.01 B. A tolerance of plus 0.5 percent in the diameter of the test device will be permitted.
- (2) A homogeneous material throughout, with a density greater than 1.0 as related to water at 39.2 degrees F, and a surface Brinell hardness of not less than 150.
- (3) Center bored and through bolted with a 1/4-inch minimum diameter steel shaft having a yield strength of not less than 70,000 pounds per square inch, with eyes or loops at each end for attaching pulling cables.
- (4) Each eye or loop shall be suitably backed with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.

b. **PULL-THROUGH DEVICE PROCEDURE:** Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water. If the device fails to pass freely through a pipe run, replace pipe which has the excessive deflection and completely retest in same manner and under same conditions as specified.

3. **DEFLECTION DEVICE:** The Contractor shall determine whether the allowable deflection has been exceeded by use of a deflection measuring device.

a. **DEFLECTION MEASURING DEVICE:** This device shall be sensitive to 1.0 percent of the diameter of the pipe being tested and accurate to 1.0 percent of the indicated dimension. The deflection measuring device shall be approved by the Construction Manager prior to use.

b. **DEFLECTION MEASURING DEVICE PROCEDURE:** Measure deflections through each run of installed pipe. If deflection readings in excess of the maximum



allowable specified in paragraph 15065-1.01 B are obtained, retest pipe by a run from the opposite direction. If retest continues to show a deflection in excess of the allowable, remove pipe which has excessive deflection, replace with new pipe, and completely retest in the same manner and under the same conditions.

### 3.05 DISINFECTION

A. Disinfection of HDPE piping shall be in accordance with the Navajo Area Standards & Construction Requirements, AWWA C651, and as specified in Section 15050.

\*\* END OF SECTION \*\*

SECTION 15085

PIPING CONNECTIONS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies the following methods of connecting metallic piping: flanges, threading, mechanical couplings, equipment connection fittings, dielectric unions, and welding.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). 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, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ANSI B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B18.2.1	Square and Hex Bolts and Screws Inch Series
ANSI B18.2.2	Square and Hex Nuts (Inch Series)
ANSI B31.1	Power Piping
ANSI B31.3	Chemical Plant and Petroleum Refinery Piping
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators Qualifications
ASTM B98	Copper-Silicon Alloy Rod, Bar and Shapes

Reference	Title
ASTM F37	Standard Test Methods for Sealability of Gasket Materials
ASTM F104	Standard Classification System for Nonmetallic Gasket Materials
ASTM F152	Standard Test Methods for Tension Testing of Nonmetallic Gasket Materials
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Service-Size 4 in. through 144 in.
AWWA C219	Bolted, Sleeve-Type Couplings for Plain-End Pipe
AWWA C550	Protective Epoxy Coatings for Valves and Hydrants
AWWA C606	Grooved and Shouldered Joints
AWWA M11	Steel Pipe-A Guide for Design and Installation
NSF 61	Drinking Water System Components - Health Effects

### 1.03 SUBMITTALS

In addition to the material listed in the detailed specification, the following submittals shall be provided in accordance with Section 01300:

1. For Equipment Connection Fittings used in pumping applications submit thrust rod stretch calculations in accordance with paragraph 2.01D. and dimensional layout data.

### PART 2--PRODUCTS

#### 2.01 FLANGE ASSEMBLIES

##### A. FLANGES:

1. GENERAL: Flanges shall either be flat flanges or convoluted ring flanges as specified in the following paragraphs.

2. FLAT FLANGES: Cast iron flanges shall be faced in accordance with ANSI B16.1. Where companion flanges are used, the flanges on pipe shall be refaced to be flush with the companion flange face. Class 150 and Class 300 forged steel flanges shall be raised face conforming to ANSI B16.5. Lightweight slip-on flanges shall be plain face conforming to AWWA C207, Class B and ANSI B16.5. Unless otherwise specified, steel flanges shall be ANSI B16.5, Class 150 or AWWA C207, Class D. Class E AWWA flanges shall be provided where test pressure exceeds 175 psi. Plain faced flanges shall not be bolted to raised face flanges.

3. CONVOLUTED RING FLANGES: Convoluted ring flanges shall be ductile iron, forged steel or cast stainless steel, designed to bear on hubs welded to the pipe and shall be as manufactured by Improved Piping Products. The Construction Manager knows of no equal. The flange joints shall be rated for not less than 150 percent of the test pressures listed in Section 15050 and shall conform to the requirements of ANSI B 16.5 and AWWA C207. The flange manufacturer shall be prepared to demonstrate, by certified pressure test that the flanges will meet these requirements.

B. GASKETS:

Gasket material shall be as specified in paragraph 15085-2.03.

Gaskets for plain faced flanges shall be the full face type. Thickness shall be 1/16 inch for pipe 10 inches and less in diameter and 1/8 inch for pipe 12 inches and larger in diameter. Unless otherwise specified, gaskets for raised face flanges shall match the raised face and shall be 1/16 inch thick for pipe 3-1/2 inches and less in diameter and 1/8 inch thick for pipe 4 inches and larger.

C. BOLTS:

Flange assembly bolts shall be ANSI B18.2.1 standard square or hexagon head bolts with ANSI B18.2.2 standard hexagon nuts. Threads shall be ANSI B1.1, standard coarse thread series; bolts shall be Class 2A, nuts shall be Class 2B. Bolt length shall conform to ANSI B16.5.

Unless otherwise specified, bolts shall be carbon steel machined bolts with hot pressed hexagon nuts. Bolts for submerged service shall be made of Type 316 stainless steel in conformance with ASTM F593, marking F593F. Nuts for submerged service shall be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100, designation H04 or alloy C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.

## 2.02 MECHANICAL COUPLINGS

A. SLEEVE-TYPE COUPLINGS:

Unless otherwise specified, sleeve-type mechanical pipe couplings shall be Smith-Blair Type 411, Dresser Style 38, or equal, with the stop removed from the middle ring. Reducing couplings shall be Smith-Blair Type 415, Dresser Style 62, or equal. Sleeve-type flanged coupling adapters shall be Smith-Blair Type 913, Dresser Style 128, or equal. Insulating couplings shall be Smith-Blair Type 416, Dresser Style 39, or equal.

Bolts for submerged service shall be made of Type 316 stainless steel in conformance with ASTM F593, marking F593F. Nuts for submerged service shall be made of copper-silicon alloy

bronze conforming to ASTM B98, alloy C65100, designation H04, or alloy C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.

Gaskets shall be as specified in paragraph 15085-2.03 and AWWA C111.

**B. PLAIN END COUPLINGS:**

Plain end pipe couplings for pipe sizes 6 inches and smaller shall be Gustin-Bacon 200, Victaulic Style 99, or equal for Schedule 80 pipe and Gustin-Bacon 205, Victaulic Style 90, or equal for lighter weight pipe. Plain end couplings for pipe sizes 8 inches and larger shall be Gustin-Bacon 200, Victaulic Style 99, or equal. Unless otherwise specified, bolts and nuts shall comply with AWWA C606.

Gaskets shall be as specified in paragraph 15085-2.03 and AWWA C606.

**C. GROOVED END COUPLINGS:**

Grooved end flexible-type couplings shall be Gustin-Bacon 100, Victaulic Style 77, or equal. Grooved end rigid-type couplings shall be Gustin-Bacon 120 Rigi-Grip, Victaulic Style 07 Zero-Flex, or equal. Flexible-type couplings shall be used for all piping greater than 12 inches in diameter; for pipe 12 inches in diameter and less in rack-mounted tunnel piping applications; and for grooved joints adjacent to pump or blower suction and discharge where grooved couplings are used for noise and vibration control. All other applications for piping 12 inches in diameter and less shall utilize rigid-type couplings. Grooved end flanged coupling adapters shall be either Gustin-Bacon 154, Victaulic Style 741, or equal. Snap-joint grooved end couplings shall be Gustin-Bacon 115, Victaulic Style 78, or equal. Cut grooves are not permitted on fabricated or lightwall pipe.

Unless otherwise specified, bolts and nuts shall comply with AWWA C606. Bolts for submerged service shall be Type 316 stainless steel in conformance with ASTM F593, marking F593F. Nuts for submerged service shall be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100, designation H04 or alloy C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.

Gaskets shall be as specified in paragraph 15085-2.03 and AWWA C 606.

**D. EQUIPMENT CONNECTION FITTINGS**

Equipment connection fittings shall provide both lateral and angular misalignment adjustment between equipment connection flanges and the connection to field piping systems by providing individually adjustable flexible joints at each connection. In addition, equipment

connection fittings shall provide full pressure thrust restraint between the field piping connection and equipment connection flanges.

Equipment connection fittings shall consist of two flanged coupling adapters, a plain end section of pipe and thrust restraint rods and associated fittings designed to transmit thrust without transmitting shear to the thrust restraint rods and without compromising provisions for accommodating angular and parallel misalignment. Materials and features shall conform to the requirements established in this paragraph. Standard “dismantling joints” incorporate only one flanged coupling adapter and are not acceptable substitutes. Equipment connection fittings shall be Romac ECF Series, or Baker Coupling Company, Los Angeles or equal, modified as specified to provide the required features.

Equipment connection fittings shall each consist of a single sleeve of plain end piping conforming to the requirements of the specified piping system of sufficient length to span the gap between the connection at the equipment and the connection at the field piping with gasketed flange adapters at each end. Thrust restraint shall be provided by means of all threaded rod spanning between flanges and male rod nuts and female washers that are rounded to provide a ball-joint type self aligning feature. All threaded restraint rod shall project through flange and mating flange coupling adapter bolt holes or through holes in restraint lug plates that extend above the flanges and are secured to the flanges with a minimum of two flange bolts. Where the all threaded rods project through flange bolt holes, ball joint type nut and washer combinations and lock washers shall be provided at each face, each end. Where restraint lug plates are employed, ball joint type nuts and washers shall be provided only on the outside faces of the plates and the nuts shall have a self locking feature that prevents nut movement due to vibration or other operational or environmental causes. Double nutting with non-locking nuts shall not be an acceptable method of providing the self locking feature. Thrust rod diameter and material shall be selected to provide sufficient freedom of movement through all bolt holes to allow unrestricted maximum adjustment of equipment connection fittings to accommodate piping misalignment without transmitting any shear to the thrust rods and also to permit full development of thrust restraint at all thrust rod tension take-ups. Design of equipment connection fittings shall conform to AWWA C219.

Thrust rods, restraint lug plates, nuts, washers and lock washers shall be Type 316 stainless steel, all selected to develop full rated piping system pressure thrust forces. Equipment connection fittings for pump applications shall have thrust rod number and diameter selected such that thrust rod stretch under piping system operating pressure does not exceed 2 mils. Calculations shall be submitted. Dry film molybdenum di-sulfide anti-galling compound shall be factory applied to ends of thrust rods, covering all threads subject to nut travel and tightening. Gaskets shall be as specified in paragraph 15085-2.03. Flange gaskets shall be full face type. Follower gaskets shall be compression wedge type.

Sleeves shall be carbon steel or as specified for the specific piping system. Pressure rating of flange adapters shall equal or exceed the pressure rating of mating flanges. All metal portions of equipment connection fittings, with the exception of 316 stainless steel components, shall be coated and lined with fusion bonded epoxy conforming to AWWA C550 and NSF 61.

## E. DISMANTLING JOINTS

Dismantling joints may be used as takedown couplings in accordance with paragraph 15085-3.03. Dismantling joints shall fully restrained double flange fittings consisting of a flange coupling adapter and flanged spool piece that allows for longitudinal adjustment. Thrust restraint shall be provided by means of all threaded rod spanning between flanges and secured to the flanges with a minimum of two flange bolts. Design of equipment connection fittings shall conform to AWWA C219. Sleeves shall be carbon steel or as specified for the specific piping system. Pressure rating of flange adapters shall equal or exceed the pressure rating of mating flanges. All metal portions of equipment connection fittings, with the exception of 316 stainless steel components, shall be coated and lined with fusion bonded epoxy conforming to AWWA C550 and NSF 61. Dismantling joints shall be Romac DJ-400, Smith Blair 975, or Crane-Viking Johnson Dismantling Joint.

## F. SLEEVE BAND COUPLINGS

Sleeve band couplings shall be Victaulic Depend-O-Lock. Unless otherwise noted, couplings for liquid service shall be Model F x F Type 2 fully restrained, shouldered high deflection couplings with standard width band. Couplings shall comply with AWWA C-219. Couplings for use with air systems shall be Airmaster restrained Depend-O-Lock couplings in conformance with AWWA C-606. Sleeve band couplings are acceptable wherever sleeve type couplings are used (paragraph 15085-2.02 A.)

## G. FLEXIJOINT

Where specified Flexijoint couplings shall be Flanged Romac Flexijoint couplings. The Flexijoint is a flexible, ductile iron joint that can accommodate expansion, contraction, rotation and bending and is rated at 350 psi working pressure. The joint can accommodate 15 to 20 degree deflection depending on size. Body shall be ductile iron, lock rings Type 410 stainless steel, and ring gasket, casing, ball and cover shall be EPDM molded watertight construction. All metal portions of Flexijoint coupling including the stainless steel lock rings shall be coated and lined with fusion bonded epoxy conforming to AWWA C550 and NSF 61. For buried installations, install with polyethylene baggy cover in accordance with the manufacturer's instructions.

## 2.03 GASKETS

Gaskets designated in Section 15050 shall be as follows:

1. EPDM: ethylene-propylene-diene-terpolymer.
2. Neoprene: neoprene.
3. Nitrile: nitrile (Buna N).

4. Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder; ASTM F104 (F712400), 2500 psi (ASTM F152), 0.2 ML/HR LEAKAGE FUEL A (ASTM F37).
5. Compressed gasketing consisting of organic fibers (Kevlar) and SBR binder; ASTM F104 (F712400), 2500 PSI (ASTM F152), 0.1 ml/hr leakage Fuel A (ASTM F37).
6. Gylon gasketing, Garlock Style 3500, 2000 psi (ASTM F152), 0.22 ml/hr Fuel A (ASTM F37).
7. Gylon gasketing, Garlock Style 3510, 2000 psi (ASTM F152), 0.04 ml/hr Fuel A (ASTM F37).
8. Gylon gasketing, Garlock Style 3504, 2000 psi (ASTM F152), 0.12 ml/hr Fuel A (ASTM F37).
9. TFE: noncreeping tetrafluoroethylene (TFE) with insert filler.
10. PTFE bonded EPDM: PTFE bonded to EPDM in full-face gasket having concentric-convex molded rings; Garlock Stress Saver 370 or equal.

#### 2.04 THREAD

Pipe thread dimensions and size limits shall conform to ANSI B1.20.1.

#### 2.05 DIELECTRIC UNIONS

Dielectric unions shall be EPCO, Capitol Manufacturing, or equal.

#### 2.06 COATINGS

Unless otherwise specified, flange assemblies and mechanical type couplings for buried installation shall be field coated with System M-1 as specified in Section 09900.

#### 2.07 PRODUCT DATA

In accordance with Section 01300, the Contractor shall provide for each welder, a welder qualification certificate indicating the welder is certified for pipe welding in accordance with ASME Boiler and Pressure Vessel, Section IX. Each welder's certificate shall be provided to the Construction Manager prior to that welder working on the job.

### PART 3--EXECUTION



### 3.01 PIPE CUTTING, THREADING AND JOINTING

Pipe cutting, threading and jointing shall conform to the requirements of ANSI B31.1.

### 3.02 PIPE WELDING

Pipe shall be welded by ASME-certified welders using shielded metal arc, gas shielded arc or submerged arc welding methods. Welds shall be made in accordance with the requirements of ANSI B31.1 for piping Systems 8, 26, and 28 specified in Section 15050. Welds shall be made in accordance with the requirements of ANSI B31.3 for piping System 20 specified in Section 15050. Welds for piping systems not specified above shall be made in accordance with AWWA C206.

### 3.03 TAKEDOWN COUPLINGS

Takedown couplings shall be screw unions, flanged or grooved end mechanical coupling type joints and shall be provided as specified. Flanged or grooved end joints shall be employed on pipelines 2-1/2 inches in diameter and larger. Where piping passes through walls, takedown couplings shall be provided within 3 feet of the wall, unless specified otherwise.

A union or flanged connection shall be provided within 2 feet of each threaded end valve.

### 3.04 FLEXIBILITY

Unless otherwise specified, piping passing from concrete to earth shall be provided with two pipe couplings or flexible joints (or a single Flexijoint) as specified on the buried pipe within 2 feet of the structure for 2-inch through 6-inch diameter pipe; within 3 feet of the structure for 8-inch through 24-inch diameter pipe; and within one and one-half pipe diameters of the structure for larger pipe. Where required for resistance to pressure, mechanical couplings shall be restrained in accordance with Chapter 13 of AWWA M11, including Tables 13-4, 13-5 and 13-5A, and Figure 13-20.

### 3.05 DIELECTRIC CONNECTIONS

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 as specified in paragraph 15085-2.05 may be used instead of the specified insulating sections. Where copper pipe is supported from hangers, it shall be insulated from the hangers, or copper-plated hangers shall be used.

### 3.06 EQUIPMENT CONNECTION FITTINGS

Where shown, equipment connection fittings shall be provided between field piping systems and equipment inlet and outlet connections.

**\*\* END OF SECTION\*\***

Piping Connections  
15085-8

Bodaway-Gap Contract 2  
Bid Issue

SECTION 15102

RESILIENT-SEATED GATE VALVES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies iron-body, resilient-seated gate valves.

1.02 QUALITY ASSURANCE

A. REFERENCES:

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.

Reference	Title
ANSI B16.1-89	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800
ASTM A126-84	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
AWWA C111-17	Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C550	Protective Interior Coatings for Valves and Hydrants
AWWA C509-15	Resilient-Seated Gate Valves for Water Supply Service
NTUA	Navajo Area Standards & Construction Requirements

PART 2--PRODUCTS

2.01 GATE VALVES FOR WATER MAINS

Gate valves 3 through 12 inches in size shall comply with AWWA C509, including applicable hydrostatic testing. The seal shall be drop-tight. All internal and external surfaces of the valve including the interior of the gate shall be coated with a two part epoxy coating in accordance with AWWA C550.

Valve working pressure rating shall the greater of 235 psi minimum or equal to or greater than the rated pressure of the waterline on which the valve is installed.

Gate valves shall be supplied by a single manufacturer.

Resilient Seated Gate Valves  
15102-1

## 2.02 MATERIALS

The body of the valve shall be cast iron, with a full round port opening equal to or exceeding the diameter of the corresponding pipe. The body shall have integrally cast guides to insure the gate is properly guided through complete travel, and shall be free of pockets and bridges in the valve bottom.

The sealing mechanism shall consist of a free draining bi-directional compression seating gate, which ensures a 100 percent bubble tight seal in the closed position against the line flow. The gate shall be constructed with a rubber seal mechanically retained between two epoxy coated gate halves which are securely fastened with stainless steel recessed capscrews.

Gate valves shall be of the nonrising stem type. The stem shall be 400 series stainless steel and shall be independent of the bronze stem nut. A four bolt bonnet cover shall contain a grit and dust cap protecting two O-ring stem seals and the nylon bushing located above the stem collar. A teflon washer shall be located between the stem collar and bonnet as an antifriction device.

End connections shall be furnished as specified in Section 15050 and shown on the drawings. Mechanical joints are to be per ANSI/AWWA C111/A21.11; flanged joints shall conform to ANSI standard B16.1, Class 150. End connections shall be restrained.

## 2.03. MANUAL OPERATORS:

Gate valves shall be provided with counter clockwise opening geared operators.

Exposed valves shall be supplied with an enclosed bevel gear and handwheel to permit side operation.

Buried valves shall be provided with enclosed spur gears and 2" square operating nuts to permit operation through a valve box from above.

## 2.04 VALVE BOXES

Valve boxes shall be installed on all buried valves and shall be 5-1/4-inch Nominal diameter shaft, two-piece adjustable screw type equal to Tyler no. 6850 series. The length of the box shall be sufficient to permit access to the valve at the specified depth of bury. Tyler series extensions will be utilized to extend the valve box when required. The word "water" shall be cast onto the Lid.

## 2.05 SUBMITTAL DATA

The following information shall be provided in accordance with Contractor submittal requirements:

1. Full product submittal including manufacturer's cut sheets, details of construction, and product information.

Resilient Seated Gate Valves  
15102-2

Bodaway-Gap Contract 2  
Bid Issue

## PART 3--EXECUTION

### 3.01 VALVE INSTALLATION

Gate valves shall be installed in the closed position.

Before installing the valve, care shall be taken to see that all foreign material and objects are removed from the interior of the valve. The valve shall be opened and closed to see that all moving parts are in working order.

All valves shall be set and jointed to the pipe in the manner as set forth in the AWWA Standards for the type of connecting ends furnished. All valves shall be set in and tied to poured in-place concrete support blocks as per the IHS Standard Detail.

Valves and valve boxes shall be set plumb and valves boxes shall be placed over the valve in such a manner that the valve box does not transmit shock or stress to the valve. The cast iron valve box cover shall be set flush with, or slightly above, the finished grade. A 2-foot by 2-foot by 4-inch reinforced concrete pad shall be poured around each valve box. Before the concrete has hardened, the Contractor shall neatly scribe in the concrete pad the valve size and a line representing the direction of flow of water through the valve.

**\*\*END OF SECTION\*\***

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Resilient Seated Gate Valves  
15102-4

Bodaway-Gap Contract 2  
Bid Issue

## SECTION 15118

### SPRING-LOADED SWING CHECK VALVES

#### PART 1--GENERAL

##### 1.01 DESCRIPTION

This section specifies spring-loaded swing check valves.

##### 1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). 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, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A536	Ductile Iron Castings
ASTM B148	Aluminum-Bronze Sand Castings
AWWA C508	Swing-Check Valves for Waterworks Service, 2 In. Through 24 In. NPS

#### PART 2--PRODUCTS

##### 2.01 MANUFACTURERS

Candidate manufacturers include Golden Anderson, APCO or equal.

Spring-Loaded Swing Check Valves  
15118-1

## 2.02 MATERIALS

Materials of construction shall be as follows:

Component	Material
Body, cover	Cast iron, ASTM A126, Class B
Disc	Ductile iron, ASTM A536
Seat rings	Aluminum bronze, ASTM B148 or Stainless steel, ASTM A276, Type 316
Hinge shafts and hinge pins	Stainless steel, ASTM A276, Type 301 or 304
Shaft bushings	Bronze, AWWA C508

Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

## 2.03 MANUFACTURE

Disc, disc arm, shaft, keyways, lever and spring shall be capable of closing within .05 seconds of pump stoppage and fluid moving at velocity of 8 feet per second. Spring tension shall be adjustable. The valve design shall permit mounting levers and springs on either side of the valve. The design of the spring attachment shall permit adjustment of closing force by tensioning the spring or replacement with different active length springs.

Valves shall be provided with a clear opening equal to or greater than the connecting piping, with no raised seating surface. Seats shall be threaded onto the body or fitted with an O-ring seal and locked in place with stainless steel screws or pins and shall be replaceable. Shafts shall be provided with stuffing box and packing or O-ring seals at each end. Seals shall be externally replaceable. Minimum shaft diameters shall be as follows:

Valve Inlet Connection Size, inches	Shaft diameter, inches
3	0.75
4	0.825
6	1.0

The pivot arm shall be secured to the disc with either twin bolted connections with lockwashers or a pinned nut. In either instance, the connection shall be designed to prevent disc movement relative to the arm. Shaft bearings shall extend the entire length of the shaft other than

Spring-Loaded Swing Check Valves

15118-2

the section required for the disc arm attachment. Disc and lever arms shall be keyed to the shaft and retained by bushings or pins.

Unless otherwise specified, valves shall, as a minimum, conform to the following pressure ratings:

Size, inches	Working pressure, pressure, psig	Hydrostatic test
2 through 12	175	350

Check valves wetted parts shall be coated with fusion bonded epoxy.

#### 2.04 SUBMITTAL DATA

Manufacturer's catalog information including dimensions, cross-sectional views, details of construction and materials list shall be provided in accordance with Section 01300.

#### PART 3--EXECUTION

Spring loaded swing check valves shall be installed in accordance with the manufacturer's recommendations.

**\*\*END OF SECTION\*\***



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Spring-Loaded Swing Check Valves  
15118-4

Bodaway-Gap Contract 2  
Bid Issue

SECTION 15125

STEEL PIPE CASING

PART 1 GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies steel pipe casings to be installed by directional drilling or open excavation. The Contractor shall make a complete submittal of the installation methods and materials for review and acceptance prior to the commencement of work and shall be responsible to coordinate permit requirements, casing spacers, carrier pipe, restraint systems, end seals and testing to provide a complete and properly installed carrier pipe and casing.

The Contractor shall obtain insurance and permits as required by the utility, railroads or roadways where casings are specified and include in the bid price all associated insurance and permits costs necessary to complete the work.

B. DEFINITIONS:

1. CARRIER PIPE: Pipe installed within the casing pipe.

C. REFERENCE STANDARDS

The publications listed below form part of this specification to the extent referenced and are referred to in the text by the basic designation only. References shall be made to the latest edition of said standards unless otherwise called for.

Reference	Title
ASTM A283	Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
AWWA C200	Standard for Steel Water Pipe 6 Inches and Larger.
AWWA C206	Standard for Field Welding of Steel Water Pipe.
AWS D1.1	Structural Welding Code.
IHS	Standard Drawing No. W-24
IHS	Standard Drawing No. W-35

1.02 QUALITY ASSURANCE

A. LINE AND GRADE

The Contractor shall be responsible to obtain the required line and grade for the carrier pipe. The carrier pipe shall be fully supported by casing spacers and not contact or rest on the casing.

## B. WELDING REQUIREMENTS

All welding shall be performed by qualified welding operators in accordance with the requirements of ANSI/AWWA C206 and ANSI/AWS D1.1.

All welding procedures shall be either pre-qualified in accordance with ANSI/AWS D 1.1 for full penetration welds, or qualified by testing, as required.

### 1.03 SUBMITTALS

Submittals shall be in accordance with Section 01300.

Submit the following prior to commencement of the Work:

- A. Pipe casing; diameter, thickness, materials, class of steel per ASTM standard, design calculations, linings or coatings and welding procedures and details.
- B. Installation plan detailing the length and placement of the casing, installation procedures, lubricants, schedule, equipment, safety plan and contingency plan.
- C. Record copies of potholes performed
- D. Product data for carrier pipe, carrier pipe restraint systems, casing spacers, and end seals
- E. Record copies of required permits
- F. Welder Certificates: Certify welders and welding procedures employed on the work, verifying AWS qualification for the project weld types within the previous 12 months. Qualify procedures and personnel according to AWS D1.1.

### 1.04 DESIGN REQUIREMENTS

The Contractor shall submit structural and deflection calculations for provided steel casings. Design calculations shall demonstrate adequacy of the steel grade and thickness to withstand service loading (earth, live and hydrostatic loads), buckling and installation forces. Pipe shall be capable of withstanding the forces imposed by the process of installation, as well as the final in-place loading conditions. Design calculations shall be signed and stamped by a Licensed Professional Engineer of the State of Arizona.

The minimum wall thickness shall not be less than specified or less than required by the agency having jurisdiction over the road, railroad or utility.

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The minimum length of the casing shall be the greater of the length shown, extents shown on Standard Drawing No WS-17a or per the minimum length per approved permit.

## PART 2 -- MATERIALS

### 2.01 PIPE CASINGS

- A. Pipe shall be steel, plain end, have minimum yield point strength of 35,000 psi and conform to ASTM A 283/A 283M, Grade D unless otherwise specified. Permaolok steel casing pipe and other steel grades may be used upon review and acceptance by the Construction Manager. Provide Permalok casing pipe as manufactured by Permalok Corporation, 472 Paul Avenue, St. Louis, MO 63135 (800-280-5511), or equal.
- B. The ends of the pipe shall be perpendicular to the longitudinal axis of the pipe with a maximum deviation of no more than 1/16 inch per foot of pipe diameter, with a maximum of ¼ inch, measured with a square and a straight edge across the end of the pipe.
- C. Pipe ends shall be square and smooth so that installation loads are evenly distributed against the pipe end faces without point loads when the pipe is installed.
- D. The exterior of the casing pipe shall be coated with coal tar epoxy or bituminous asphalt.

### 2.02 CASING SPACERS

Wood skids shall be provided per Standard Drawing No. WS-18. At the Contractor's option, manufactured casing spacers may be stainless steel, centered-restrained position type with PVC liner and non-metallic anti-friction runners.

### 2.03 CASING END SEALS

Unless otherwise specified, casing end seals shall be synthetic rubber, conical shape, pull-on or wrap-around style, minimum ¼" thick with Type 304 stainless steel bands.

### 2.04 WARNING/IDENTIFICATION TAPE

Where casings are installed in open cut excavations, Warning/Identification Tape materials shall be provided.

## PART 3 -- EXECUTION

### 3.01 GENERAL

Proper care shall be used to prevent damage in handling, moving and placing casing pipe. All pipe shall be lowered into the trench in a manner that prevents damage and shall not be dropped, dragged or handled in a manner that will cause dents, cracks, or other damage.

### 3.02 PROTECTION OF EXISTING UTILITIES AND FACILITIES

The Contractor shall be responsible for the care and protection of all existing utilities, facilities, and structures in or near the area of the work.

The Contractor shall pothole existing utilities within and adjacent to proposed location of casings. Coordinate potholing and casing installation with the utility owners.

### 3.03 CARRIER PIPE INSTALLATION

Upstream and downstream elevations of the casing and the required line and grade of the carrier pipe shall be field verified prior to installing the carrier pipe.

Carrier pipe shall be pushed into the casing incorporating the use of casing spacers. PVC carrier pipe joints shall be mechanically restrained. The annular space between the carrier pipe and casing shall be not be backfilled.

The portion of carrier pipe installed within a casing shall be tested prior to installation of the end seals or backfill of the annular space.

### 3.04 CASING SPACERS

Skids or spacers shall be used to prevent the carrier pipe bell from touching the casing and to maintain a uniform space between the carrier pipe and casing interior. Wooden skids shall be installed per Standard Drawing No. WS-18. Casing spacers shall be installed on the carrier pipe at intervals per the manufacturer's recommendations with a minimum of three spacers per pipe section equally spaced.

### 3.05 CASING END SEALS

Casing end seals shall be provided for all casings and shall be installed in accordance with the manufacturer's recommendations.

### 3.06 TOLERANCES

- A. Casing Pipe Vertical and Horizontal Alignment: Plus or minus 3 inches prior to installation of carrier pipe.
- B. Pipe Bells: Minimum 3/4-inch clearance to casing inside diameter.

**\*\*END OF SECTION\*\***

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## SECTION 15150

### AIR RELEASE AND VACUUM VALVES FOR CLEAN WATER SERVICE

#### PART 1--GENERAL

##### 1.01 DESCRIPTION

###### A. SCOPE:

This section specifies air release valves, air and vacuum valves, and combination air valves for clean water service, pumping, and storage applications.

###### B. TYPES:

1. **AIR RELEASE VALVES:** Air release valves (ARV) shall have a small venting orifice to vent the accumulation of air and other gases with the line or system under pressure. Size and capacity shall be as specified.

2. **AIR AND VACUUM VALVES:** Air and vacuum valves (AVV) shall have a large venting orifice to permit the release of air as the line is filling or relieve the vacuum as the line is draining or is under negative pressure. Size and capacity shall be as specified.

3. **COMBINATION AIR VALVES:** Combination air valves (CAV) shall have operating features of both the air and vacuum valve and the air release valve. They include both single- and dual-body construction. Size and capacity shall be as specified.

4. **AIR VALVES FOR VERTICAL TURBINE PUMPS:** Air valves for vertical turbine pumps (ATP) shall consist of an air and vacuum valve with throttling device for sizes 3-inch and less, and a dual body construction combination air valve mounted on top of a surge check for sizes 4-inch and larger. Size and capacity shall be as specified.

##### 1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). 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, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A240	Heat-Resisting Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels

## PART 2--PRODUCTS

### 2.01 ACCEPTABLE PRODUCTS

Air release and vacuum valves shall be APCO as manufactured by Valve and Primer Corporation, Crispin as manufactured by Multiplex Manufacturing Company, or equal, modified to provide the specified features and to meet the specified operating conditions.

### 2.02 MATERIALS

Component	Material
Body, cover	Cast iron, ASTM A126, Grade B
Float	Type 316 SS, ASTM A240
Seat	Buna-N or Type 316 SS
Trim	Type 316 SS, ASTM A240

Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

### 2.03 CONSTRUCTION

Air release valves shall be float operated, compound lever type, except air release valves less than 1-inch may be simple lever type.

Air and vacuum valves shall be designed to protect the float from direct contact of the rushing air and water to prevent the float from closing prematurely in the valve. The seat shall be fastened into the valve cover, and shall be easily removed if necessary. The float shall be center or peripheral guided for positive shutoff into the seat.

Combination air valves, unless otherwise specified, shall be single-body construction in sizes 1- through 6-inch and dual-body construction in sizes 8-inch and larger. Single-body construction shall be designed to provide all functions within one housing. The body inlet shall be baffled to protect the float and the large and small orifices shall be designed so that during large orifice closure, the small air release orifice will open to allow small amounts of air to escape. Dual-body construction shall combine one air and vacuum valve and one air release valve with interconnecting piping and gate valve. All combination air valves shall be 1-inch in size.

Air valves for vertical turbine pumps (sizes 3-inch and less) shall be designed and constructed as specified for air and vacuum valves except the discharge orifice shall be fitted with a throttling device to regulate and restrict air venting and establish a pressure loading on the rising column of water on pump start. Unless otherwise specified, air valves, 4-inch and larger, shall be dual body combination air valves except the inlet shall be fitted with a surge check to prevent water column entering the valve on pump start.

Valves shall be suitable for pressures up to 150 psi.

#### 2.04 PRODUCT DATA

The following information shall be provided in accordance with Section 01300:

1. Manufacturer's product data.
2. Applicable O&M instruction manuals per Section 01730.

#### PART 3--EXECUTION

Air release and vacuum valves shall be installed in accordance with the manufacturer's recommendations. Unless otherwise specified, isolation valves per Section 15050 shall be provided below each air valve. Piping from air release and vacuum valves shall be provided to equipment drains or floor drains, located in the Well Pump House No. 3 for the disposal of nuisance water releases.

**\*\*END OF SECTION\*\***



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SECTION 15184

MANUAL VALVE AND GATE OPERATORS AND  
OPERATOR APPURTENANCES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies manual operators for valves and operator appurtenances.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). 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, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AWWA C500	Gate Valves 3 through 48 inch NPS, for Water and Sewage Systems
NTUA	Navajo Area Standards & Construction Requirements

PART 2--PRODUCTS

2.01 GENERAL

Except as specified in valve specification sections, manual operators shall be as specified herein. Operators shall be mounted on the valve and provided as a unit. Each valve body or operator shall have cast thereon the word "OPEN," an arrow indicating the direction to open, and flow direction arrows.

## 2.02 OPERATORS

### A. GENERAL:

Manual operators shall have operating torques less than 80 foot-pounds. Unless specified otherwise, each manual operator shall be provided with an operating wheel. Unless specified otherwise, the direction of rotation of the operator shall be counterclockwise for opening.

### B. WRENCH NUTS:

Wrench nuts shall comply with Section 3.15 of AWWA C500. A minimum of two operating keys, but no less than one key per every ten valves, shall be provided for operation of the wrench nut operated valves.

### C. CHAIN WHEELS:

Chain wheels shall be ductile iron. Operating chains shall be galvanized.

## 2.03 OPERATOR APPURTENANCES

### A. VALVE BOXES:

Valve boxes shall be cast iron and shall have suitable base castings to fit properly over the bonnets of their respective valves and heavy top sections with stay-put covers. Covers shall be hot-dip galvanized.

### B. FLOOR BOXES:

Floor boxes shall be hot-dip galvanized. Where the operating nut is in the concrete slab, the floor box shall be bronze bushed. Where the operating nut is below slab, the opening in the bottom of the box shall be sufficient for passage of the operating key.

### C. ADJUSTABLE SHAFT VALVE BOXES:

Adjustable shaft valve boxes shall be concrete or cast iron Brooks No. 3RT, Christie G5, Empire 7-1/2 valve extension box, or equal. Box covers on water lines shall be impressed with the letter "W." Gas line covers shall be impressed with the letter "G."

## 2.04 PRODUCT DATA

Manufacturer's catalog information and other data confirming conformance to design and material requirements shall be provided in accordance with Section 01300.

## PART 3--EXECUTION

### 3.01 GENERAL

Installation shall be as specified herein. Valve operators shall be located so that they are readily accessible for operation and maintenance. Valve operators shall be mounted for unobstructed access, but mounting shall not obstruct walkways. Valve operators shall not be mounted where shock or vibration will impair their operation. Support systems shall not be attached to handrails, process piping, or mechanical equipment.

### 3.02 OPERATORS

#### A. GENERAL:

Valves shall be provided with manual operators, unless specified otherwise. Where possible, manual operators shall be located between 48 inches and 60 inches above the floor or a permanent work platform.

#### B. WRENCH NUTS:

Wrench nuts shall be provided on buried valves, on valves which are to be operated through floor boxes, and where specified. Extended wrench nuts shall be provided if necessary so that the nut will be within 6 inches of the valve box cover.

#### C. CHAIN WHEELS:

Unless otherwise specified, valves with centerlines more than 7 feet, 6 inches above the specified operating level shall be provided with chain wheels and operating chains. Chain wheel operated valves shall be provided with a chain guide. Operating chains shall be looped to extend within 4 feet of the specified operating level below the valve. For plug-type valves 8 inches and larger, the operator shall be provided with a hammer blow wheel. Hooks shall be provided for chain storage where the chain may hang in a walkway.

### 3.03 OPERATOR APPURTENANCES

#### A. VALVE BOXES:

Valve boxes extending to finished surfaces shall be provided for buried valves.

#### B. FLOOR BOXES:

Floor boxes shall be provided for wrench operation of valves located below concrete slabs. Each floor box and cover shall be of the depth required for installation in the slab.

**\*\*END OF SECTION\*\***

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Navajo Nation  
WESTERN NAVAJO PIPELINE PHASE 1

BC PROJECT NO.: 150360

BODAWAY-GAP WELL, STORAGE TANK AND PIPELINE

DIVISION 16

ELECTRICAL

16000	General Requirements for Electrical Work
16030	Electrical Acceptance Testing
16155	Individual Motor Starters
16431	Arc Flash Analysis, Short Circuit Study, and Protective Device Coordination Report

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## SECTION 16000

### GENERAL REQUIREMENTS FOR ELECTRICAL WORK

#### PART 1--GENERAL

##### 1.01 DESCRIPTION

###### A. SCOPE:

This section specifies general requirements for electrical work for modifications to the Bodaway-Gap water system. Detailed requirements for specific electrical items are specified in other sections but are subject to the general requirements of this section. The electrical drawings and schedules included in this project manual are functional in nature and do not specify exact locations of equipment or equipment terminations.

Schedule and coordinate work to minimize water system control outages. Refer to Sections 01014 and 17900.

Summary of work, is further detailed in Section 17000:

1. Bodaway-Gap Tank exists. This site communicates with existing and new system sites via existing telemetry, and relays signals to the Electrical Substation for communication with other water systems and SCADA. Provide SCADA and altitude valve.
2. Bodaway-Gap Well No. 1 exists.
3. Bodaway-Gap Well No. 2 exists.
4. Provide Bodaway-Gap Tank No. 2. Provide equipment, telemetry, and solar power system. Test and verify operation of Well 3 to control tank level.
5. Provide Bodaway-Gap Well No. 3. Provide equipment and telemetry inside building.
6. Bodaway-Gap Electrical Substation exists. Provide telemetry. This site relays signals to the existing Bodaway-Gap Tank from the Cameron Pump Station No. 2 and 3 (separate contract), and Cedar Ridge Pump Station No. 1 and 2 (separate contract) via telemetry for communication with SCADA. Provide telemetry.
7. Preston Mesa Site exists. This site provides telemetry to SCADA interface for the Bodaway-Gap system, Cameron Pump Station No. 2 and 3 (provided



under separate contract), and Cedar Ridge Pump Station No. 1 and 2 (provided under separate contract). Provide SCADA.

8. Provide motor starters and telemetry units per details from Navajo Area Indian Health Service/NTUA – Technical Provisions 4.0 included in the Drawings.
9. Provide work as specified and per Indian Health Services – Navajo Nation – Standard Drawings.
10. Provide testing per Section 01660, 16030, and 17030.
11. Provide arc flash hazard analysis and labeling per Section 16431.
12. Telemetry PLC and touchscreen programming will be provided as specified in Paragraph 17000-1.01 B, coordinate work, programmers, and provide testing. Refer also to Section 17000.
13. Equipment to be Owner furnished:
  - a. Only that which is labeled as “EXISTING” on drawings.
14. All replaced or removed items shall be salvaged. Salvaged items shall be properly disconnected to retain their full salvage value and cleaned before turning over to the Owner.
15. Work for this system is related to work for two other water systems, refer to Spec. 01010.

**B. DEFINITIONS:**

1. **ELEMENTARY OR SCHEMATIC DIAGRAM:** A schematic (elementary) diagram shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement. The schematic diagram facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or parts.

2. **ONE-LINE DIAGRAM:** A one-line diagram shows by means of single lines and graphical symbols the course of an electrical circuit or system of circuits and the components, devices or parts used therein. Physical relationships are usually disregarded.

3. **BLOCK DIAGRAM:** A block diagram is a diagram of a system, instrument, computer, or program in which selected portions are represented by annotated boxes and interconnecting lines.

4. **WIRING DIAGRAM OR CONNECTION SYSTEM:** A wiring or connection diagram includes all of the devices in a system and shows their physical relationship to each other including terminals and interconnecting wiring in an assembly. This diagram shall be (a) in a form showing interconnecting wiring only by terminal designation (wireless diagram), or (b) a panel layout diagram showing the physical location of devices plus the elementary diagram.

5. **ARRANGEMENT, LAYOUT, OR OUTLINE DRAWINGS:** An arrangement, layout, or outline drawing is one which shows the physical space and mounting requirements of a piece of equipment. It may also indicate ventilation requirements and space provided for connections or the location to which connections are to be made.

1.02 **QUALITY ASSURANCE**

A. **REFERENCES:**

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). 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, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
NECA-1	National Electrical Contractors Association – Standard Practices for Good Workmanship in Electrical Contracting
NFPA	National Fire Protection Association
NFPA-70	National Electrical Code (NEC) 2011
NFPA-70E	Electrical Safety in the Workplace
ACI 318	Building Code Requirements for Structural Concrete
	Navajo Area Indian Health Service/NTUA – Technical Provisions 4.0 for Motor Control Center and Tank Control Panel
	Indian Health Service – Navajo Nation – Standard Drawings

General Requirement for Electrical Work  
16000-3

**B. IDENTIFICATION OF LISTED PRODUCTS:**

Electrical equipment and materials shall be listed for the purpose for which they are to be used, by an independent testing laboratory. Three such organizations are Underwriters Laboratories (UL), Canadian Standards Association (CSA), and Electrical Testing Laboratories (ETL). Independent testing laboratory shall be acceptable to the inspection authority having jurisdiction.

When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority, to undergo inspection at the manufacturer's place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.

**C. FACTORY TESTS:**

Where specified in the individual product specification section, factory tests shall be performed at the place of fabrication and performed on completion of manufacture or assembly. The costs of factory tests shall be included in the contract price.

**D. POWER UTILITY:**

The power utility is Navajo Tribal Utility Authority (NTUA).

1. Coordinate power utility disconnection and connection with the power utility. Provide installations per their requirements.
2. Provide submittals per paragraph 1.03 B.

**1.03 SUBMITTALS**

The following submittals shall be provided in accordance with Section 01300:

**A. SHOP DRAWINGS:**

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. A copy of the contract document Drawings E-100 through E-140 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
3. Catalog cuts of equipment, devices, and materials for products to be provided. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc. Catalog cuts shall be edited to show only the items, model numbers, and information which apply. Submit catalog cuts for only the following:
  - a. Service Entrance Meter Socket.
  - b. Any proposed alternates to specified manufacturers and model equipment.
  - c. Well pump motor starter shall be submitted separately under Section 16155.

**B. POWER UTILITY:**

1. After shop drawing review, submit Service Entrance Meter Socket to power utility for review:
  - a. Bodaway-Gap Well 3.

**1.04 DRAWINGS**

Where the Contractor is required to provide information on drawings as part of the specified work, such drawings shall be prepared on 11 by 17 inch drafting media complete with borders and title blocks clearly identifying project name, equipment and the scope of the drawing.

Drawing quality and size of presentation shall be such as to permit 50 percent reduction of such drawings for insertion in operation and maintenance manuals.

## 1.05 PROJECT/SITE CONDITIONS

### A. GENERAL:

Unless otherwise specified, equipment and materials shall be sized and derated for the ambient conditions specified in Section 01800, but not less than an ambient temperature of 45 degrees C at an elevation ranging from sea level to 6,500 feet without exceeding the manufacturer's stated tolerances.

### B. CORROSIVE AREAS:

The following areas are designated as corrosive:

- a. Well pump house chlorine room

### C. HAZARDOUS (CLASSIFIED) AREAS:

The following areas are designated as hazardous (classified) in accordance with the NEC:  
None.

### D. SEISMIC:

Electrical equipment, supports, and anchorage shall be designed and installed in accordance with the seismic design requirements specified in Section 01900 and on the Structural drawings.

## 1.06 STORAGE OF MATERIALS AND EQUIPMENT

Materials and equipment shall be stored as specified in paragraph 01605-3.0 E. Equipment and materials to be located indoors shall be stored indoors and sealed with plastic film wrap.

## PART 2--PRODUCTS

### 2.01 EQUIPMENT AND MATERIALS

#### A. GENERAL:

Equipment and materials shall be new and free from defects. All material and equipment of the same or a similar type shall be of the same manufacturer throughout the work. Standard production materials shall be used wherever possible.

#### B. EQUIPMENT FINISH:

Unless otherwise specified, electrical equipment shall be painted by the manufacturer.

### 2.02 600 VOLT WIRE AND CABLE

General Requirement for Electrical Work  
16000-6

A. INSULATION:

1. MEPR/CPE multi-conductor control cable, XLP or CPE insulation and jacket.
2. XHHW-2 for single conductors
3. THWN for indoor lighting and receptacles
4. PVC jacket and insulation for shielded signal cables.
5. Coaxial cable as specified in Section 17000.
6. Ethernet cable, CAT6 with factory attached RJ-45 connections.
7. SOOW or SJOOW for portable cord.

B. CONDUCTORS:

1. Copper, stranded per ASTM B8.

C. COLOR CODING:

1. CONTROL CONDUCTORS:

Single-conductor control conductors shall have the following colors for the indicated voltage:

Control Conductor	120V
Power (AC)	Black
Control (AC)	Red
Neutral	White
Ground	Green
Power (DC)	Blue
Control (DC)	Violet

2. POWER CONDUCTORS:

Power conductors shall have the following colors for the indicated voltage:

Power Conductor	480V	208/120V
Phase A	Brown	Black
Phase B	Orange	Red
Phase C	Yellow	Blue
Ground	Green	Green
Neutral	-	White

Cables may be black with colored 3/4-inch vinyl plastic tape applied at each cable termination. Tape shall be wrapped with 25 percent overlay to provide 3 inches minimum coverage.

3. SIGNAL CONDUCTORS:

Signal cable conductors shall be color coded black and white for pairs or black, white, and red for triads.

D. SPLICING AND TERMINATING MATERIALS:

Connectors shall be tool applied compression type of correct size and UL listed for the specific application. Connectors shall be tin-plated high conductivity copper.

Connectors for wire sizes No. 8 AWG and larger shall be compression tool installed one-hole lugs up to size No. 3/0 AWG, and two-hole or four-hole lugs for size No. 4/0 and larger. Mechanical clamp, dimple, screw-type connectors are not acceptable. In-line splices and taps shall be used only by written consent of the Construction Manager.

Power conductor splices shall be compression type, made with a compression tool die approved for the purpose, as made by Thomas and Betts Corp., or equal. Splices shall be covered with electrical products designed for the application, insulated, and covered with a heat-shrinkable sleeve or boot, as specified elsewhere.

Motor connection kits shall consist of heat-shrinkable, polymeric insulating material over the connection area and high dielectric strength mastic to seal the ends against ingress of moisture and contamination. Motor connections may use the Tyco Electronics removable boot product line.

E. CORD GRIPS:

Cord grips shall be provided where indicated on the Drawings to attach flexible cord to equipment enclosures. Cord grips shall consist of a threaded aluminum body and compression nut with a neoprene bushing and stainless steel wire mesh for strain relief. Cord grip shall provide a watertight seal at enclosure interface and sized to accommodate the flexible cord.

## F. WIRE MARKERS

Each power and control conductor shall be identified at each terminal to which it is connected. Conductors size No. 10 AWG or smaller shall have identification sleeves. Conductors No. 8 AWG and larger shall use cable markers of the locking tab type. Tabs shall be white plastic with conductor identification number permanently embossed.

Conductors shall be identified in accordance with paragraph 16000-1.07 B. Adhesive strips are not acceptable.

The letters and numbers that identify each wire shall be machine printed on sleeves with permanent black ink with figures 1/8 inch high. Sleeves shall be yellow or white tubing and sized to fit the conductor insulation. Shrink the sleeves with hot air after installation to fit the conductor.

Conductor and Wire Marker Manufacture:

1. TMS Thermofit Marker System by Raychem Co
2. Sleeve style wire marking system by W. H. Brady Co.
3. Or equal.

## 2.03 RACEWAY

### A. BOXES AND GUTTERS:

1. Well chlorine addition and storage room: Non-metallic, NEMA 4X.
2. Well control room, outdoors: Painted Steel, NEMA 3R.

### B. SUPPORTS, HANGERS, AND RACKS:

1. Well chlorine addition and storage room: Stainless Steel or Fiberglass.
2. Well control room, outdoors: Galvanized Steel.

### C. RACEWAY:

1. Well chlorine addition and storage room: PVC coated rigid steel.
2. Well control room, outdoors: Galvanized rigid steel.
3. Underground: PVC schedule 40, taped or PVC coated rigid steel 90 degree elbows at transition to above-ground.

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4. Final connections: Liquidtight flexible conduit.

D. RACEWAY MARKERS:

1. Solid aluminum with 0.036-inch minimum thickness.
2. Raceway number stamped or engraved in 3/16-inch minimum height characters
3. Attached to the raceway with 316 stainless steel wire.
4. Engraving per circuits shown on panel schedules and one-line diagrams.

E. UNDERGROUND MARKING TAPE

Underground detectable marking tape shall be for early warning protection of digging around direct buried cables, conduits, and concrete duct banks. Tape shall be OSHA approved.

Marking tape example: Low density polyethylene plastic, nominally 6 inches wide and 4 mil thickness with metallic lined tape with red polyethylene film on top and clear polyethylene film on the bottom. Tape shall be imprinted with a warning continuously along the length similar to: "CAUTION - STOP DIGGING - BURIED ELECTRIC LINE BELOW."

Tape Products: Brady "Identoline"; Services and Materials "Buried Underground Tape"; Somerset (Thomas & Betts) "Protect-A-Line"; or equal.

## 2.04 COMPONENTS

A. 120V RECEPTACLES:

Receptacle shall be duplex, 20 ampere, NEMA 5-20R, and shall accept NEMA 5-15P and 5-20P plugs. Receptacle and plug shall be corrosion resistant, marine duty with polycarbonate weatherproof-in-use covers.

Manufacturers: Hubbell 53CM62/53CM21, or equal.

B. SWITCHES:

Switches shall be 20-ampere with weatherproof/ corrosion resistant neoprene plate. Switches shall be mounted in "FS" type copper-free aluminum or PVC mounting boxes.

Manufactures: Hubbell or Arrow-Hart as follows:

	Hubbell with 17CM50 plate	Arrow-Hart with 2881 plate
Single pole	1281	2991
Double pole	1282	2992
3-way	1283	2993
4-way	1284	2994

C. DEVICE PLATES:

Device plates shall be corrosion-resistant/marine-duty type.

D. LUMINAIRES:

Provide as specified on drawings. Provide lamps where applicable.

E. GROUND RODS:

Ground rods shall be copper covered steel, 3/4-inch diameter and 10-feet long. Rods shall have threaded type removable caps so that extension rods of same diameter and length may be added where necessary.

F. GROUNDING CONNECTORS:

1. Compression connections shall be irreversible, cast copper as manufactured by Thomas and Betts, or equal.
2. Bolted connectors shall be Burndy, O. Z. Gedney, or equal.
3. Exothermic welding products shall be Erico's Cadweld Plus system with a remotely operated battery powered electronic ignition device and moisture resistant weld metal cup for the required mold, or equal.

G. TEST WELLS:

Provide concrete test well with cover and connect the ground grid extension using a removable connector.

H. TERMINAL BLOCKS:

Unless otherwise specified, terminal blocks shall be panhead strap screw type. Terminals shall be provided with integral marking strips that permanently identify with the connecting wire numbers as shown on the drawings:

1. Terminal blocks for P-circuits (power 208-600 volts)
  - a. Rated not less than the conductor current rating
  - b. Rated less than 600 volts AC.
2. Terminal blocks for C-circuits and S-circuits:
  - a. Rated not less than 20 amperes
  - b. Rated less than 600 volts AC.
3. Terminals shall be tin-plated.
4. Insulating material shall be nylon.

## 2.05 EQUIPMENT

### A. TRANSFORMERS:

Provide as specified on drawings.

### B. LOAD CENTERS:

1. Provide as specified on drawings.
2. Provide metal oxide varistor (MOV) surge protective device (SPD) integral within each panelboard that indicates the status and condition of the SPD, tested per NEMA LS-1, rated IEEE C3 Combined Wave of 20kV and 10kA with 200kAIC internal fusing and listed / labeled per UL 1449.
3. Provide "Circuit Directory and Circuit Identification" in accordance with NEC 408.4. Each circuit shall be of sufficient detail to allow each circuit to be distinguished from other circuits. Circuit identification shall include load location and provide equipment or instrument Tag Number and Tag Description, where shown on the drawings.

### C. SAFETY DISCONNECT SWITCHES:

Heavy duty fused and non-fused disconnect switches with current range of 30 to 600 amperes shall be provided as shown on the drawings with the enclosure type matching the area rating. Provide lock-off provision for a hasp padlock. Provide visible knife blades through a cover viewing window. Provide shielded or insulated line terminals with quick-make / quick-break switch operator. Provide internal barrier kit for additional personnel barrier from accidental contacts with live parts. Provide a legend plate with equipment tag, equipment description, and power feeder circuit source and location identification.

Fuse clips shall be Class R rejection type and sized for UL Class R, one-time, time-delay fuses. Fuse assembly shall have a minimum short circuit capacity of 100,000 amps symmetrical.

Provide fuses as shown and one set of spare fuses with each switch.

D. SERVICE ENTRANCE METER SOCKET:

Provide as specified on drawings.

E. MOTOR STARTERS:

Provide as specified on drawings and per Spec. 16155.

F. TELEMETRY PLC:

Provide as specified on drawings and per Spec. 17110.

## 2.06 NAMEPLATES

A. MATERIALS:

Nameplates shall be made from laminated phenolic plastic.

1. Nominal size: 3/4 inch high by 2 inches long.
2. Black backgrounds with 3/16-inch white letters.
3. Fastened using self-tapping stainless steel screws.

B. ENGRAVING:

1. Abbreviations shall be submitted to the Construction Manager prior to manufacture because of space limitations.
2. Nameplate adhesives will not be permitted on the outside of enclosures.
3. Provide nameplate for each electrical equipment item engraved as follows:  
(EQUIPMENT NAME) / (VOLTAGE) VOLTS.

## 2.07 PRODUCT DATA

The following information and product data specified under individual specification sections shall be provided in accordance with Section 01300.

1. Applicable operation and maintenance information on an item-by-item basis in accordance with Section 01730. Include final reviewed submittal.

2. Test results for motors and electrical systems on the forms specified in Section 16030. A file of the original test results shall be maintained by the Contractor. Prior to acceptance of work, the resulting file shall be provided to the Construction Manager.
3. Record documents specified in Section 01720 and paragraph 16000-3.03.

## PART 3--EXECUTION

### 3.01 GENERAL

#### A. CONSTRUCTION:

The work under Division 16 shall be performed in accordance with these specifications.

Refer to the National Electrical Contractors Association's (NECA) National Electrical Installation Standards (NEIS) for Standard Practices for Good Workmanship in Electrical Contracting (NECA-1) as a minimum baseline of quality and workmanship for installing electrical products and systems that defines what is meant by "neat and workmanlike" as required by the National Electrical Code Section 110-12. Specified requirements supersede NECA practices.

Electrical layout drawings are diagrammatic, unless otherwise detailed or dimensioned. The Contractor shall coordinate the location of electrical material or equipment with the work.

Major electrical openings may compromise the structural integrity of the slab and wall elements. Major electrical openings are defined as openings or penetrations greater than two times the wall thickness in any dimension, and include duct bank transitions into a building through structural elements. Major electrical openings shall be constructed according to standard details on the drawings, up to an opening dimension of three feet. For opening dimensions greater than three feet, construct walls and slabs as specifically detailed on the drawings for that case. Major electrical openings proposed by the Contractor shall be submitted to the Structural Engineer of Record for the project for review.

Minor changes in location of electrical material or equipment made prior to installation shall be made at no cost to the Owner.

#### B. CONDUITS IN CONCRETE CONSTRUCTION:

Conduits for power, control and instrumentation may be embedded in and pass through concrete construction subject to the limitations in this paragraph. Where concrete strength or serviceability requirements prevent the direct embedment of conduit, provide adequate support, bracing, and serviceability details:

1. Concrete strength shall not be impaired significantly by the embedment of conduits in or through structural sections.
2. Conduit layout shall conform to the requirements of ACI 318, Sections 3.3 – Aggregates and 6.3 – Conduits and Pipes Embedded in Concrete.
3. Conduits shall be treated similarly to reinforcing steel for purposes of clearance. In general, code sections require conduit spacing the greater of:
  - a. 1.33 times the maximum concrete aggregate size, clear
  - b. Three diameters center to center

Alternate spacing and layout shall be as reviewed and accepted by the Engineer.

4. Conduit and raceway penetrations through walls and slabs where one side is a conditioned or an occupied space and the other side not, or one side has liquid or groundwater contact and the other not, shall be detailed and constructed to prevent liquid and moisture penetration through the wall or slab section for each conduit.

#### C. HOUSEKEEPING:

Electrical equipment shall be protected from dust, water and damage. Motor control centers, switchgear, and buses shall be wiped free of dust and dirt, kept dry, and shall be vacuumed on the inside within 30 days of acceptance of the work.

Before final acceptance, the Contractor shall touch up any scratches on equipment.

Electrical equipment temporarily exposed to weather, debris, liquids, or damage during construction shall be protected as specified in paragraph 01605-3.0 F.

#### D. ELECTRICAL EQUIPMENT LABELING

Electrical equipment shall have field marked signs and labeling to warn qualified persons of the potential electric arc flash hazards per NEC Article 110.16 Flash Protection.

Electrical equipment shall have NFPA 70E labels installed stating the results of the Arc Flash analysis specified in Section 16431 Short Circuit and Protective Device Coordination Study Report.

Electrical distribution equipment and utilization equipment shall be field labels to identify the power source and the load as specified. Refer to NEC Article 110.22 for Identification of

Disconnecting Means installation criteria. Specific information is required such as the equipment tag number and equipment description of both the power source and the load equipment.

#### E. MOTOR CONNECTIONS

Verify that the motors are purchased with the correct size motor termination boxes for the circuit content specified as shown on the power single line diagrams or submit custom fabrication drawing indicating proposed motor termination box material, size, gasket, termination kit, grounding terminal, motor lead connection method, and motor terminal box connection/support system. Verify the motor termination box location prior to raceway rough-in.

#### F. CONDUCTOR INSTALLATION

An enclosure containing disconnecting means, overcurrent devices, or electrical equipment shall not be used as a wireway or raceway for conductors not terminating within the enclosure. Provide wireways, raceways, termination boxes, or junction boxes external to the enclosure for the other conductors.

### 3.02 TESTING

#### A. GENERAL:

Refer to Section 16030.

### 3.03 RECORD DOCUMENTS

Contract documents shall be maintained and annotated by the Contractor during construction, including the record drawings specified in Section 01720.

**\*\*END OF SECTION\*\***

## SECTION 16030

### ELECTRICAL ACCEPTANCE TESTING

#### PART 1--GENERAL

##### 1.01 DESCRIPTION

###### A. SCOPE:

This section specifies the acceptance testing of electrical materials, power distribution and utilization equipment and circuits. Contractor shall provide all labor, tools, material, power, and other services necessary to provide the specified tests.

###### B. SCHEDULE:

Provide testing for all equipment at the following sites:

1. Bodaway-Gap Tank 2.
2. Bodaway-Gap Well 3.
3. Existing Bodaway-Gap Tank altitude valve.
4. Bodaway-Gap Electrical Substation telemetry.
5. Preston Mesa telemetry.

##### 1.02 REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). 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, regardless of whether the document has been superseded by a version



with a later date, discontinued or replaced.

Reference	Title
NFPA-70	National Electrical Code (NEC)

### 1.03 SUBMITTALS

#### A. PRE TEST:

1. Functional testing and checkout procedures and schedule shall be submitted in accordance with Section 01300.

## PART 2--PRODUCTS

### 2.01 TEST EQUIPMENT AND MATERIALS

Test instruments shall be calibrated to references traceable to the National Institute of Standards and Technology and shall have a current sticker showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required.

### 2.02 PRODUCT DATA

In accordance with Section 01300, the Contractor shall submit the completed test report forms for each site as specified in Part 3 herein.

## PART 3--EXECUTION

### 3.01 TESTING

#### A. GENERAL:

The following specified tests, including correction of defects where found and the subsequent re-testing, shall be completed prior to energization of the equipment or systems. Submit all completed test report forms in a 3-ring binder type notebook at the project Substantial Completion date.

A 1,000 volt megohmmeter shall be used for insulation resistance measurements.

#### B. INSULATION RESISTANCE MEASUREMENTS:

1. GENERAL: Insulation resistance measurements shall be made on conductors and electrical equipment that will carry current. Minimum acceptable values of insulation resistance shall be in accordance with the applicable NETA-ATS, ICEA, NEMA, or

ANSI standards for the equipment or material being tested. The ambient temperature at which insulation resistance is measured shall be recorded on the test form.

2. CONDUCTOR AND CABLE TESTS: The phase-to-ground insulation resistance shall be measured for all circuits 120 volts and above except lighting circuits. Measurements may be made with motors and other load equipment connected. Insulation resistance measurements shall be recorded in a format similar to Forms 16000-A and 17000-A contained in Section 01999, and submitted for acceptance. Insulation with resistance of less than 10 megohms is not acceptable.

3. MOTOR TESTS: The Installed Motor Test Form, 16000-B, contained in Section 01999, shall be completed for each motor after installation and submitted for acceptance. All motors shall have their insulation resistance measured before they are connected.

Motors 50 HP and larger shall have their insulation resistance measured at the time of delivery and when they are connected. Insulation resistance values less than 50 megohms are not acceptable.

Verify that motors are connected to rotate in the correct direction. Verification may be accomplished by momentarily energizing the motor, provided the Contractor confirms that neither the motor nor the driven equipment will be damaged by reverse operation.

4. POWER DISTRIBUTION EQUIPMENT: Transformers, panelboards, and other power distribution equipment shall have their insulation resistance measured phase-to-phase and phase-to-ground. Utilize forms 16000-C, D, and M provided in Section 01999 as examples.

5. POWER UTILIZATION EQUIPMENT: Test receptacles and power outlets using a device to verify polarity, grounding, and the correct wiring connections.

#### C. FUNCTIONAL TESTING:

Contractor shall submit a description of proposed functional test and checkout procedures conforming to the following requirements, including a schedule for conducting these procedures, not less than 30 days prior to the performance of functional testing.

Prior to functional testing, all protective devices shall be adjusted and made operative.

Prior to energization of associated equipment, perform a functional checkout of all electrical and instrumentation control circuits as specified in the following and in Division 17. Checkout shall consist of energizing each control circuit and operating each control, alarm, safety device, and each interlock, in turn, to verify that the specified action occurs.

### 3.02 PROTECTIVE DEVICE FIELD SETTINGS

The Contractor or Study Firm shall verify, and certify in the acceptance test final report,

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that the protective device coordination study settings for new and existing equipment based on the Short Circuit and Protective Device Coordination Report specified in Section 16431 have been implemented.

### 3.03 ARC FLASH SIGN INSTALLATION

The Contractor shall install the Arc Flash Hazard signs per direction from Section 16431 Study Firm.

**\*\*END OF SECTION\*\***

SECTION 16155

INDIVIDUAL MOTOR STARTERS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies individual motor starters and motor controllers installed in enclosures other than motor control centers. Refer to drawings for product, device, and circuit requirements.

Provide well pump starter panel per details from NTUA Technical Provisions 4.0 for Motor Control Center 3 Phase Soft Start Pump Panel, as included in the Bid Documents.

B. DERATING:

The starter shall be derated for operation at elevation of approximately 5,460 feet at Leupp.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid or on the effective date of the Agreement if there were no Bids. 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, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
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Reference	Title
NEMA ICS 1	General Standards For Industrial Control and Systems
NEMA 250	Enclosures for Electrical Equipment (1000-Volt Maximum)

B. LISTED PRODUCTS:

Equipment and components shall be Underwriters Laboratory (UL) listed for the purpose per Section 16000 or UL recognized.

C. ENVIRONMENTAL CONDITIONS:

Refer to Section 16000.

1.03 SUBMITTALS

The following submittals shall be provided in accordance with Section 01300:

A. SHOP DRAWINGS:

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. A check mark 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 Owners 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. A copy of the contract document Drawings E-101 and E-102 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to

include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

3. A copy of the contract document NTUA Technical Provisions 4.0 for Soft Start Pump Panel drawings, as included in the Bid Documents, relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
4. Catalog cuts of equipment, devices, and materials for products to be provided. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.
5. Starter layout drawings, schematic diagrams, and bill of materials.
6. Nameplate engraving schedule:
  - a. Indicate engraving by line.
  - b. Character size.
  - c. Nameplate size.
  - d. Panel and equipment tag number and description.
7. Verification of fault withstand ratings, and interrupting ratings.

## PART 2--PRODUCTS

### 2.01 GENERAL

Equipment material shall be new, free from defects, and industrial grade, as specified. Each type of equipment, component, accessory, and device used throughout the work shall be manufactured by one firm, where possible.

### 2.02 WELL No. 3 PUMP STARTER PANEL

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Equipment and components shall be as specified on the drawings referenced in Paragraph 1.01 A, and in this Section where not specified on the drawings.

A. SOFT STARTER:

Starter shall be a Reduced Voltage Solid State (RVSS) “soft” starter as specified. Starter shall be derated per Paragraph 1.01 B.

2.03 WIRING

Conductors shall be 90-degree C switchboard type. Conductors shall be identified with tag numbers as specified in 16000.

2.04 MANUAL STARTERS

Manual starters shall comprise a horsepower rated quick-make, quick-break, toggle mechanism together with overloads in all phase conductors.

2.05 NAMEPLATES

Nameplates shall be provided in accordance with the requirements of 16000.

2.06 PRODUCT DATA

The following product data shall be provided in accordance with Section 01300:

1. Operating and maintenance as specified in Section 01730, including:
  - a. Final reviewed submittal
  - b. As-built drawings.
  - c. Record of soft starter configurations.
2. A copy of the electrical diagrams in a plastic folder in the units.

PART 3--EXECUTION

3.01 DEVICE CALIBRATION AND TESTING

Size the overload relay heater elements or adjust the solid-state overload device to the actual nameplate full load amperes of the motor connected to the starter.

Adjust motor circuit protector to the lowest setting not causing false tripping.

Configure the soft starter as required for the pump operation. Record settings and include with operations and maintenance manual.

Record the settings on each motor controller and record the settings as part of the Record As-Built drawing submittal.

### 3.02 TESTING

Local motor starters and circuits shall be tested in accordance with Section 16030.

**\*\*END OF SECTION\*\***



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## SECTION 16431

### ARC FLASH AND SHOCK RISK ASSESSMENT, SHORT CIRCUIT STUDY, AND PROTECTIVE DEVICE COORDINATION REPORT

#### PART 1--GENERAL

##### 1.01 DESCRIPTION

###### A. GENERAL:

This section specifies that the Contractor subcontract an independent full member NETA Engineering and Study Firm / Testing Firm to prepare:

1. Electrical equipment short circuit study (SCS).
2. Protective device coordination study (PDCS) report.
3. Arc flash analysis (AFA) and labeling.

###### B. SCHEDULE:

Provide study, report, and labeling for all equipment at the following sites:

1. Bodaway-Gap Tank No. 2.
2. Bodaway-Gap Well No. 3.

###### C. SCOPE:

The Short Circuit and Protective Device Coordination Report shall include analysis including Utility Company equipment that affect the installed equipment's short circuit ratings, protective device ratings and protective device settings.

Report shall also include analysis of the equipment's short circuit ratings, protective device ratings and protective device settings affected by the installed equipment.

Report shall include the results of the arc flash hazard analysis study for energized electrical equipment in accordance with the methods outlined in IEEE Standard 1584 and stated hereinafter.

Work shall include the fabrication of signs with the arc flash hazard study results and the installation of the signs on the equipment in accordance with NFPA 70E Table 3-3.9.3 that includes

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the personnel protective equipment (PPE) risk category, the energy available, and the clothing recommendation.

## 1.02 QUALITY ASSURANCE

### A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

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Reference	Title
IEEE 141	Recommended Practice for Electric Power Distribution for Industrial Plants
IEEE 242	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
NFPA 70E	Standard for Electrical Safety in the Workplace
NETA ATS	Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems, 1999

### B. QUALIFICATIONS:

The short circuit and coordination report shall be performed, and signed by the professional electrical engineer (Study Firm) responsible for the studies and registered to practice engineering in the state of Arizona.

## 1.03 SCHEDULE

The report shall be completed, submitted to the Construction Manager for acceptance and reworked to include the Construction Manager comments and corrections, as required. The report  
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shall be approved by the Construction Manager prior to purchase and fabrication of electrical equipment including switchgear.

A copy of the Construction Manager accepted report shall be sent by the Contractor to all affected manufacturers prior to fabrication.

#### 1.04 SUBMITTALS

The report specified in this Section shall be provided in accordance with Section 01300.

### PART 2--PRODUCTS

#### 2.01 REPORT

The product shall be a certified report summarizing the short circuit and coordination study and conclusions or recommendations which may affect the integrity of the electric power distribution system.

##### A. REQUIREMENTS:

As a minimum, the report shall include the following:

1. The equipment manufacturer's information used to prepare the study.
2. Power Utility Company system information applicable to the project.
3. Short circuit calculations listing short circuit levels at each bus. Provide a sketch of the bus and use both the project term and the bus-code-name to identify the bus, branches, sources, loads. Base the system on the Project One-Line diagram.
4. Coordination study time-current curves including the instrument transformer ratios, model numbers of the protective relays, and the relay settings associated with each breaker.
5. Comparison of short circuit duties of each bus to the interrupting capacity of the equipment protecting that bus.
6. Data used as input to the report that includes cable impedances, source impedances, equipment ratings for the equipment being purchased for the project, etc.
7. Assumptions made during the study.

ARC Flash and Shock Risk Assessment, Short Circuit Study, and  
Protective Device Coordination Report

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## PART 3--EXECUTION

### 3.01 GENERAL

Provide a short circuit and coordination study on the electrical power distribution system as specified and as described in Section 6.1 of NETA ATS. The studies shall be performed in accordance with IEEE Standards 141 and 242 and shall utilize the ANSI method of short circuit analysis in accordance with ANSI C37.010.

The studies shall be performed using actual equipment data. The coordination study shall use the data from the same manufacturer of protective relay and overcurrent devices as being provided by the equipment manufacturer.

For new equipment, the Contractor shall provide copies of final reviewed equipment submittals upon request by the Study Firm.

Any power distribution equipment outages shall be scheduled in advance and coordinated with the Owner to limit water service outages.

### 3.02 NOT USED

### 3.03 SHORT CIRCUIT STUDY

The Contractor shall be responsible to obtain and verify all data needed to perform the study. As a minimum, the short circuit study shall include the following:

#### A. ONE-LINE DIAGRAM:

1. Location and function of each protective device in the system, such as relays, direct-acting trips, fuses, etc.
2. Type designation, current rating, range or adjustment, manufacturer's style and catalog number for all protective devices.
3. Power, voltage ratings, impedance, primary and secondary connections of all transformers.
4. Type, manufacturer, and ratio of all instrument transformers energizing each relay.
5. Nameplate ratings of all motors and generators.

6. Sources of short circuit currents such as utility ties, generators, and induction motors.
7. Significant circuit elements such as transformers, cables, breakers, fuses, reactors, etc.
8. Emergency as well as normal switching conditions, as applicable.
9. The time-current setting of existing adjustable relays and direct-acting trips, as applicable.

**B. IMPEDANCE DIAGRAM:**

1. Available MVA, voltage, and impedance from the power utility company.
2. Local generated capacity impedance.
3. Bus impedance.
4. Transformer and/or reactor impedances.
5. Cable impedances.
6. Equipment impedances.
7. System voltages.
8. Grounding scheme for the project: resistance grounding, solid grounding, or no grounding.

**C. CALCULATIONS:**

1. Determine the paths and situations where short circuit currents are the greatest.
2. Study shall address bolted faults and calculate the 3-phase and line-to-ground short circuits of each case.
3. Calculate the maximum and minimum fault currents.

**3.04 ARC FLASH AND SHOCK RISK ASSESSMENT**

The Contractor shall be responsible to obtain and verify all data needed to perform the study. The arc flash and shock risk assessment study shall include the following IEEE Standard 1584 nine step analysis process:

1. Collect system and installation data.
2. Determine modes of operation.
3. Determine bolted fault current.
4. Determine arc fault current.
5. Determine protective device characteristic and arc fault duration.
6. Document system voltages and equipment class.
7. Select working distances.
8. Calculate incident energy.
9. Calculate the arc flash protection boundary.

### 3.05 PROTECTIVE DEVICE COORDINATION STUDY

As a minimum, the coordination study for the power distribution system shall include the following on 5-cycle, log-log graph paper:

1. Time-current for each protective relay or fuse showing graphically that the settings will provide protection and selectivity within industry standards. Each curve shall be identified, and the tap and time dial settings shall be specified.
2. Time-current curves for each device shall be positioned to provide for maximum selectivity to minimize system disturbances during fault clearing. Where selectivity cannot be achieved, the Construction Manager shall be notified as to the cause.
3. Time-current curves and points for cable and equipment damage.
4. Circuit interrupting device operating and interrupting times.
5. Indicate maximum fault values on the graph.
6. Sketch of bus and breaker arrangement.

### 3.06 IMPLEMENTING PDCS SETTINGS

The Study Firm or Contractor shall implement the protective device coordination study settings on new equipment as required in Section 16030, based on the Engineers accepted Protective Device Coordination Report specified herein and submit a final amended report of the Record As-Built electrical equipment protective device settings subsequent to start-up and testing.

### 3.07 ARC FLASH SIGN INSTALLATION

The Study Firm shall work with the Contractor for implementing the Arc Flash Hazard sign installation requirements for electrical equipment as specified in NEC Article 110.16 Flash Protection and NFPA 70E.

**\*\*END OF SECTION\*\***



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ARC Flash and Shock Risk Assessment, Short Circuit Study, and  
Protective Device Coordination Report  
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Navajo Nation  
WESTERN NAVAJO PIPELINE PHASE 1

BC PROJECT NO.: 150360

BODAWAY-GAP WELL, STORAGE TANK AND PIPELINE

DIVISION 17

INSTRUMENTATION

17000	General Requirements for Instrumentation and Control
17030	Process Instrumentation and Control System Testing
17110	Instrument and Control Panels
17900	Control Specifications

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## SECTION 17000

### GENERAL REQUIREMENTS FOR INSTRUMENTATION AND CONTROL

#### PART 1--GENERAL

##### 1.01 DESCRIPTION

###### A. SCOPE:

This section specifies general requirements which are applicable to providing a complete, functional process control, instrumentation, communication, and telemetry systems and modifications for the Bodaway-Gap water system. The requirements of this section are applicable to all work specified in Division 17 of these specifications.

Schedule and coordinate work to minimize water system control outages. Refer to Sections 01014 and 17900.

Electrical requirements applicable to this work include those specified in Section 16000 for general electrical requirements.

###### B. DESCRIPTION OF WORK:

1. Bodaway-Gap Tank exists. This site communicates with existing and new system sites via existing telemetry, and relays signals those and from the Bodaway-Gap Electrical Substation to the Preston Mesa Site for communication with SCADA. Provide SCADA and altitude valve.
2. Bodaway-Gap Well No. 1 exists.
3. Bodaway-Gap Well No. 2 exists.
4. Provide Bodaway-Gap Tank No. 2. Provide equipment, telemetry, and solar power system. Test and verify operation of Well 3 to control tank level.
5. Provide Bodaway-Gap Well No. 3. Provide equipment and telemetry inside building.
6. Bodaway-Gap Electrical Substation exists. Provide telemetry. This site relays signals to the existing Bodaway-Gap Tank from the Cameron Pump Station No. 2 and 3 (separate contract), and Cedar Ridge Pump Station No. 1 and 2 (separate contract) via telemetry for communication with SCADA. Provide telemetry.

General Requirements for Instrumentation and Control  
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7. Preston Mesa Site exists. This site provides telemetry to SCADA interface for the Bodaway-Gap system, Cameron Pump Station No. 2 and 3 (provided under separate contract), and Cedar Ridge Pump Station No. 1 and 2 (provided under separate contract). Provide SCADA.
8. Provide telemetry units per details from NTUA Technical Provisions 4.0 for DC Tank Control Panel, AC Tank Control Panel, and Pump PLC Control Panel.
9. Provide work as specified and per NTUA Standard Drawings and Indian Health Services – Navajo Nation – Standard Drawings.
10. Provide testing per Section 01660, 16030, and 17030.
11. Telemetry PLC and touchscreen programming will be provided by Others. Programmer to program the following and witness testing. Coordinate work, programmers, and provide testing for the following:
  - a. Bodaway-Gap Tank telemetry program modifications and SCADA programming addition for the Bodaway-Gap, Cameron, and Cedar Ridge systems.
  - b. Bodaway-Gap Tank No. 2 addition.
  - c. Bodaway-Gap Well No. 3 addition.
  - d. Bodaway-Gap Electrical Substation telemetry addition.
3. Preston Mesa Site SCADA addition.
12. Equipment to be Owner furnished:
  - a. Only that which is labeled as “EXISTING” on drawings.
13. All replaced or removed items shall be salvaged. Salvaged items shall be properly disconnected to retain their full salvage value and cleaned before turning over to the Owner.
15. Work for this system is related to work for two other water systems, refer to Spec. 01010.

C. DEFINITIONS:

General Requirements for Instrumentation and Control  
17000-2

Bodaway-Gap Contract 2  
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1. SYSTEMS INTEGRATOR: A firm engaged in the business of detailed control system design and engineering, instrumentation component purchase, system and panel assembly, programming, and implementing the specified process control and industrial automation systems.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). 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, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
IEEE 100	Standard Dictionary of Electrical and Electronics Terms
ISA S5.4	Instrument Loop Diagrams
ISA S20	Specification Forms For Process Measurement and Control Instrumentation, Primary Elements, and Control Valves
ISA S51.1	Process Instrumentation Terminology
ISA TR20.00.01	Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations
NEMA ICS 1	General Standards for Industrial Control and Systems

B. SYSTEMS INTEGRATOR RESPONSIBILITY:

1. GENERAL

- a. The specified control system and instrumentation integration including panel building, instrument calibration, testing, start-up, operational testing, and training shall be performed by a Systems Integrator staffed with qualified personnel, possessing necessary equipment and experience in performing similar installations.

General Requirements for Instrumentation and Control  
17000-3

- b. The control system components shall, as far as practical, be of one manufacturer.
- c. The components, modules, devices, and control system equipment shall be recognized industrial quality products. Recognized commercial or office grade products are prohibited.
- d. The overall system performance shall be demonstrated to and accepted by Owner.

2. SYSTEMS INTEGRATOR QUALIFICATIONS:

- a. The following Systems Integrators are pre-qualified to perform the work specified in Division 17 without the need to provide Evidence of Experience:
  - 1) None.
- b. Contractor-proposed Systems Integrator shall be evaluated based on submittal of the following Evidence of Experience:
  - 1) Submit evidence of experience in performing three similar successful projects in the last five years with one project currently in progress or competed within the last two years.
  - 2) Submit project descriptions with contact names, addresses, and telephone numbers from the project Owner, General Contractor, and Principal Design Firm.
  - 3). Submit organization chart and resumes for proposed project personnel.
  - 4) Submit Training and Certification information. Completion of the following training courses or appropriate portions thereof or possession of the following certifications included with the Systems Integrator's personnel experience requirements described above:
    - a) Project manager: Control System Engineer (CSE) registration, Professional Engineer (PE) registration.
    - b) Systems engineer: Control System Engineer (CSE) registration, Professional Engineer (PE) registration,

or completion of the relevant core courses in the Engineering Skills Training program.

- c) Programmer: Control System Engineer (CSE) registration, Professional Engineer (PE) registration.
  - d) Field instrument technician: Certified Control Systems Technician (CCST) registration or completion of the relevant core courses in the Technical Skills Training program.
  - e) Certified training programs, as offered by ISA.
- 5) Submit financial data for Systems Integrator division when subsidiary to a parent corporation. Include two years of financial data.
- a) Financial Statement.
  - b) Balance Sheet.
  - c) Dun & Bradstreet Report.

#### C. PROCESS EQUIPMENT COORDINATION

1. Division 17 specified equipment shall be coordinated for proper operation with equipment related process equipment specified in other Divisions.
2. Equipment shall be integrated, furnished, and installed in conformance with the drawings, specifications, and the recommendations of the equipment manufacturer and the related processes equipment manufacturers.
3. Systems Integrator shall obtain manufacturer's technical information for items of equipment not provided with, but directly connected to, the control system. Provide the necessary coordination and components for correct signal interfaces between specified equipment and the control system.
4. Systems Integrator shall coordinate with project subcontractors and equipment suppliers.
5. Systems Integrator shall provide installation supervision for the duration of the project, a minimum of four man-weeks on-site.



6. Conflicts between the plans, specifications, manufacturer/vendor drawings and installation instructions, etc., shall be presented to the Construction Manager for resolution before proceeding.

### 1.03 ENVIRONMENTAL CONDITIONS

#### A. GENERAL:

Specified data communication and process control equipment shall suitable for operation in indoor locations and in outdoor locations. Ambient conditions are specified in Section 01800.

#### B. CORROSIVE LOCATIONS:

Corrosive locations: Chlorine storage areas.

### 1.04 FUNCTIONAL REQUIREMENTS

#### A. GENERAL:

The instrumentation and control system functions are shown on the drawings and specified in subsequent sections of Division 17. The Systems Integrator drawings and integration practices shall be as defined in IEEE 100, ISA S51.1, and NEMA ICS 1.

### 1.05 SUBMITTALS

The following information shall be provided in accordance with and Section 01300:

#### A. SYSTEMS INTEGRATOR QUALIFICATIONS:

1. Systems Integrator Evidence of Experience per paragraph 17000-1.02 B 3. Acceptable review required prior to any other Division 17 submittal.

#### B. SHOP DRAWINGS:

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. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each requested 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 for requested deviations from the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. A copy of the contract document Electrical Drawings E-101 through E-140 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". *Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.*
3. A copy of the contract document NTUA Technical Provisions 4.0 for DC Tank Control Panel and PLC Control Panel drawings relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
4. Nameplate list with material, tag number and description as specified herein.
5. Catalog cuts of equipment, devices, and materials for products to be provided. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc. Catalog cuts shall be edited to show only the items, model numbers, and information which apply. Submit catalog cuts for only the following:
  - a. Radio components, and list by location.
  - b. Level transmitter.
  - c. Flow meter and indicator.
  - d. Instruments and Controls specified on Drawings.

## PART 2--PRODUCTS

### 2.01 GENERAL

General Requirements for Instrumentation and Control  
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A. MATERIALS AND QUALITY:

Equipment material shall be new, free from defects, and industrial-grade, as specified. Each type of instrument, instrument accessory, and device used throughout the work shall be manufactured by one firm, where possible.

Equipment and components shall be as specified on the drawings referenced in Paragraph 1.01 B, and in this Section where not specified on the drawings.

B. RADIO COMPONENTS:

1. Antenna, directional: Kathrein SCALA TY-900, 10 dB Yagi.
2. Antenna, omni-directional: Kathrein SCALA K7515641, 5 db.
3. Transmission Line: Times Microwave LMR-400 with type N connectors.
4. CommScope Andrews 221213 or 3M 2212 tape kit.

C. LEVEL (PRESSURE) TRANSMITTER:

1. NEMA 4/IP 67, stainless steel wetted parts, 4-20mA output. Provide 0-15 psi range to match or exceed tank height plus elevation below tank to vault connection of up to 32 feet, 0-30 psi range for taller tanks Wika C10 in-lieu of Ametek 88 shown on NTUA Technical Provisions W-32.

D. OTHERS:

1. Flow meter:
  - a. Refer to NTUA Technical Provisions W-14.
  - b. Honeywell evoQ4 Electromagnetic with replaceable battery. Factory certified calibration.
  - c. Honeywell MX 42 VP Module, pulse and Sensus protocol AMI encoder outputs.
  - d. Honeywell EA\_Water 3.0 AMI module, wall mount.
2. Flow indicator:
  - a. Red Lion PAXI0020, pulse input. Configure for flow rate and total. Provide interposing relay if required between MX 42 pulse output and indicator.

b. Red Lion optional 4-20mA analog output module.

c. NEMA 4 enclosure, minimum 12" x 8" x 6" deep. Nameplate: "DISCHARGE FLOW RATE AND TOTAL".

3. Well level transducer: Refer to NTUA Technical Provisions W-30.

## 2.02 NAMEPLATES

Nameplates shall be provided for all field mounted instrument, analyzer, or equipment specified in Division 17. Nameplate lettering shall include the equipment or instrument loop title and the instrument or equipment tag number, where nameplate engraving is not specified or shown. Nameplates shall be machine engraved black phenolic with white 5/32-inch high lettering, as minimum, unless otherwise specified or shown. Nameplate wording may be changed without additional cost or time, if changes are made prior to commencement of engraving.

Nameplates shall be attached to support hardware with a minimum of two self-tapping type 316 stainless steel screws in a readily visible location so the nameplate will remain to identify the service when the device is removed. Field instrument nameplates shall be attached with braided stainless steel straps where not stand mounted.

## 2.03 PRODUCT DATA

The following Product Data shall be provided in accordance with Section 01300.

1. Record drawings specified by paragraph 17000-3.03 shall be provided in accordance with Section 01720. Provide record drawing prints of all drawings following project start-up, but prior to acceptance of the work showing the final constructed state of the instrumentation and control systems.
2. Operating and maintenance information shall be provided in accordance with Section 01730. Include the following in each Operation and Maintenance manual:
  - a. Final reviewed Submittals, including revised as-built record drawings.
  - b. Manufacturer's operation and maintenance instructions, edited for this project.
  - c. Written record of menu configuration, jumpers, switch settings, and other configurable parameters for each instrument.

General Requirements for Instrumentation and Control  
17000-9

Bodaway-Gap Contract 2  
Bid Issue

## PART 3--EXECUTION

### 3.01 INSTALLATION

#### A. GENERAL:

Equipment shall be installed in locations that are accessible for operation and maintenance services. Equipment not accessible shall be reinstalled at no cost to the Owner.

Installation, calibration, settings, and testing procedures are specified in Section 17000 and subsequent sections of Division 17.

#### B. FIELD EQUIPMENT:

Equipment shall be provided with ports and adjustable items accessible for in-place testing and calibration. Install equipment between 48 inches and 60 inches above the floor or permanent work platform. Equipment shall be mounted to avoid shock or vibration that may impair operation. Equipment shall be mounted for unobstructed access and walkways. Equipment support systems shall not be attached to handrails, process piping or mechanical equipment.

Instruments and cabinets supported by concrete walls shall be spaced 5/8 inch by strut channel between instrument or cabinet and wall. Block wall shall have additional installation supports, as required, to avoid damage to the wall. Equipment supports shall be hot-dip galvanized, 316L stainless steel in chlorine areas.

Support systems including panels shall be designed in accordance with Section 01900 to prevent deformation greater than 1/8 inch in any direction under the attached equipment load and under an external load of 200 pounds.

In wet or outdoor areas, conduit penetrations into instrument housing shall be made through the bottom (preferred) or side of enclosures to minimize water entry from around or from inside of conduits. Provide conduit hubs for connections and waterproof mastic for moisture sealant.

Nameplates shall be provided for all field mounted equipment. Nameplates shall be attached to support hardware with a minimum of two self-tapping Type 316 stainless steel screws in a readily visible location, but such that if the field device is changed out, the nameplate will remain to identify the service.

#### C. ELECTRICAL POWER CONNECTIONS:

Equipment electric power wiring shall comply with Division 16. Power disconnect switches shall be provided within sight of equipment and labeled to indicate the specific equipment served and the power source location. "Within sight of" is defined as having an unobstructed view from the equipment served and within 50 feet of the equipment served.

D. SIGNAL CONNECTIONS:

Equipment electric signal connections shall be made on terminal blocks or by locking plug and receptacle assemblies. Flexible cable, receptacle and plug assemblies shall be used where shown or specified.

Jacketed flexible conduit shall be used between equipment and rigid raceway systems. Flexible cable assemblies may be used where plug and receptacle assemblies are provided and the installation is not subject to mechanical damage in normal use. The length of flexible conduit or cord assemblies shall not exceed 2 feet, except where sufficient length is required to allow withdrawal of instruments for maintenance or calibration without disconnection of conduit or cord assemblies.

E. LEVEL (PRESSURE) TRANSMITTER:

1. Demonstrate accuracy of level reading.

3.02 FIELD TESTS AND INSPECTIONS

A. DELIVERY INSPECTION:

The Contractor shall notify the Owner's Representative upon arrival of any material or equipment to be incorporated into the work. The Contractor shall remove protective covers or otherwise provide access in order that the Owner's Representative may inspect such items.

B. INSPECTION AND INSTALLED TESTS:

Refer to Section 17030 – Process Instrumentation and Control System Testing.

3.03 RECORD DOCUMENTS

Contract document drawings shall be maintained and annotated by the Contractor during construction, including the record drawings specified in Section 01720.

**\*\*END OF SECTION\*\***

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## SECTION 17030

### PROCESS INSTRUMENTATION AND CONTROL SYSTEM TESTING

#### PART 1--GENERAL

##### 1.01 DESCRIPTION

This section specifies Contractor and Systems Integrator performance in testing and documentation of process instrumentation and control system materials and equipment (PICS). Additional specific testing has been added to Paragraph 3.03 per Navajo Area Indian Health Service – Technical Provisions for Motor Control Center and Tank Control Panel.

The term instrumentation covers field and panel instruments, primary sensing elements, transmitters, power supplies, and monitoring devices.

Provide the labor, tools, material, power, and services necessary to provide the process instrumentation and control system inspection and testing specified herein. Coordinate all testing with Sections 01660 and 16030:

- A. Factory Acceptance Testing (FAT)
- B. Pre-Operational Performance Testing Sequence:
  - 1. Telemetry PLC Control Panel
  - 2. Wiring Testing
  - 3. Telemetry Communications
  - 4. Instrumentation Calibration
  - 5. Loop Testing
- C. Functional Testing Sequence:
  - 1. Process Control Strategy Testing
  - 2. Control System Closed Loop Commissioning
  - 3. Functional Checkout



D. Operational Testing:

1. System Acceptance Testing (SAT)

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents with additional references listed in Section 17000. All references shall be to the current edition of the document unless specifically stated otherwise. 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. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no bids). If referenced documents have been discontinued by the issuing organization, reference 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, reference 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.

Reference	Title
ISA S51.1	Process Instrumentation Terminology

B. PROJECT LABELING

The items specifying project labeling herein shall include the following as a minimum: Owner's name, facility name, project name, and project number.

1.03 SUBMITTALS

Submittal material, to be submitted in accordance with Section 01300, shall consist of the following:

A. PRE-TESTING SUBMITTAL:

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. A check mark shall denote full compliance with a paragraph as a whole.

If deviations from the specifications are indicated, and therefore requested by the Contractor, each requested 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 for requested deviations from the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. A marked copy of specification section 01660.
3. Control descriptions per paragraph 17030-2.02 C.
4. I/O Interface Summaries per paragraph 17030-2.02 D.
5. Testing status spreadsheets per paragraph 17030-2.02 A. 3.
6. Test procedures per paragraph 17030-3.01 D.
7. Proposed test forms per PART 3 of this Section 17030, detailed for each test for this project.
8. Certified Factory Calibration Reports for Flow Instruments.

B. FAT:

1. FAT schedule of tests and demonstrations, and location.

## PART 2--PRODUCTS

### 2.01 GENERAL

Provide test forms, documentation, and records as specified in the following paragraphs.

### 2.02 TESTING DOCUMENTATION

A. NOT USED

B. NOT USED

### C. CONTROL DESCRIPTION

Provide a control description outlining operation for each process area's system. The Control Description Specification Section 17900 may be used as a basis.

### D. I/O INTERFACE SUMMARY

Provide I/O spreadsheets for each process area's system. Spreadsheets to include the following for each I/O point:

1. Signal number/tag
2. Annotation description that may be logically abbreviated and that is subject to approval.
3. Complete physical I/O channel designation and addressing or communication I/O register designation.
4. True/False status designations for digital I/O.
5. Process range; engineering units and any multipliers; and raw signal range count for analog I/O.
6. Signals: Fixed point and scaled at the Controller with minimum four significant implied digits of scaling. E.g.: 0 to 14.00 at Controller for a pH range of 0 to 14 at Operator Interface.
7. Provide Operator Interface scaling to display decimal digits required.

### 2.03 PRODUCT DATA

Provide the following product data submittal after completion of testing.

The following information shall be provided in accordance with specification Section 01300:

1. Completed test forms per PART 3.
2. List of factory calibrated items and calibration certificates.
3. Record of radio modem readings per PART 3.

## PART 3—EXECUTION

### 3.01 GENERAL

#### A. GENERAL REQUIREMENTS:

Materials, equipment, and construction included under this specification shall be inspected in accordance with this section and subsequent sections of this division. Testing shall be performed by the Contractor in accordance with this and subsequent sections of this Division.

No required test shall be applied without prior notice to the Construction Manager. Between 60 and 70 days before the commencement of any testing activity, the Contractor shall provide a detailed step-by-step test procedure complete with forms for the recording of test results, testing equipment used, and a place for identification of the individual performing or, if applicable, witnessing the test.

Provide detail assistance to the Contractor in generating form 01660-A, customized for this project. Submit detailed form prior to testing per the requirements of Section 01660.

#### B. TECHNICIAN QUALIFICATIONS:

Field instruments and analyzers shall be calibrated and set up by a certified instrument technician qualified to calibrate the instrumentation.

Technicians shall be qualified by completion and certification from training courses offered by The Instrumentation, Systems, and Automation Society (ISA), the instrumentation and analyzer manufacturer's training courses, or technician training courses at a recognized trade school that specializes in instrumentation calibration.

#### C. TEST EQUIPMENT AND MATERIALS:

Provide test equipment to conduct the specified tests that simulate inputs and read outputs with a rated accuracy at the point of measurement at least three times greater than the component under test.

Test instruments shall have a current calibration sticker showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required. Certified calibration reports traceable to the National Institute of Standards and Technology shall be included with the final test report.

Provide buffer solutions and reference fluids for tests of analytical equipment.

#### D. FIELD TEST PROCEDURE DOCUMENTATION:

Test procedures submitted for approval within 60 days prior to the start of testing.

Test procedures for each analog and discrete loop in the process control system shall be organized and assembled in separate volumes for each process area. Final test records shall be submitted in electronic form by scanning and converting the records and files to Adobe PDF format, to preserve actual signatures and signoffs.

Test procedure documentation shall include a detailed, step-by-step description of the required test procedure, panel and terminal block numbers for points of measurement, input test values, expected resultant values, test equipment required, process setup requirements, and safety precautions.

Test report forms for each loop, including forms for wiring, piping, and individual component tests, shall be included with the test procedure documentation. The actual test results shall be recorded on these forms and a final test report assembled as specified in paragraph 17030-3.05.

Test report forms shall be preprinted and completed to the extent possible prior to commencing testing. Test report forms that document the field test procedures shall include the following information:

1. Project name.
2. Process area associated with the equipment under test.
3. Instrument loop description.
4. Instrument loop identification number.
5. Instrument nameplate data.
6. Instrument setup and configuration parameters.
7. Time and date of test.
8. Inspection checklist and results.
9. Reference to applicable test procedure.
10. Expected and actual test results for each test point in the loop including programmable controller data table or register values.
11. Test equipment used.

12. Space for remarks regarding test procedure or results, unusual or noteworthy observations, etc.
13. Name, date, and signature of testing personnel.
14. Test witness' name and signature.

E. PERFORMANCE DEVIATION TOLERANCES:

Tolerances shall be specified in Division 17. Where tolerances are not specified, refer to the manufacturer's published performance specifications.

Overall accuracy requirements for loops consisting of two or more components shall be the root-summation-square (RSS) of the component accuracy specifications. Tolerances for each required calibration point shall be calculated and recorded on the associated test report form.

F. INSTALLED TESTS:

Equipment and System Performance and Operational Testing - Section 01660 specifies testing of the mechanical, electrical, instrumentation and HVAC systems. The Contractor's Quality Assurance Manager shall coordinate, manage, and supervise the quality assurance program that includes:

1. Testing plan with the sequence for the test work.
2. Calibration program for all instruments and analyzers.
3. Documentation program that records tests results.
4. Performance testing program systems.

Test forms provided shall conform to the requirements of reference forms 17000-A through 17000-M included in Section 01999. Additional or detailed forms shall be developed as necessary to suit complex instrumentation. Usage of terms used on test forms shall comply with ISA S51.1.

G. WITNESSING:

The Owner reserves the right to observe factory and field instrumentation testing and calibration procedures. The Owner shall be notified prior to testing, as specified herein.

3.02 FACTORY TEST

A. FACTORY ACCEPTANCE TEST (FAT):

Process Instrumentation and Control System Testing  
17030-7

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1. GENERAL: Control system equipment shall be subject to a Factory Acceptance Test with the factory acceptance tests and subsequent retests witnessed by the Construction Manager and Owner. Control system panel programmable logic controllers shall be loaded with the PLC software, Operator Interface software and the programming and graphic configuration application software at the control system equipment supplier's factory prior to the FAT.

Equipment, panel instruments, panels, or cabinets shall be inspected with factory testing performed. Provide written notice to the Owner thirty working days before the commencement of the FAT activity and include:

- a. Schedule for the FAT.
- b. Location of the FAT.
- c. Testing equipment used.
- d. Detailed test procedure with forms for the recording of test results.
- e. Sign-off spaces for the individuals performing and witnessing the tests.

2. FACTORY ACCEPTANCE TEST PROCEDURES: Panels provided shall be interlocked or networked as applicable, operated, and checked-out by the equipment supplier prior to the FAT. Submit certification indicating that the panels are ready for the FAT.

The FAT shall include the following:

- a. Visual inspection of equipment, instruments, control panels, and graphic displays.
- b. Validation of each input loop and output loop by simulated signals for analog inputs and by shorting discrete inputs.
- c. Validation shall include:
  - 1) Monitoring state changes on operator interface screens based on the inputs state change.
  - 2) Observation of online PLC programming application software with the associated PLC outputs state change.
  - 3) Outputs triggered by operator interface software devices (pushbuttons, sliders, manually-entered values, etc.)

- 4) Calibration and operation of instruments on or in the control panels.
- d. Repair of loops which do not pass validation.
- e. Retest of the FAT at no additional cost.

Panels that pass the FAT may be shipped to the site upon shipping schedule and storage accommodation approval by the Construction Manager.

### 3.03 PRE-OPERATIONAL PERFORMANCE TESTING

#### A. GENERAL REQUIREMENTS:

In general, tests shall be performed in the following order:

#### B. TELEMETRY PLC CONTROL PANEL:

Perform the following, witnessed by the Owner and Programmer. Test form 17000-L:

1. Review dimensions, component layout, and wiring.
2. Examine cabinets and components to determine that specified hardware has been installed.
3. Examine wiring and panel assembly against specification requirements for quality of workmanship.
4. Inventory all panel parts and appropriate documentation.

#### C. WIRING TESTS:

Electrical power and signal cable ring-out and resistance testing. Conducted in accordance with Sections 16000 and 16030. Wiring tests shall not be conducted until cables have been properly terminated, tagged and inspected.

1. Power and Control: Per Section 16030.
2. Signal: Test form 17000-A.

#### D. TELEMETRY COMMUNICATIONS:

Perform the following, witnessed by the Owner and Programmer. Test form 17000-M:

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1. Examine antenna/cable assembly for quality of workmanship. The cable connection to the antenna shall be sealed with tape, then covered with vulcanizing rubber and sealed with tape.
2. Provide laptop PC for radio-modem configuration. After complete radio and transmission system installation, connect specified cable from radio to PC. Perform the following:
  - a. Perform VSWR test. Record reflected power reading and submit as Product Data. The system will not be accepted with a reflected power of > 0.2 watts at 1 watt rated output. Test to be performed with radio timeout timer and frequency hopper functions temporarily disabled.
  - b. Record radio system address.
  - c. Verify radio antenna alignment to the other specified radio location.
  - d. Record RSSI readings after antenna alignment is complete. Communications are not to exceed -100 dBm.
  - e. Verify unit is set for master mode if tank site, remote mode for wells. If configured for master, check for long polling (Modbus messaging).
  - f. Verify radio setting Buff = On.
  - g. Verify radio to PLC communication settings:
    - i. Baud Rate = 9600
    - ii. Data Bits = 8
    - iii. Parity = Even
    - iv. Stop Bits = 1
3. Transmission line or antenna related fault or trouble conditions shall be investigated and resolved to the satisfaction of the Owner. Replace damaged transmission line or related components, lightning protectors, poles, towers, or connectors that were installed improperly. Re-align antennas as required for maximum signal strength.
4. Inventory all panel parts and appropriate documentation.

E. INSTRUMENTATION CALIBRATION:

1. Instruments and final elements shall be field calibrated in accordance with the manufacturer's recommended procedures and tested in accordance with the Contractor's test procedure.

2. Individual Component Calibration and Testing shall not commence until Instruments and Component Inspections are completed and documented to the satisfaction of the Owner.
3. Analog instrument calibrated at 0, 10, 50, 90, and 100 percent of the specified full scale range. Each signal sensing trip and process sensing switch shall be adjusted to the required setting. Test data recorded on test forms as specified herein.
4. Final element alignment tested and adjusted to verify that each final element operates smoothly over the full range in response to the specified process control signals.
5. Test data shall be entered on the applicable test forms at the time of testing: Alarm trips, control trips, and switches shall be set to initial values specified in Section 17200 Instrument Index at this time. Final elements shall be checked for range, dead-band, and speed of response.
6. Any component that fails to meet the required tolerances shall be repaired or replaced by the manufacturer. Repeat the specified tests until the component is within tolerance.
7. Install a calibration sticker on each instrument following successful calibration that indicates the date of calibration, the name of the testing company, and personnel who calibrated the instrument.
8. Test forms 17000-C through 17000-I.
9. **CERTIFIED TEST REPORTS:** Field test and inspection activities include verification of instrument parameter setup, verification of instrument zero, and performance at three operating points within the instrument range. Instrument which fail to demonstrate proper performance shall be returned for re-calibration or replaced as agreed depending on the impact to the project as determined by the Construction Manager.

Where instrument field calibration is not feasible, certified factory calibration reports may be submitted that includes the name and address of the laboratory that conducts the calibration testing. Certified factory test reports may be submitted for the following instrument types in lieu of field calibration:

TABLE-A. FACTORY CALIBRATION INSTRUMENT LIST

Instrument Identification	Instrument Section	Description
-	17000	Magnetic flow meter

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LST	17000	Level (pressure) transmitter
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F. LOOP TESTING:

1. Loop Testing shall not commence until the Individual Component Calibration and Testing has been completed and documented to the satisfaction of the Owner.
2. Each instrument loop shall be tested as an integrated system. Check operation from field instruments to transmitter to receiving components to the vendor panel or the Plant Control System Operator Interface Station. Test signals shall be injected at the process impulse line connection where the measuring technique permits, and otherwise at the most primary signal access point.
3. Testing of loops with an interface to a programmable logic controller shall include verification of the programmable logic controller input/output assignment and verification of operation of the input/output system and processor. Inspect the data table or register in the programmable logic controller memory to verify proper operation.
4. If the output control or monitoring device fails to indicate properly, corrections to the loop circuitry or device shall be made. The test shall be repeated until devices and instruments operate as required.
5. Correct loop circuitry and repeat the test until the instruments operate properly.
6. Test form 17000-J.

3.04 FUNCTIONAL TESTING

A. PROCESS CONTROL STRATEGY/FUNCTIONAL TESTING:

1. Control Strategy Testing shall not commence until the Loop Testing has been completed and documented to the satisfaction of the Owner.
2. Control Strategy Testing is performed by the Programmer and Contractor and consist of installing and debugging the PLC control logic program, verifying the interface points between the PLCs and field devices and equipment, and exercising the control strategies. Control Strategy Testing will be performed on one PLC at a time.

3. Provide qualified personnel to immediately correct any deficiencies in the Work that may be encountered during Control Strategy Testing. Failure of the Contractor to provide such personnel in a timely manner may prolong the time allotted to complete Control Strategy Testing.

B. CONTROL SYSTEM CLOSED LOOP TESTING:

1. Closed-Loop Commissioning shall not commence until the Control Strategy Testing has been successfully completed and documented to the satisfaction of the Owner.
2. Closed-loop commissioning tests, performed as part of the system tests, shall demonstrate stable operation of each loop under operating conditions. Tests shall include adjustment of loop tuning parameters.
3. Tuning parameters: gain (or proportional band), integral time constant, and derivative time constant for each control loop, adjusted to provide 1/4-amplitude damping, unless otherwise specified.
4. The loop response to a step disturbance shall be provided for each loop. Two graphs shall be made for cascaded control loops, one showing the secondary loop response with its set point in manual, and the second showing overall loop response.

C. FUNCTIONAL CHECKOUT:

Conducted to verify the operation of discrete and hardwired control devices, refer to Section 01660. Exercise the operable devices and energizing the control circuit. Operate control element, alarm device, and interlocks to verify the specified action occurs.

3.05 OPERATIONAL TESTING

System Acceptance Test (SAT) shall be performed after component and subsystem tests have been completed. The test of the completed system shall be performed in full operation and shall demonstrate that all functional requirements of this specification have been met. SAT shall demonstrate the following:

1. Each component of the system operates correctly with all other components of the system.
2. Analog control loops operate in a stable manner.
3. Hard-wired and software equipment interlocks perform correctly.

4. Process control sequences perform correctly.
5. PLC application program performs monitoring and control functions correctly.
6. Operator interface graphics represent the monitoring and control functions correctly.

**\*\*END OF SECTION\*\***

## SECTION 17110

### INSTRUMENT AND CONTROL PANELS

#### PART 1--GENERAL

##### 1.01 DESCRIPTION

###### A. SCOPE:

This section specifies requirements for Telemetry PLC units for the Bodaway-Gap water system.

Provide Telemetry PLC units as specified in Paragraph 17000-1.01 B. Panels shall be arranged to separate control and instrument devices from power wiring. Panel shall be arranged for dedicated field wiring terminations rated for 600 Vac or less for power, control, and instrument signal wiring shall be fabricated by a UL-508A recognized facility and shall bear the appropriate UL 508A Industrial Control Panel label.

Provide telemetry units per details from NTUA Technical Provisions 4.0 for DC Tank Control Panel, AC Tank Control Panel, and PLC Control Panel (Simplex Well with Soft Starter).

###### B. SUBMITTAL DRAWINGS:

1. GENERAL: The drawings included in the project manual are functional in nature and do not show exact locations of equipment or interconnections between equipment. The Contractor's Systems Integrator shall prepare detailed installation drawings as specified below.

Drawings prepared in AutoDesk AutoCAD, or similar with borders and title blocks identifying the project, system, revisions to the drawing, and type of drawing. Each revision of a drawing shall include the date and description of the revisions. Drawing prints shall be 11" x 17" with a minimum lettering size of 1/8".

Diagrams shall carry a uniform and coordinated set of wire numbers and terminal block numbers in compliance with panel wiring and Section 17110, to permit cross-referencing between contract documents and the drawings prepared by the Contractor.

2. CONNECTION DIAGRAMS: Show components of a control panel in an arrangement similar to the actual layout of the panel including internal wiring between devices within the panel. Show terminal blocks used for internal wiring or field wiring, identified as such. Indicate insulation color code, signal polarities, and wire numbers and terminal block numbers.

3. INTERCONNECTION DIAGRAMS: Show panels, panel devices, and field devices with wire numbers, cable numbers, raceway numbers, terminal box numbers, terminal block numbers, panel numbers, and field device tag numbers.

4. ELEMENTARY OR SCHEMATIC DIAGRAM: Shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement. Provide schematics for internal panel power distribution, lighting, and any panel HVAC.

5. ARRANGEMENT, LAYOUT, OR OUTLINE DRAWINGS: Show the dimensioned external and interior control panel views with components and Bill of Material. Provide panel heat load calculations, and indicate cooling or ventilation provisions as required.

6. NETWORK BLOCK DIAGRAM: A network block diagram is a diagram of the overall SCADA system, with annotated boxes to show the primary network components (controllers, hubs, switches, computers, displays), and annotated interconnecting lines that show the system communication media and communication protocols.

## 1.02 QUALITY ASSURANCE

### A. REFERENCES:

This section contains references to the following documents that are part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid or on the effective date of the Agreement if there were no Bids. 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, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
EIA RS-310C	Racks, Panels, and Associated Equipment
NEMA 250	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

Reference	Title
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508A	Industrial Control Panels

**B. LISTED PRODUCTS:**

Equipment and components shall be Underwriters Laboratory (UL) listed for the purpose per Section 16000 or UL recognized.

The control panels shall have factory applied UL 508A labels.

**C. FACTORY TESTING:**

Prior to shipment, the manufacturer shall test the functional operation of the control panel as described in the control description Section 17030.

**D. WARRANTY:**

In addition to the guarantee specified in the General Conditions, the equipment, components, and assemblies provided shall be warranted against defects in materials and workmanship of a period of 1 year from the date of completion of all testing specified in Section 17030. Provide warranty service when requested. Provide all costs for transportation, labor, and replacement parts associated with a service call required under the warranty. Cost reimbursement will be provided for the service call and any repair work if it is determined that the control system was damaged by vandalism or an Act of God. Cost reimbursement will also be made if the call was due to a non-functioning device which was not part of the Contract installation, or for blown fuses or tripped circuit breakers.

**E. TELEMETRY PLC DRAWINGS:**

1. Drawings:
  - a. Cover sheet with site name.
  - b. Discrete I/O wiring.
  - c. Analog I/O wiring.
  - d. Power Distribution.
  - e. Backplane layout with bill of materials.



- f. Communication cable pinouts.
- g. Nameplate list with material, color, tag number, and description.

### 1.03 SUBMITTALS

Submittals and transmittal procedures for submittals are defined in Section 01300. Submit In accordance with the procedures set forth in Section 01300 that include drawings, information and technical data for equipment and as required in Section 17000. Submittal information shall be included in one complete submittal.

#### A. SHOP DRAWINGS:

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. A check mark 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 Owners 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. A marked copy of specification section 17000.
3. A copy of the contract document Electrical Drawings E-101 through E-140 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
4. A copy of the contract document Instrumentation Drawing I-001 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for

the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

5. A copy of the contract document NTUA Technical Provisions 4.0 DC Tank Control Panel, AC Tank Control Panel, and Pump Control Panel drawings relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
6. Catalog cuts of equipment, devices, and materials for products to be provided. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc. Catalog cuts shall be edited to show only the items, model numbers, and information which apply. Submit catalog cuts for the following:
  - a. Radio components.
  - b. PLC and modules.
  - c. Touchscreen.
  - d. Power supplies.
  - e. SCADA Network components.
7. Manufacturer's installation manual excerpts, as to be used for this project:
  - a. Installation details/drawings.
  - b. Electrical connection diagrams
  - c. Calibration procedures.
8. Telemetry PLC drawings and diagrams generated in CAD for the telemetry equipment specified in paragraph 1.02 E. and similar to those included in the drawings.

9. SCADA Network Cabinet drawings generated in CAD for the telemetry equipment specified in paragraph 1.02 E. and 17000-1.01 B. similar to those included in the drawings:
  - a. Backplane layout with bill of materials.
  - b. Block diagram of components and interconnections.
10. List of miscellaneous items, cables, spare and replenishment parts.

#### 1.04 ENVIRONMENTAL CONDITIONS

Refer to Section 17000.

### PART 2--PRODUCTS

#### 2.01 FABRICATION

##### A. GENERAL:

Panels shall be designed for the seismic requirements of Section 17000. Structures, equipment, and devices shall be braced to prevent damage from specified forces. Equipment panels shall be capable of operation following a disturbance.

Nameplates with tag number and equipment description shall identify face-mounted instruments. Instruments shall be mounted for access to components and ease of removal. Cutouts for future equipment shall be blanked off with suitable covers. Instrument tag numbers shall be identified on the panel rear.

Face-mounted equipment shall be flush or semi-flush with flat-black escutcheons. Face-mounted instruments that are more than 6 inches deep, weigh more than 10 pounds, or exert more than a 4 ft-lb moment force on the face of the panel shall be supported underneath at the rear by a 1-inch x 1/8-inch thick steel angle.

Panels less than 60 inches high shall be provided with floor stands to raise the top of the panel to 60 inches above the floor or work platform. Panels that weigh less than 100 pounds may be wall mounted.

Panels with specified requirements including stainless steel or aluminum mounting requirements that are indicated on the project drawings or on the project details take precedence over the panel types or panel features indicated herein.

#### 2.02 PANEL AND COMPONENTS

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Equipment material shall be new, free from defects, and industrial-grade, as specified. Each type of equipment, component, accessory, and device used throughout the work shall be manufactured by one firm, where possible.

Equipment and components shall be as specified on the drawings referenced in Paragraph 1.01 A, and in this Section where not specified on the drawings.

## 2.03 NOT USED

## 2.04 NAMEPLATES

External door-mounted components and the panel description shall be identified with plastic nameplates. Machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.

The machine engraved laminated black phenolic nameplates with white lettering shall be provided for panel-mounted equipment. Nameplate engraving shall include the instrument tag number and description in 3/32-inch minimum size lettering.

The machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.

The nameplates shall be attached to the panel with a minimum of two self-tapping 316 stainless steel screws. Provide RTV sealant for nameplates for NEMA-4X stainless steel panels.

The nameplate wording may be changed without additional cost or time prior to commencement of engraving. Submit nameplate legend with the panel submittal.

## 2.05 PANEL FEATURES

### A. INTERCONNECTION WIRING:

#### Panel Interconnecting Wiring:

1. Panel control wiring: Single conductor stranded copper NFPA No. 70 Type MTW No. 18 AWG minimum, with an exception for factory supplied PLC wiring harnesses that are U.L. approved.
2. Panel instrument wiring: Twisted No. 18 AWG shielded pair or tri conductors.

3. Panel power wiring: Conductors specified in Division 16 and meet the NFPA No. 70 NEC requirements for power including phase, grounded, and grounding conductors.
4. Wiring shall be supported independently of terminations by lacing to panel support structure or by slotted flame retardant plastic wiring channels.
5. Wiring channels shall comply with UL 94, Type V.
6. Wiring channel fill shall not exceed 50 percent.

**B. CONDUCTOR IDENTIFICATION:**

Wiring shall be tagged at terminations with machine printed plastic sleeves with three-part wire numbers for instrument and control panel internal conductors:

1. Part-1: Prefix of the wire number shall be the instrument loop number or equipment tag number.
2. Part-2: Code letter and wire colors per the following tables.
3. Part-3: Number that identifies individual circuit conductor Terminal Number.

Code	120 Vac Conductor	Color
L	Power	Black
C	Control	Red
N	Neutral	White
PG	Ground	Green

Code	V dc Conductor	Color
PS	24 Vdc Power	Violet
PS	24 Vdc Control	Blue
PS	24 Vdc Common	Brown
S+	Signal (+)	White
SG	Signal Ground	Black

EG	Equipment Ground	Green
FV	Panel Foreign Voltage	Yellow

C. CONDUCTOR INSTALLATION AND PROTECTION:

1. Power and control wiring shall be carried in covered channels separate from low voltage signal circuits. An interior steel barrier shall be provided between AC control devices and the electronic equipment.
2. Terminal blocks shall be strap screw type rated for 600 volts. Each terminal trip shall have a unique identifying alphanumeric code at one end and a vinyl-marking strip running the entire length of the terminal strip with a unique number for each terminal. Numbers shall be machine printed and 1/8 inch high.
3. No more than two connections shall be made to one terminal.
4. Wire connectors shall be locking fork tongue or ring tongue insulated crimp type terminals.
5. Terminal blocks shall be;
  - a. Buchanan 0621-1
  - b. Allen-Bradley 1492-HM1 600 V 30-amperes, finger-safe terminal block.
  - c. Allen-Bradley 1492-CD3 600 V 35-amperes with #8 screw terminal block for ring or spade terminals.
  - d. Phoenix Contact or Weidmuller equal products.

D. FIELD WIRING:

Field wiring shall be connected to separate dedicated terminal blocks in a dedicated part of the panel where the field cables enter the panel.

E. FUSE AND FUSE HOLDERS:

1. Fuses for 120 Vac circuits shall have a minimum of 12,000-amperes interrupting capacity and blown fuse indicators.

2. Fuses for 24 Vdc circuits shall be fast acting glass tube type rated 1/8 or 1/10 amp for 4-20 mA loops.
3. Fuses for 24 Vdc circuits shall be 1/2 amp for the power supply to individual instruments.
4. Fuse holders shall be tip-out or draw-out type.
5. Provide Phoenix Contact or equal products.

F. CONTROL POWER:

120 Vac control power source: Single power source for all control and DC power.

1. Provide direct current power supplies, as required for the load.
2. Provide UPS for PLC and derived loop power as specified, as required for the load.

G. NOT USED

H. ACCESSORIES:

1. Include GFCI convenience receptacle.
2. Print pocket.

2.06 SURGE PROTECTION

Surge protectors shall be as specified on Drawings.

2.07 PANEL GROUNDING

- A. Provide as specified on Drawings.
- B. Field analog wiring shields shall only be grounded at the signal ground bar. Test to verify that single ground point at panel signal ground bar.

2.08 PANEL DRAWING PROTECTION

Provide wiring diagrams in accordance with Section 01300. Provide a panel-wiring diagram and schematic for each panel in a plastic bag or plastic container to avoid water damage and aging.

2.09 RADIO COMPONENTS

1. Radio: Provide GE MDS Trans-NET EL805-MD9X1AFCS0WN, spread-spectrum 928/952 MHz.
2. Transmission Line: Times Microwave LMR-300, 3', with type N connectors.
3. Radio to PC configuration cable, GE MDS 03-3246A01. Provide one for the entire system.

## 2.10 SCADA NETWORK CABINET

1. Microwave Link Equipment: As directed by NTUA including radio/modem, antenna, transmission line, surge protectors, and appurtenances.
2. Inverter, 48 Volt DC to 120 Volt AC, 1,000 watt. PureSine, MajorSine, or equal or other power supplies as directed by NTUA. For Cabinets located on sites with 48 Volt DC power.
3. Power supply, 120 Volt AC to 48 Volt DC, GE Slimline EP1000UTEZ, or equal or other power supply as directed by NTUA. For Cabinets located on sites with 120 Volt AC power.
4. Batteries, C&D Technologies TEL Series.
5. Provide power distribution fuses and terminal blocks for Microwave Link Equipment power.
6. Freestanding pad-lockable NEMA 4 Cabinet, front and rear access, air conditioner, Sun West Engineering or equal.
7. Provide the above completely assembled per bid allowance, with interconnecting Ethernet cables and power connections. Generate layout drawings per paragraph 1.01 B. and submit.
8. Initiate request for information (RFI) to confirm above part numbers prior to shop drawings submittal. Manufacturer model numbers and availability subject to change.

## 2.11 SPARE PARTS

The following spare parts shall be provided:

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1. Five each of each type and rating of fuse used in the panels.

## 2.12 PRODUCT DATA

The following data shall be provided in accordance with Section 01300:

1. Manufacturer's operation and maintenance information as specified in Section 17000 including final reviewed submittal and as-built drawings.
2. Test results as specified in Section 17030-Part 2.

## PART 3--EXECUTION

### 3.01 GENERAL

All conduit shall enter the panels from the bottom. Provide Myers hub for rigid steel conduit entry.

Field panels and cabinets shall be mounted in compliance with paragraph 17000-3.01 B.

Provide panels with the As-built schematic, connection, and interconnection diagrams located in a print pocket on the inside of the door. Place documentation in a water proof clear bag in the panel document holder.

### 3.02 NOT USED

### 3.03 PANEL POWER SUPPLY

Power supply and conditioning equipment shall be mounted and connected in compliance with the manufacturer's instructions.

Final raceway connections shall be a flexible conduit in compliance with Division 16.

### 3.04 FACTORY TESTING

The control panel shall be assembled, interconnected, and functionally tested at the assembly shop prior to shipment. The Owner/Engineer shall have the option of witnessing the functional shop test. The Contractor shall notify the Owner/Engineer at least two (2) weeks in advance prior of the scheduled functional shop test.

### 3.05 FIELD TESTING

Field verify the following for Instrument and Control Panels:

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1. Control circuits grounded with one terminal of each load device connected to the grounded conductor.
2. Control contacts installed in the ungrounded side of the circuit.
3. Signal and control wiring installed in separate wireways.
4. Barriers between the power wiring and the signal and control wiring.
5. Connected to the plant grounding system, as specified.
6. Center-line of wall-mounted panels shall be 48 inches above the floor.
7. Inner door contains a copy of the Record elementary and wiring diagrams.
8. Inner door contains a protected drawing holder.
9. Drawings enclosed in a transparent, protective jacket.
10. Functions as specified.
11. Mounted with stainless steel unistrut, fittings, and fasteners.
12. Tested in accordance with Section 16030 and Section 17030.

**\*\*END OF SECTION\*\***

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## SECTION 17900

### CONTROL SPECIFICATIONS

#### PART 1--GENERAL

##### 1.01 DESCRIPTION

###### A. SCOPE:

This section specifies the control specification strategies for modifications to the Navajo Nation Bodaway-Gap Water Systems that are based on Programmable Logic Controller (PLC) based Telemetry systems.

Telemetry System Programming and Touchscreen Graphics Development responsibilities: Refer to Section 17000.

The Control Specification strategies describe sequential and interlocking control functions, analog control functions, and color-graphic video display operator interfaces including alarm and event logging. The generic term used herein shall be Telemetry.

The Contractor shall provide all necessary labor and equipment to test the control strategies per Section 17030.

###### B. WATER SYSTEM:

Refer to the General Notes on Drawing I-001 for a brief overview of the water system control requirements.

#### PART 2—PRODUCTS – NOT USED

#### PART 3--EXECUTION

##### 3.01 STANDARD INTERLOCKS

Interlocks (I) shutdown and prevent equipment from operating:

1. Hardwired interlocks are effective whether the PLC system is in operation or not, and in hand and auto modes unless noted.
2. Software interlocks are provided by the PLC, and are usually only effective when the equipment is operating in auto mode unless noted.

The following describe general interlock features for all systems:

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## II – MOTOR PROTECTION

Equipment motor protection includes overload and/or VFD or RVSS fault or Motor Protection Relay alarm, hardwired only. Manual reset required at the starter, VFD, or RVSS.

### 3.02 STANDARD GENERAL CONTROL STRATEGIES

Control Strategies (CS) define common equipment operations performed by the PLC and displayed by the Telemetry system. Hardwired control strategies are effective for equipment control whether the PLC system is in operation or not, and in hand and auto modes unless noted.

Control Strategies unique to each process system are defined beginning in paragraph 3.10 below. The following describe general control features for all systems:

#### CS1 - EQUIPMENT RUN TIME TOTALIZATION

Equipment run time totalization will be calculated and maintained by the PLC based on equipment run status. Totalize in hours from 0 to 9999.

TELEMETRY: Display total in hours.

#### CS2 - FLOW TOTALIZATION

Flow totalization will be calculated and maintained by the PLC whenever flow signals exceeds 2-1/2 % of full scale value and analog signal has not failed (refer to CS10). Totalize in gallons times 1,000 (kGal) or gallons times 1,000,000 (MGal) as shown on the P&ID. Totalize from 0 to 9999.

TELEMETRY: Display total in kGal or MGal as shown on P&ID.

Previous 24 hour day flow totalization will also be calculated and maintained by the PLC.

TELEMETRY: Summary display of previous day totals in kGal or MGal as shown on P&ID.

#### CS3 - PROCESS ALARM(S), SELF-RESETTING

Process alarms as shown on the P&ID will be determined and maintained by the PLC:

1. Low-Low Alarm: Point value is equal to or less than a predetermined alarm value.
2. Low Alarm: Point value is equal to or less than a predetermined alarm value.

3. High Alarm: Point value is equal to or greater than a predetermined alarm value.
4. High-High Alarm: Point value is equal to or greater than a predetermined alarm value.

An analog point which is in alarm status will not be changed to normal status until the point value changes by the predetermined deadband value for the point, initial setting of 5% of full scale range. PLC alarm setpoints are provided in paragraph 17200-3.03 instrument index.

TELEMETRY: Display alarms. Display active and cleared-but-unacknowledged alarms in the alarm summary.

#### CS7 - PROCESS ALARM(S), MANUAL RESET FROM TELEMETRY REQUIRED

Process alarms as shown on the P&ID will be determined and maintained by the PLC:

1. Low-Low Alarm: Point value is equal to or less than a predetermined alarm value.
2. Low Alarm: Point value is equal to or less than a predetermined alarm value.
3. High Alarm: Point value is equal to or greater than a predetermined alarm value.
4. High-High Alarm: Point value is equal to or greater than a predetermined alarm value.

An analog point which is in alarm status will not be changed to normal status until reset by the Telemetry Operator and the point value changes by the predetermined deadband value for the point, initial setting of 5% of full scale range. PLC alarm setpoints, if any, are provided in paragraph 17900-3.03.

TELEMETRY: Display alarms. Display active and cleared-but-unacknowledged alarms in the alarm summary. Telemetry allows Operator reset of alarms.

#### CS9 - DISCRETE POINT STATUS

The status of each discrete input point will be maintained in the PLC.

The status of each logical discrete point will also be maintained in the PLC. Logical points are points which depend upon the status of one or several discrete input points.

TELEMETRY: Display the status of all discrete and logical discrete status points.

## CS10 - ANALOG POINT STATUS

Analog input points will be checked by the PLC for the following status conditions:

Failed: Point value is less than or greater than the specified value range typically less than 3.6 milliamps (mA) and greater than 21.6 mA. Where the PLC module cannot read outside the 4-20 mA range, use discrete alarm bits available from the module or PLC status function block.

TELEMETRY: Display alarm. Display active and cleared-but-unacknowledged alarm in the alarm summary

## CS11 - GENERAL EQUIPMENT DISCREPANCY

The failure of driven equipment to respond will be monitored by the Telemetry system. Equipment will be considered to be in discrepancy under the following conditions:

1. The equipment is in AUTO and the Telemetry system attempts to operate the equipment and it does not respond within a defined time period, typically 15 seconds.
2. The equipment is in AUTO and running and for whatever reason other than the Telemetry system requesting the equipment to "STOP," the equipment stops.

## CS12 - TELEMETRY INPUTS AND OUTPUTS STATUS

The PLC will monitor status of each individual input, output, and communication module, and all processor statuses available.

TELEMETRY: Display racks with status for each module, using descriptive terms for alarms. Display processor battery status. Display alarms. Display active and cleared-but-unacknowledged alarm in the alarm summary

## CS16 - TREND PLOTS

TELEMETRY workstations will graphically plot trends of all process variables (pressure, flow, temperature, level, analytical, electrical kW and Power Factor) in real-time and from historical data. The plant operator will be able to select the plotting interval, within the limits of the actual data collection. Four trends per display view will be possible.

In addition to the plotted data, a trend will include:

1. Time
2. Date
3. Tag number

4. Plotting interval
5. Time at start
6. Time at latest value.
7. Range and units

#### CS17 – COLOR NOTATION FOR DYNAMIC OBJECTS ON CONTROL GRAPHIC DISPLAY SCREENS

All dynamic objects on control graphic display screens will be provided with multiple-color display with high performance graphics to identify status as tabulated below:

Equipment	Status	Required color
Motor	Running	Dark Grey
Motor	Ready or Off	Light Grey (Neutral)
Valve	Opened position	Light Grey
Valve	Closed position	Dark Grey
All	Power on	Light Grey
All	Abnormal condition	Amber (Yellow)
All	Advisory, Control Mode	Blue

#### CS18 - DIGITAL ALARM SYSTEM

Alarms as shown on the P&ID will be determined and maintained by the PLC, whether or not specific control strategies are provided. Digital inputs can be from field instruments (level switches, pressure switches, etc.), local control panels (relay outputs, alarm module outputs, switches), and packaged systems (designated terminals with packaged units).

TELEMETRY: Display alarms. Display active and cleared-but-unacknowledged alarms in the alarm summary.

#### CS19 - DATA ARCHIVING HISTORIAN AND HISTORICAL FUNCTIONS

None. These are provided by the separate Regional SCADA System.

#### CS20 - DIGITAL STATUS SYSTEM

All digital input status will be displayed on Telemetry screens as required by the reference drawings and specifications regardless whether or not specific control strategies are provided. Each digital input will be shown in its appropriate process screen and/or equipment status screen. Digital inputs can be originated from field instruments (motorized actuators, HVAC related air handling units, power management related contact inputs, level switches,



pressure switches, etc.), local control panels (relay outputs, alarm module outputs, switches), and packaged systems (designated terminals with packaged units).

#### CS24 - DATA TRANSFER REQUIREMENTS BETWEEN THE PLCs AND THE TELEMETRY SYSTEM

Digital inputs and analog inputs to the Telemetry system and the software logic generated alarms will be displayed or annunciated at the Telemetry touchscreen as specified on the Drawings and in this Section.

The Telemetry system will generate separate alarms if communication is lost with any PLC.

Data displayed on the Telemetry installed on this project will be available to the existing Regional SCADA System.

For the Lower Greasewood Telemetry System, the Regional SCADA System RTU is located at the Lower Greasewood Tank.

For the Ganado Telemetry System, the Regional SCADA System RTU is located at the Ganado Tank.

#### CS51 – ALTERNATION - SOFTWARE

Equipment run-time equalization by alternating the lead/follow/2<sup>nd</sup> follow/etc. assignment of two or more pumps, PLC. Alternation occurs when all of the pumps in that group stop.

### 3.03 CONTROL STRATEGY – BODAWAY-GAP TANK LEVEL

A. P&ID: I-001

B. GENERAL DESCRIPTION:

The existing Tank level is maintained by existing Wells 1 and 2, and the Tank site altitude valve providing water from Bodaway-Gap Tank No. 2. Wells 1 and 2 have chlorination systems, refer to Paragraph 3.04 regarding Tank No. 2.

C. CONTROL STRATEGY OVERVIEW:

The existing Tank Telemetry PLC periodically requests via radio the status and alarm data, and sends the tank level signal to the existing Wells 1 and 2 Telemetry PLCs.

Start/stop setpoints for existing Wells 1 and 2 are Operator adjustable at the Well Telemetry PLC Touchscreens.

Open/close setpoints for the Tank site altitude valve are Operator adjustable at the Tank Telemetry PLC Touchscreen.

D. LOCAL CONTROL:

1. Field - Tank:

Mechanical Level indication

2. Field - Well:

Well Discharge Pressure indication  
Well Discharge Flow indication

3. Well MCC:

HAND-OFF-AUTO selector

4. Interlocks per 17900-3.01:

II – MOTOR PROTECTION

E. REMOTE OR AUTOMATIC CONTROL:

1. Control Strategy, per above and including:

CS1 - EQUIPMENT RUN TIME TOTALIZATION  
CS2 - FLOW TOTALIZATION

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CS11 - GENERAL EQUIPMENT DISCREPANCY  
CS16 - TREND PLOTS

2. Software Interlocks per 17900-3.01: None.

3. TELEMETRY - TANK:

Tank Level indication  
Touchscreen indication of Telemetry from the Wells

4. TELEMETRY - WELL:

RUN status  
Soft Start FAULT alarm  
Soft Start HIGH TEMPERATURE alarm  
Soft Start OVERCURRENT alarm  
AUTO status  
Pump Motor Amps indication  
Well Level indication  
Flow and Total indication

5. TELEMETRY – ALTITUDE VALVE:

OPEN/CLOSE control status

6. TELEMETRY – FOR REGIONAL SCADA:

The above Telemetry signals, Bodaway-Gap Wells 1, 2, and 3, Bodaway Gap Tank No. 2, Cedar Ridge water system, and Cameron Pump Station No. 2 and 3 signals are all forwarded from the Tank Telemetry PLC to the Preston Mesa Telemetry PLC for Ethernet access by the Regional SCADA RTU.

3.04 CONTROL STRATEGY – BODAWAY-GAP TANK No. 2 LEVEL

A. P&ID: I-001

B. GENERAL DESCRIPTION:

The Tank level is maintained by Well No. 3. Well No. 3 has a chlorination system.

C. CONTROL STRATEGY OVERVIEW:

The Tank Telemetry PLC periodically requests via radio the status and alarm data, and sends the tank level signal to the Well No. 3 Telemetry PLC.

Start/stop setpoints for Well No. 3 are Operator adjustable at the Well Telemetry PLC Touchscreen.

D. LOCAL CONTROL:

1. Field - Tank:  
Mechanical Level indication
2. Field - Well:  
Well Discharge Pressure indication  
Well Discharge Flow indication
3. Well MCC:  
HAND-OFF-AUTO selector
4. Interlocks per 17900-3.01:  
I1 – MOTOR PROTECTION

E. REMOTE OR AUTOMATIC CONTROL:

1. Control Strategy, per above and including:  
CS1 - EQUIPMENT RUN TIME TOTALIZATION  
CS2 - FLOW TOTALIZATION  
CS11 - GENERAL EQUIPMENT DISCREPANCY  
CS16 - TREND PLOTS
2. Software Interlocks per 17900-3.01: None.
3. TELEMETRY - TANK:  
Tank Level indication  
Touchscreen indication of Telemetry from the Wells
4. TELEMETRY - WELL:  
RUN status  
Soft Start FAULT alarm  
Soft Start HIGH TEMPERATURE alarm  
Soft Start OVERCURRENT alarm  
AUTO status  
Pump Motor Amps indication  
Control Specifications  
17900-9

Well Level indication  
Flow and Total indication

5. TELEMETRY – FOR REGIONAL SCADA:

The above Telemetry signals are all forwarded from the Tank Telemetry PLC to the Electrical Substation Telemetry PLC for Ethernet access by the Regional SCADA RTU.

3.05 CONTROL STRATEGY – BODAWAY-GAP ELECTRICAL SUBSTATION

A. P&ID: I-001

B. GENERAL DESCRIPTION:

The Telemetry PLC forwards telemetry signals from Cameron Pump Station No. 2 and 3, and Cedar Ridge System to the existing Bodaway-Gap Tank for forwarding to Preston Mesa Site Regional SCADA RTU.

3.06 CONTROL STRATEGY – PRESTON MESA SITE

A. P&ID: I-001

B. GENERAL DESCRIPTION:

The Telemetry PLC interfaces telemetry signals from the existing Bodaway-Gap Tank for the entire Bodaway-Gap System, Cameron Pump Station No. 2 and 3, and Cedar Ridge System to the Regional SCADA RTU.

**\*\*END OF SECTION\*\***