

2. AMENDMENT/MODIFICATION NO. 0001	3. EFFECTIVE DATE 12 September 2003	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. (If applicable)
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6. ISSUED BY Department of the Army Corps of Engineers, Los Angeles P.O. Box 532711 Los Angeles, CA 90053-2325	7. ADMINISTERED BY (If other than Item 6)
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8. NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP Code)	(✓)	9A. AMENDMENT OF SOLICITATION NO. DACW09-B-03-0012
	(X)	9B. DATED (SEE ITEM 11) 22 September 2003 (Bid Opening)
		10A. MODIFICATION OF CONTRACTS/ORDER NO.
		10B. DATED (SEE ITEM 13)

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers tended. is extended, is not ex-

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods:

(a) By completing Items 8 and 15, and returning 0 copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA (If required)
N/A

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS, IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

- (✓) A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.
- B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).
- C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:
- D. OTHER (Specify type of modification and authority)

E. IMPORTANT: Contractor is not, is required to sign this document and return _____ copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)
RIO SALADO - PHOENIX REACH, PHASE 1B/2, Phoenix, AZ

- REPLACE TABLE OF CONTENTS
- REPLACE SECTION 00010, BID SCHEDULE AND NOTES
- REPLACE SECTION 01270, MEASUREMENT AND PAYMENT
- REPLACE SECTION 02371, WIRE MESH GABIONS
- ADD NEW SECTION 02661, FLEXIBLE MEMBRANE LINER (FML)
- REPLACE SECTION 11214, SUPPLY WELL PUMPS
- REPLACE SECTION 13405, PROCESS CONTROL

REPLACE DRAWINGS: C-34; C-38; C-38A; C-49; C-51; C-57; C-58; L-168; L-169; and L-176

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER (Type or print)	16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print)		
15B. CONTRACTOR/OFFEROR	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA	16C. DATE SIGNED
_____ (Signature of person authorized to sign)		BY _____ (Signature of Contracting Officer)	

PROJECT TABLE OF CONTENTS

DIVISION 00 - DOCUMENTS

00010 BID SCHEDULE
00100 INSTRUCTIONS, CONDITIONS, AND NOTICES TO BIDDERS
00600 REPRESENTATIONS AND CERTIFICATIONS
00700 CONTRACT CLAUSES
00800 SPECIAL CONTRACT REQUIREMENTS
00850 WAGE RATES

DIVISION 01 - GENERAL REQUIREMENTS

01200 GENERAL REQUIREMENTS
01270 MEASUREMENT AND PAYMENT
01312 QUALITY CONTROL SYSTEM (QCS)
01330 SUBMITTAL PROCEDURES
01355 ENVIRONMENTAL PROTECTION
01356 STORM WATER POLLUTION PREVENTION MEASURES
01420 SOURCES FOR REFERENCE PUBLICATIONS
01451 CONTRACTOR QUALITY CONTROL

DIVISION 02 - SITE WORK

02230 CLEARING AND GRUBBING
02300 EARTHWORK
02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS
02371 WIRE MESH GABIONS
02373 GEOTEXTILE
02510 WATER SUPPLY AND DISTRIBUTION SYSTEM PIPELINES
02531 SANITARY SEWERS
02630 STORM-DRAINAGE SYSTEM
02661 FLEXIBLE MEMBRANE LINING (FML)
02722 AGGREGATE BASE COURSE
02741 HOT-MIX ASPHALT (HMA) FOR ROADS
02748 BITUMINOUS TACK COATS
02763 PAVEMENT MARKINGS
02770 CONCRETE SIDEWALKS AND CURBS AND GUTTERS
02811 UNDERGROUND SPRINKLER SYSTEMS
02821 FENCING
02846 WETLANDS PLANTING
02870 SITE FURNISHINGS
02915 TRANSPLANTING EXTERIOR PLANT MATERIAL
02921 SEEDING
02930 EXTERIOR PLANTING
02935 EXTERIOR PLANT MATERIAL MAINTENANCE

DIVISION 03 - CONCRETE

03307 CONCRETE FOR MINOR STRUCTURES
03600 GROUT

DIVISION 04 - MASONRY

04200 MASONRY

DIVISION 05 - METALS

05120 STRUCTURAL STEEL

05500 MISCELLANEOUS METAL

DIVISION 07 - THERMAL & MOISTURE PROTECTION

07920 JOINT SEALANTS

DIVISION 09 - FINISHES

09900 PAINTS AND COATINGS

09915 COLOR SCHEDULE

09971 COATING OF EQUIPMENT

DIVISION 11 - EQUIPMENT

11214 SUPPLY WELL PUMPS

DIVISION 13 - SPECIAL CONSTRUCTION

13405 PROCESS CONTROL

DIVISION 15 - MECHANICAL

15050 BASIC MECHANICAL MATERIALS AND METHODS

15060 PIPING SUPPORT SYSTEMS

15955 PIPING LEAKAGE TESTING

DIVISION 16 - ELECTRICAL

16010 BASIC ELECTRICAL REQUIREMENTS

16050 BASIC ELECTRICAL MATERIALS AND METHODS

16110 RACEWAYS

16120 CONDUCTORS

16403 MOTOR CONTROL CENTERS

16405 AC INDUCTION MOTORS

16425 SWITCHBOARDS

16450 GROUNDING

16485 ADJUSTABLE FREQUENCY DRIVE SYSTEMS

16520 EXTERIOR LIGHTING

16950 ELECTRICAL TESTING

-- End of Project Table of Contents --

SECTION 00010

BID SCHEDULE

PART 1 GENERAL

1.1 ENVIRONMENTAL RESTORATION

1.1.1 Earthwork and Drainage

Item	Description	Quantity	Unit	Unit Price	Amount
0001	CLEARING, GRUBBING, AND DEMOLITION	1	Job	LS	_____.
0002	GENERAL SITE EXCAVATION FOR PROJECT FACILITIES				
A	FIRST 8,800 CUBIC YARDS	8,800	CY	_____.	_____.
B	OVER 8,800 CUBIC YARDS	2,200	CY	_____.	_____.
0003	GENERAL SITE FILLS AND EMBANKMENTS FOR PROJECT FACILITIES				
A	FIRST 21,000 CUBIC YARDS	21,000	CY	_____.	_____.
B	OVER 21,000 CUBIC YARDS	5,200	CY	_____.	_____.
0004	EXCAVATION AND DISPOSAL OF CONSTRUCTION DEBRIS, HOUSEHOLD WASTE, INERT MATERIAL, TIRES, AND NON-SEGREGATED MIXED WASTE.				
A	FIRST 400 TONS OF CONSTRUCTION DEBRIS	400	Tons	_____.	_____.
B	OVER 400 TONS OF CONSTRUCTION DEBRIS	100	Tons	_____.	_____.
C	FIRST 70 TONS OF HOUSEHOLD WASTE	70	Tons	_____.	_____.
D	OVER 70 TONS OF HOUSEHOLD WASTE	30	Tons	_____.	_____.
E	FIRST 70 TONS OF INERT MATERIAL	70	Tons	_____.	_____.
F	OVER 70 TONS OF INERT MATERIAL	30	Tons	_____.	_____.
G	FIRST 15 TONS OF TIRES	15	Tons	_____.	_____.
H	OVER 15 TONS OF TIRES	10	Tons	_____.	_____.
I	FIRST 400 TONS OF NON-SEGREGATED MIXED WASTE	400	Tons	_____.	_____.
J	OVER 400 TONS OF NON-SEGREGATED MIXED WASTE	100	Tons	_____.	_____.
0005	STORM DRAIN PIPING AND STRUCTURES	1	Job	LS	_____.
0006	ARCHITECTURAL FENCE AND GATES	2,700	LF	_____.	_____.

1.2 WATER SUPPLY AND DISTRIBUTION

1.2.1 Pressurized Water Distribution System

0007	WELL RSSW NO. 3	1	Job	LS	_____.
0008	WELL RSSW NO. 4	1	Job	LS	_____.
0009	WELL RSSW NO. 5	1	Job	LS	_____.
0010	WELL RSSW NO. 6	1	Job	LS	_____.
1.3 HABITAT					
1.3.1 Other Habitat					
0011	AQUATIC/WETLAND/RESERVOIR SEEDING	2,400	SF	_____.	_____.
0012	PRIORITY 1 SEEDING	3,570,000	SF	_____.	_____.
0013	TRANSPLANTING OF NATIVE TREES	20	Each	_____.	_____.
1.3.2 Owner Furnished Plants					
0014	PLANTING OF 1 GALLON PLANTS	33,000	Each	_____.	_____.
0015	PLANTING OF 15 GALLON PLANTS	253	Each	_____.	_____.
0016	PLANTING OF 24" BOX PLANTS	167	Each	_____.	_____.
1.3.3 Irrigation					
0017	OVERBANK PERMANENT DRIP IRRIGATION SYSTEM	1	Job	LS	_____.
0018	TERRACE AND SLOPE TEMPORARY DRIP IRRIGATION SYSTEM	1	Job	LS	_____.
0019	PLANT ESTABLISHMENT (12 MONTHS DURATION)	1	Job	LS	_____.
1.3.4 Staging Area					
0020	SW 7TH AVE STAGING AREA SITEWORK	1	Job	LS	_____.
0021	SE 7TH ST STAGING AREA SITEWORK	1	Job	LS	_____.
0022	SE 16TH ST STAGING AREA SITEWORK	1	Job	LS	_____.
1.3.5 Roads					
0023	MAINTENANCE ROAD (BY OTHERS) ASPHALTIC CONCRETE FINAL LIFT	45,000	SY	_____.	_____.
0024	TERRACE ROAD	53,000	SY	_____.	_____.
0025	ACCESS ROAD ASPHALTIC CONCRETE	2,000	SY	_____.	_____.
1.4 RECREATION					
1.4.1 Hardscape					

0026	SOFT SURFACE TRAILS	800	SY	_____.	_____.	_____.
0027	STAGING AREA ACCESS CONTROL GATE	5	Each	_____.	_____.	_____.
0028	MAINTENANCE ROAD ACCESS CONTROL GATE	15	Each	_____.	_____.	_____.
0029	TERRACE ROAD ACCESS CONTROL GATE	7	Each	_____.	_____.	_____.
1.4.2 Facilities						
0030	PEDESTRIAN NODE A	1	Job	LS	_____.	_____.
0031	PEDESTRIAN NODE B	1	Job	LS	_____.	_____.
0032	PEDESTRIAN NODE C	1	Job	LS	_____.	_____.
0033	PEDESTRIAN NODE D	1	Job	LS	_____.	_____.
0034	PEDESTRIAN NODE E	1	Job	LS	_____.	_____.
0035	SEWER SYSTEM	1	Job	LS	_____.	_____.
0036	PORTABLE WATER SYSTEM	1	Job	LS	_____.	_____.
0037	OVERLOOK A	1	Job	LS	_____.	_____.
0038	OVERLOOK B	1	Job	LS	_____.	_____.
0039	OVERLOOK C	1	Job	LS	_____.	_____.
0040	WATERFALL	1	Job	LS	_____.	_____.
1.5 OPTION ITEMS						
1.5.1 Landscape						
0041	PRIORITY 2 SEEDING	4,270,000	SF	_____.	_____.	_____.
0042	SOUTH OVERBANK (CENTRAL AVE TO 16TH STREET) PLANTING	1	Job	LS	_____.	_____.
0043	SOUTH OVERBANK (CENTRAL AVE TO 16TH STREET) IRRIGATION	1	Job	LS	_____.	_____.
0044	ADDITIONAL PLANT ESTABLISHMENT PERIOD	12 Months		_____.	_____.	_____.

TOTAL ESTIMATED AMOUNT \$ _____.

Abbreviations:

- LF = Linear Foot
- SF = Square Feet
- CY = Cubic Yard
- LS = lump sum
- SY = Square Yard

NOTE: Section 00010 - Solicitation Contract Form

CLAUSES INCORPORATED BY FULL TEXT

1. All extensions of the unit prices shown will be subject to verification by the Government. In case of variation between the unit price and the extension, the unit price will be considered to be the bid.

2. If a modification to a bid based on unit prices is submitted which provides for a lump sum adjustment to the total estimated amount, the application of the lump sum adjustment to each unit price in the Price Schedule must be stated. If it is not stated, the bidder agrees that the lump sum adjustment shall be applied on a pro rata basis to every unit price in the Price Schedule.

3. For the purpose of initial evaluation of bids, the following will be utilized in resolving arithmetic discrepancies found on the face of the Price Schedule as submitted by the bidder:

- a. Obviously misplaced decimal points will be corrected;
- b. In case of discrepancy between the unit price and the extended price, the unit price will govern;
- c. Apparent errors in extensions of unit prices will be corrected;
- d. Apparent errors in addition of lump sum and extended prices will be corrected.

4. For the purpose of bid evaluation, the Government will proceed on the assumption that the bidder intends the bid to be evaluated on the basis of unit prices the totals arrived at by the resolution of arithmetic discrepancies as provided above and the bid will be so reflected on the abstract of bids.

5. The lump sum "LS" line items in the Price Schedule are not "Estimated Quantity" line items and are not subject to the "Variation in Estimated Quantity" contract clause.

6. The Contract Clause 52.232-27, "Prompt Payment for Construction Contracts" requires that the name and address of the contractor official, to whom payment is to be sent, be the same as that in the contract or in a proper Notice of Assignment.

7. Principal Contracting Officer. The Contracting Officer who signs this contract will be the Principal Contracting Officer for this contract. However, any Contracting Officer assigned to the Los Angeles District, contracting within his authority, may take formal action on this contract when the Principal Contracting Officer is unavailable and the action needs to be taken.

8. Amounts and prices shall be indicated in either words or figures, NOT BOTH.

9. Payment of Electronic Funds Transfer (EFT) is the mandatory method of payment. The Contractors attention is directed to Contract Clause No. 52.232-33 "Mandatory Information for Electronic Funds Transfer" located in Section 00800.

10. The bidder shall distribute his indirect costs (overhead, profit, bond, etc.,) over all items in the Price Schedule. The Government will

review all submitted Price Schedules for any unbalancing of the items. Any submitted Price Schedule determined to be unbalanced may be considered non-responsive and cause the bidder to be ineligible for contract award.

11. The bidder shall furnish labor, material, equipment, etc., necessary to perform all work in strict accordance with the terms and conditions set forth in the contract in include all attachments thereto.

12. Some quantities are ESTIMATED, the bidders prices MUST BE FIRM.

13. Bidder is cautioned to check his Price Schedule carefully prior to submission. If the Price Schedule contains unit prices, they should be rounded off to the second decimal point only NOT EXTENDED FUTHER.

14. At the formal bid opening for this solicitation, all hand carried bids submitted prior to 12:45 p.m. on the bid opening date will be accepted in Room 980 by available personnel. For the time period 12:30p.m. to 1:00 p.m., bids must be submitted to Room 980, to the bid-opening officer only. Bids will not be accepted by any other personnel or at any other location. No bid will be accepted after 1:00 p.m. The official bid opening time will be called by the Bid Opening Officer.

15. Contractor is required to fill in Cage code (Reference Section 00600, entitled "Required Central Contractor Registration" Mar 1998) and DUNS Number (Reference Section 00600, entitled, "Data Universal Numbering System (DUNS) Number" Jun1999) in Block No. 15 on Standard Form 1442, Name and Address Block (Cage Code under Code and DUNS No. under Facility Code respectively).

16. Bidders are to submit prices on all line items in the Base Bid (0001 through 0040). In addition, bidders must submit prices on Options (0041-0044). The Government contemplates award of one contract to the responsive, responsible bidder who submits the lowest bid for the Base Bid and Options.

17. The Government contemplates award on one contract to the responsive, responsible bidder who submits the low bid for the total of all the items in the Price Schedule.

CERTIFICATE OF CORPORATE PRINCIPAL

1) IF THE OFFEROR IS A JOINT VENTURE, COMPLETE THE FOLLOWING:

(Company Name) (Signature) (Title)

(Company Name) (Signature) (Title)

(Company Name) (Signature) (Title)

2) IF THE OFFEROR IS PARTNERSHIP, LIST FULL NAME OF ALL PARTNERS:

(Company Name) (Signature) (Title)

(Company Name) (Signature) (Title)

(Company Name) (Signature) (Title)

3) IF THE OFFEROR IS A CORPORATION, THE FOLLOWING CERTIFICATION SHOULD BE COMPLETED:

CERTIFICATION AS TO CORPORATE PRINCIPAL

I, _____, certify that I am the Secretary of the corporation named as principal in the within contract; that _____, who signed the said contract on behalf of the principal, was the _____ of the corporation; that I know his signature and that his signature is genuine; and that said contract was duly signed, sealed and attested for in behalf of said corporation by authority of its governing body.

CORPORATE SEAL CORPORATE PRINCIPAL

SECRETARY

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01270

MEASUREMENT AND PAYMENT

PART 1 GENERAL

- 1.1 SUBMITTALS
- 1.2 LUMP SUM PAYMENT ITEMS
 - 1.2.1 Item No. 1, Clearing, Grubbing, and Demolition
 - 1.2.1.1 Payment
 - 1.2.1.2 Unit of Measure
 - 1.2.2 Item No. 5, Storm Drain Piping and Structures
 - 1.2.2.1 Payment
 - 1.2.2.2 Unit of Measure
 - 1.2.3 Item No. 7, Well RSSW No. 3
 - 1.2.3.1 Payment
 - 1.2.4.1 Unit of Measure
 - 1.2.4 Item No. 8, Well RSSW No. 4
 - 1.2.4.1 Payment
 - 1.2.4.2 Unit of Measure
 - 1.2.5 Item No. 9, Well RSSW No. 5
 - 1.2.5.1 Payment
 - 1.2.5.2 Unit of Measure
 - 1.2.6 Item No. 10, Production Well RSSW No. 6
 - 1.2.6.1 Payment
 - 1.2.6.2 Unit of Measure
 - 1.2.7 Item No. 17, Overbank Permanent Drip Irrigation System
 - 1.2.7.1 Payment
 - 1.2.7.2 Unit of Measure
 - 1.2.8 Item No. 18, Terrace and Slope Drip Irrigation System
 - 1.2.8.1 Payment
 - 1.2.8.2 Unit of Measure
 - 1.2.9 Item No. 19, Plant Establishment
 - 1.2.9.1 Payment
 - 1.2.9.2 Unit of Measure
 - 1.2.10 Item No. 20, SW 7th Avenue Staging Area Sitework
 - 1.2.10.1 Payment
 - 1.2.10.2 Unit of Measure
 - 1.2.11 Item No. 21, SE 7th Street Staging Area Sitework
 - 1.2.11.1 Payment
 - 1.2.11.2 Unit of Measure
 - 1.2.12 Item No. 22, SE 16th Street Staging Area Sitework
 - 1.2.12.1 Payment
 - 1.2.12.2 Unit of Measure
 - 1.2.13 Item No. 30, Pedestrian Node A
 - 1.2.13.1 Payment
 - 1.2.13.2 Unit of Measure
 - 1.2.14 Item No. 31, Pedestrian Node B
 - 1.2.14.1 Payment
 - 1.2.14.2 Unit of Measure
 - 1.2.15 Item No. 32, Pedestrian Node C
 - 1.2.15.1 Payment

- 1.2.15.2 Unit of Measure
- 1.2.16 Item No. 33, Pedestrian Node D
 - 1.2.16.1 Payment
 - 1.2.16.2 Unit of Measure
- 1.2.17 Item No. 34, Pedestrian Node E
 - 1.2.17.1 Payment
 - 1.2.17.2 Unit of Measure
- 1.2.18 Item No. 35, Sewer System
 - 1.2.18.1 Payment
 - 1.2.18.2 Unit of Measure
- 1.2.19 Item No. 36, Potable Water System
 - 1.2.19.1 Payment
 - 1.2.19.2 Unit of Measure
- 1.2.20 Item No. 37, Overlook A
 - 1.2.20.1 Payment
 - 1.2.20.2 Unit of Measure
- 1.2.21 Item No. 38, Overlook B
 - 1.2.21.1 Payment
 - 1.2.21.2 Unit of Measure
- 1.2.22 Item No. 39, Overlook C
 - 1.2.22.1 Payment
 - 1.2.22.2 Unit of Measure
- 1.2.23 Item No. 40, Waterfall
 - 1.2.23.1 Payment
 - 1.2.23.2 Unit of Measure
- 1.2.24 Item No. 42, Option No. 7 South Overbank (Central Avenue to 16th Street) Planting
 - 1.2.24.1 Payment
 - 1.2.24.2 Unit of Measure
- 1.2.25 Item No. 43, Option No. 8 South Overbank (Central Avenue to 16th Street) Irrigation
 - 1.2.25.1 Payment
 - 1.2.25.2 Unit of Measure
- 1.3 UNIT PRICE PAYMENT ITEMS
 - 1.3.1 Items No. 2a and 2b, General Site Excavation for Project Facilities
 - 1.3.1.1 Payment
 - 1.3.1.2 Measurement
 - 1.3.1.3 Unit of Measure
 - 1.3.2 Items No. 3a and 3b, General Site Fills and Embankments for Project Facilities
 - 1.3.2.1 Payment
 - 1.3.2.2 Measurement
 - 1.3.2.3 Unit of Measure
 - 1.3.3 Items No. 4a through 4j, Excavation and Disposal of Construction Debris, Household Waste, Tires, Inert Material, and, Non-segregated Mixed Wastee
 - 1.3.3.1 Payment
 - 1.3.3.2 Measurement
 - 1.3.3.3 Unit of Measure
 - 1.3.4 Item No. 6, Architectural Fence and Gates
 - 1.3.4.1 Payment
 - 1.3.4.2 Measurement
 - 1.3.5 Items No. 11, Aquatic/Wetland/Reservoir Seeding
 - 1.3.5.1 Payment
 - 1.3.5.2 Measurement
 - 1.3.5.3 Unit of Measure
 - 1.3.6 Item No. 12, Priority 1 Seeding
 - 1.3.6.1 Payment

- 1.3.6.2 Measurement
- 1.3.6.3 Unit of Measure
- 1.3.7 Items No. 13, Transplanting of Trees
 - 1.3.7.1 Payment
 - 1.3.7.2 Measurement
 - 1.3.7.3 Unit of Measure
- 1.3.8 Item No. 14 through 16, Planting of Government Furnished Plants
 - 1.3.8.1 Payment
 - 1.3.8.2 Measurement
 - 1.3.8.3 Unit of Measure
- 1.3.9 Item No. 23, Maintenance Roads (by others) Asphaltic Concrete Final Lift
 - 1.3.9.1 Payment
 - 1.3.9.2 Measurement
 - 1.3.9.3 Unit of Measure
- 1.3.10 Item No. 24, Terrace Roads
 - 1.3.10.1 Payment
 - 1.3.10.2 Measurement
 - 1.3.10.3 Unit of Measure
- 1.3.11 Item No. 25, Access Road Asphaltic Concrete
 - 1.3.11.1 Payment
 - 1.3.11.2 Measurement
 - 1.3.11.3 Unit of Measure
- 1.3.12 Item No. 26, Soft Surface Trails
 - 1.3.12.1 Payment
 - 1.3.12.2 Measurement
 - 1.3.12.3 Unit of Measure
- 1.3.13 Item No. 27, Staging Area Access Control Gates
 - 1.3.13.1 Payment
 - 1.3.13.2 Measurement
 - 1.3.13.3 Unit of Measure
- 1.3.14 Item No. 28 Maintenance Road Access Control Gate
 - 1.3.14.1 Payment
 - 1.3.14.2 Measurement
 - 1.3.14.3 Unit of Measure
- 1.3.15 Item No. 29 Terrace Road Access Control Gates
 - 1.3.15.1 Payment
 - 1.3.15.2 Measurement
 - 1.3.15.3 Unit of Measure
- 1.3.16 Item No. 41, Option 5 Priority 2 Seeding
 - 1.3.16.1 Payment
 - 1.3.16.2 Measurement
 - 1.3.16.3 Unit of Measure
- 1.3.17 Item No. 44, Option No. 9: Additional 12 months of Plant Establishment Period
 - 1.3.17.1 Payment
 - 1.3.17.2 Measurement
 - 1.3.17.3 Unit of Measure

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section Table of Contents --

SECTION 01270

MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Weight Certificates; G, RE

Submit certified weight certificates for **construction debris, household waste, inert material, tires, mixed waste, and Maintenance Roads Asphaltic Concrete.**

1.2 LUMP SUM PAYMENT ITEMS

Payment items for the work of this contract for which contract lump sum payments will be made are listed in the BIDDING SCHEDULE and described below. All costs for items of work, which are not specifically mentioned to be included in a particular lump sum or unit price payment item, shall be included in the listed lump sum item most closely associated with the work involved. The lump sum price and payment made for each item listed shall constitute full compensation for furnishing all plant, labor, materials, and equipment, and performing any associated Contractor quality control, and performing any associated Contractor quality control reports, mobilization, demobilization, obtaining bonds, insurance, and permits, providing temporary facilities and utilities, payment for usage of utilities, furnishing and installing project and safety signs, furnishing, installing, and maintaining the Government field office, scheduling, providing submittals, attending meetings, preparing as-built Drawings, providing traffic control, environmental protection, meeting safety requirements, tests and reports, and for performing all work required for which separate payment is not otherwise provided.

1.2.1 Item No. 1, Clearing, Grubbing, and Demolition

1.2.1.1 Payment

Payment includes all labor and equipment required for clearing, grubbing, demolition of any specified structures, and protection of all other structures, and disposal of waste identified within the project limits.

1.2.1.2 Unit of Measure

Unit of Measure: Lump sum.

1.2.2 Item No. 5, Storm Drain Piping and Structures

1.2.2.1 Payment

Payment includes all labor and equipment for the excavation, backfilling, compacting surface restoration, furnishing and placement of stormwater outfall headwalls, catch basins, culverts, end sections, rip rap and trash racks.

1.2.2.2 Unit of Measure

Unit of Measure: Lump sum.

1.2.3 Item No. 7, Well RSSW No. 3

1.2.3.1 Payment

Payment includes all excavation, grading, compacting, surface restoration, hydrostatic pressure testing, and the furnishing and placing of backfill, structural fill, vertical turbine pump and motor, welded steel piping, fittings, and appurtenances, magnetic flowmeter, butterfly valve, air pressure/vacuum relief valve, check valve, concrete, pipe supports, reinforcing steel, concrete blocks, electrical, instrumentation and control, and all other miscellaneous items required to complete Production Well RSSW No. 3 site as shown on the Drawings and as specified.

1.2.4.1 Unit of Measure

Unit of Measure: Lump sum.

1.2.4 Item No. 8, Well RSSW No. 4

1.2.4.1 Payment

Payment includes all excavation, grading, compacting, surface restoration, hydrostatic pressure testing, and the furnishing and placing of backfill, structural fill, vertical turbine pump and motor, welded steel piping, fittings, and appurtenances, magnetic flowmeter, butterfly valve, air pressure/vacuum relief valve, check valve, concrete, pipe supports, reinforcing steel, concrete blocks, electrical, instrumentation and control, and all other miscellaneous items required to complete Well RSSW No. 4 site as shown on the Drawings and as specified.

1.2.4.2 Unit of Measure

Unit of Measure: Lump sum.

1.2.5 Item No. 9, Well RSSW No. 5

1.2.5.1 Payment

Payment includes all excavation, grading, compacting, surface restoration, hydrostatic pressure testing, and the furnishing and placing of backfill, structural fill, vertical turbine pump and motor, welded steel piping, fittings, and appurtenances, magnetic flowmeter, butterfly valve, air pressure/vacuum relief valve, check valve, concrete, pipe supports, reinforcing steel, chain link fencing, electrical, instrumentation and control, and all other miscellaneous items required to complete Well RSSW No. 5 site as shown on the Drawings and as specified.

1.2.5.2 Unit of Measure

Unit of Measure: Lump sum.

1.2.6 Item No. 10, Production Well RSSW No. 6

1.2.6.1 Payment

Payment includes all excavation, grading, compacting, surface restoration, hydrostatic pressure testing, and the furnishing and placing of backfill, structural fill, welded steel piping, fittings, and appurtenances, magnetic flowmeter, butterfly valve, air pressure/vacuum relief valve, check valve, concrete, pipe supports, reinforcing steel, concrete blocks, electrical, instrumentation and control, and all other miscellaneous items required to complete Well RSSW No. 6 site as shown on the Drawings and as specified.

1.2.6.2 Unit of Measure

Unit of Measure: Lump sum.

1.2.7 Item No. 17, Overbank Permanent Drip Irrigation System

1.2.7.1 Payment

Payment includes all labor and equipment required for excavation, backfill, and the furnishing and placement of the pipe and tubing, fittings, valve assemblies, spray sprinklers, drip emitters, controller assemblies, wire, testing, electrical, and maintenance, and all miscellaneous items required for the Overbank permanent drip irrigation system, as shown on the Drawings. In addition, the lump sum bid price shall include all of the Contractor's costs for furnishing, transporting and installing the mainline pipe and fittings, and control system wire for the Temporary Drip Irrigation System that is installed in the Overbank areas according to the Drawings and Specifications.

1.2.7.2 Unit of Measure

Unit of Measure: Lump sum.

1.2.8 Item No. 18, Terrace and Slope Drip Irrigation System

1.2.8.1 Payment

Payment includes all labor and equipment required for excavation and backfill, and the furnishing and placement of all pipe, fittings, valve assemblies, drip emitters, testing, electrical, and maintenance; and all miscellaneous items required for the terrace and slopes drip irrigation system, as shown on the Drawings.

1.2.8.2 Unit of Measure

Unit of Measure: Lump sum.

1.2.9 Item No. 19, Plant Establishment

1.2.9.1 Payment

Payment includes all labor and equipment required to operate and maintain

the landscaping and irrigation system (**Base bid Landscaping/Irrigation only**) for a 12 month period starting at substantial completion of the project. As the plants establish themselves, the Contractor will keep the newly planted areas free from undesirable weed growth as specified in the Contract documents. If plantings do not meet the specified coverage and survival criteria during the plant maintenance period, the Contractor will replace the vegetation and replant as necessary until satisfactory stands of vegetation are realized by the Contracting Officer.

1.2.9.2 Unit of Measure

Unit of Measure: Lump sum.

1.2.10 Item No. 20, SW 7th Avenue Staging Area Sitework

1.2.10.1 Payment

Payment includes all labor and equipment required for excavation, backfill, grading, and the furnishing and placement of all aggregate base course, asphalt concrete pavement, concrete, reinforcing, striping, and signage required to complete the parking lot, curb, curb and gutter, sidewalks, cast concrete seat walls, handrails, gabion baskets, salvaged ruin benches, trash and ash receptacles, sidewalk curbramp, accessible parking lots, tire treadle, drinking fountain and leach field lighting and all miscellaneous items required for the staging area sitework, as shown on the Drawings.

1.2.10.2 Unit of Measure

Unit of Measure: Lump sum.

1.2.11 Item No. 21, SE 7th Street Staging Area Sitework

1.2.11.1 Payment

Payment includes all labor and equipment required for excavation, backfill, grading, and the furnishing and placement of all aggregate base course, asphalt concrete pavement, concrete, reinforcing, striping, and signage required to complete the parking lot, curb, curb and gutter, valley gutter, cast concrete seat walls, street connection to 7th Street, sidewalks, sidewalk curbramp, accessible parking lots, tire treadle, maintenance road, salvaged ruin benches, trash and ash receptacles, lighting and all miscellaneous items required for the staging area sitework, as shown on the Drawings.

1.2.11.2 Unit of Measure

Unit of Measure: Lump sum.

1.2.12 Item No. 22, SE 16th Street Staging Area Sitework

1.2.12.1 Payment

Payment includes all labor and equipment required for excavation, backfill, grading, and the furnishing and placement of all aggregate base course, asphalt concrete pavement, concrete, reinforcing, striping, and signage required to complete the parking lot, curb, curb and gutter, salvaged ruin benches, seating node, river ruin picnic table, trash and ash receptacles, cast concrete seat walls, handrails, sidewalks, sidewalk curbramp, drinking fountain and leach field, accessible parking lots, tire treadle, staging

area, lighting and all miscellaneous items required for the staging area sitework, as shown on the Drawings.

1.2.12.2 Unit of Measure

Unit of Measure: Lump sum.

1.2.13 Item No. 30, Pedestrian Node A

1.2.13.1 Payment

Payment includes all labor and equipment required for the excavation, backfilling, compacting, and grading, gabion baskets, and the furnishing and placement of the salvaged concrete benches, concrete tree wells, concrete, decomposed granite, removal and replacement of existing sidewalk, and all miscellaneous items required for a complete pedestrian node area as shown on the Drawings.

1.2.13.2 Unit of Measure

Unit of Measure: Lump sum.

1.2.14 Item No. 31, Pedestrian Node B

1.2.14.1 Payment

Payment includes all labor and equipment required for the excavation, gabion baskets, backfilling, compacting, and grading, and the furnishing and placement of the salvaged concrete benches, concrete tree wells, concrete, decomposed granite, removal and replacement of existing sidewalk, and all miscellaneous items required for a complete pedestrian node area as shown on the Drawings.

1.2.14.2 Unit of Measure

Unit of Measure: Lump sum.

1.2.15 Item No. 32, Pedestrian Node C

1.2.15.1 Payment

Payment includes all labor and equipment required for the excavation, gabion baskets, backfilling, compacting, and grading, and the furnishing and placement of the salvaged concrete benches, concrete tree wells, concrete, decomposed granite, removal and replacement of existing sidewalk, and all miscellaneous items required for a complete pedestrian node area as shown on the Drawings.

1.2.15.2 Unit of Measure

Unit of Measure: Lump sum.

1.2.16 Item No. 33, Pedestrian Node D

1.2.16.1 Payment

Payment includes all labor and equipment required for the excavation, gabion baskets, backfilling, compacting, and grading, and the furnishing and placement of the salvaged concrete benches, concrete tree wells,

concrete, decomposed granite, removal and replacement of existing sidewalk, and all miscellaneous items required for a complete pedestrian node area as shown on the Drawings.

1.2.16.2 Unit of Measure

Unit of Measure: Lump sum.

1.2.17 Item No. 34, Pedestrian Node E

1.2.17.1 Payment

Payment includes all labor and equipment required for the excavation, gabion baskets, backfilling, compacting, and grading, and the furnishing and placement of the salvaged concrete benches, concrete tree wells, concrete, decomposed granite, removal and replacement of existing sidewalk, and all miscellaneous items required for a complete pedestrian node area as shown on the Drawings.

1.2.17.2 Unit of Measure

Unit of Measure: Lump sum.

1.2.18 Item No. 35, Sewer System

1.2.18.1 Payment

Payment includes all labor and equipment required for trench and structure excavation, processing of on-site material or importing material required for backfill, grading, surface restoration, compacting, and connecting to the existing City of Phoenix Sewer, and the furnishing and placing of concrete, reinforcing steel, clean outs, backfill, HDPE pipe and appurtenances, pipe zone material, and all other miscellaneous items required to complete the Sewer System as shown on the Drawings and as specified.

1.2.18.2 Unit of Measure

Unit of Measure: Lump sum.

1.2.19 Item No. 36, Potable Water System

1.2.19.1 Payment

Payment includes all labor and equipment required for trench and structure excavation, processing of on-site material or importing material required for backfill, grading, surface restoration, compacting, and connecting to the existing pipe, and the furnishing and placing of concrete, reinforcing steel, backfill, ductile iron pipe and appurtenances, valves, valve boxes, fire hydrant assembly, water service connection, water meter box, backflow preventer assembly, pipe zone material, thrust blocks, and all other miscellaneous items required to complete the Potable Water System at 7th Street, 7th Avenue and 16th Street as shown on the Drawings and as specified.

1.2.19.2 Unit of Measure

Unit of Measure: Lump sum.

1.2.20 Item No. 37, Overlook A

1.2.20.1 Payment

Payment includes all labor and equipment required for the excavation, backfilling, compacting and grading, and the furnishing and placement of the gabion retaining wall, cast concrete seatwall, trash receptacle, salvaged concrete header, concrete walk, Ramada, and all miscellaneous items required for a complete Overlook A as shown on the Drawings and as specified.

1.2.20.2 Unit of Measure

Unit of Measure: Lump sum.

1.2.21 Item No. 38, Overlook B

1.2.21.1 Payment

Payment includes all labor and equipment required for the excavation, backfilling, compacting and grading, and the furnishing and placement of the gabion retaining wall, cast concrete seatwall, trash receptacle, safety handrail, salvaged concrete header, concrete walk, Ramada, and all miscellaneous items required for a complete Overlook B as shown on the Drawings and as specified.

1.2.21.2 Unit of Measure

Unit of Measure: Lump sum.

1.2.22 Item No. 39, Overlook C

1.2.22.1 Payment

Payment includes all labor and equipment required for the excavation, backfilling, compacting and grading, and the furnishing and placement of the gabion retaining wall, cast concrete seatwall, trash receptacle, salvaged concrete header, concrete walk, Ramada, and all miscellaneous items required for a complete Overlook C as shown on the Drawings and as specified.

1.2.22.2 Unit of Measure

Unit of Measure: Lump sum.

1.2.23 Item No. 40, Waterfall

1.2.23.1 Payment

Payment includes all labor and equipment required for the excavation, backfilling, grading, and the furnishing and placement of the shotcrete, structural backfill, river rock, broken concrete river ruin blocks and all miscellaneous items required for a complete waterfall as shown on the Drawings.

1.2.23.2 Unit of Measure

Unit of Measure: Lump sum.

1.2.24 Item No. 42, Option No. 7 South Overbank (Central Avenue to 16th Street) Planting

1.2.24.1 Payment

The contractor will be required for soil testing, excavation, backfilling, staking, grading, and the placement of the fertilizer, soil additives, and Owner-Furnished planting material. Once the soils are ready for planting and the project's irrigation system(s) has been tested and is deemed functional, the plant contractor will be given control of the wetland water levels for plant installation and during the plant maintenance period (180 days). The contractor will install the plants per the construction drawings and specifications as well as provide a warranty. The accepted quantities of trees, shrubs and plants measured as described above will be paid for at the contract unit price bid for each for the pay items designated in the bidding schedule complete and in place. No measurement or direct payment will be made for plants selected for inspection and not planted or for the watering, care and protection of trees, shrubs and plants prior to the beginning of the landscape establishment period, tree stakes, rubber hose, wire, protective cages, pre-emergent herbicide and grass and weed removal, the cost being considered as included in the price of the contract bid items.

1.2.24.2 Unit of Measure

Unit of Measure: Lump sum.

1.2.25 Item No. 43, Option No. 8 South Overbank (Central Avenue to 16th Street) Irrigation

1.2.25.1 Payment

Payment includes all labor and equipment required for excavation and backfill, and the furnishing and placement of all pipe, fittings, valve assemblies, drip emitters, testing, electrical, and maintenance; and all miscellaneous items required for the terrace and slopes drip irrigation system, as shown on the Drawings.

1.2.25.2 Unit of Measure

Unit of Measure: Lump sum.

1.3 UNIT PRICE PAYMENT ITEMS

Payment items for the work of this contract on which the contract unit price payments will be made are listed in the BIDDING SCHEDULE and described below. The unit price and payment made for each item listed shall constitute full compensation for furnishing all plant, labor, materials, and equipment, and performing any associated Contractor quality control, environmental protection, meeting safety requirements, tests and reports, and for performing all work required for each of the unit price items.

1.3.1 Items No. 2a and 2b, General Site Excavation for Project Facilities

1.3.1.1 Payment

Payment includes all labor and equipment, including excavation and disposition of excess excavated material and unsuitable material, required

for terrace roads, maintenance roads, staging areas and other features on the project site. Specifically excluded from this item is any excavation below finish grade required to install piping, structures, and conduits.

1.3.1.2 Measurement

The total quantity of excavated material for which payment will be made will be the theoretical quantity between the ground surface as determined by a survey and the grade and slope of the theoretical cross sections indicated. No allowance will be made for overdepth excavation or for the removal of any material outside the required slope lines unless authorized.

1.3.1.3 Unit of Measure

Unit of measure: Cubic yard.

1.3.2 Items No. 3a and 3b, General Site Fills and Embankments for Project Facilities

1.3.2.1 Payment

Payment includes all labor and equipment required for processing of on-site material, placement of fill, compacting, grading, and water required for the furnishing and placement of any fills and embankments for the terrace roads, maintenance roads, staging areas and other features on the project site. Excluded from this item is any fill associated with the waterfall.

1.3.2.2 Measurement

The total quantity of fill material for which payment will be made will be the theoretical quantity between the ground surface as determined by a survey and the grade and slope of the theoretical cross sections indicated. No allowance will be made for additional fill provided outside the required slope lines unless authorized.

1.3.2.3 Unit of Measure

Unit of measure: Cubic yard.

1.3.3 Items No. 4a **through 4j**, Excavation and Disposal of Construction Debris, Household Waste, **Tires**, Inert Material, and, **Non-segregated** Mixed Waste

1.3.3.1 Payment

Payment includes all labor and equipment required for excavation, **segregation (unless non-segregation disposal is authorized)** and disposition of all construction debris, household waste, inert material, **tires**, and mixed waste.

1.3.3.2 Measurement

The total quantity of excavated material for which payment will be made will be based on the **weight measured at the disposal facility of segregated** construction debris, household waste, inert material, **tires**, and mixed waste that has been segregated from the **tires and** other excavated material.

1.3.3.3 Unit of Measure

Unit of measure: Tons.

1.3.4 Item No. 6, Architectural Fence **and Gates**

1.3.4.1 Payment

Payment includes all labor and equipment required for the excavation, backfilling, and grading and the furnishing and placement of the architectural fencing **and gates**.

1.3.4.2 Measurement

Measurement of Architectural Fence will be by the linear foot, measured from end to end, of fencing installed as shown on the drawings.

1.3.5 Items No. 11, Aquatic/Wetland/Reservoir Seeding

1.3.5.1 Payment

Payment includes all labor and equipment required for soil testing, and grading, and the furnishing and placement of the fertilizer, soil additives, and planting material. When the soils are ready for planting and the project's irrigation system(s) has been tested and is deemed functional, the plant contractor will be given control of the reservoir water levels for plant installation and during the plant maintenance period (180 days). The contractor will install the plants per the construction drawings and specifications as well as provide a warranty. As the reservoir plants establish themselves, the contractor will also keep the newly planted areas free from undesirable weed growth as specified in the projects construction documents. If plantings do not meet the specified coverage and survival criteria at the end of the plant maintenance period, the plant contractor will replace the vegetation and replant the reservoir as necessary until satisfactory stands of reservoir vegetation are realized.

1.3.5.2 Measurement

Reservoir Plantings for different habitats will be measured based on the number of square feet of each habitat type planted in the accepted work.

1.3.5.3 Unit of Measure

Unit of measure: Square foot.

1.3.6 Item No. 12, Priority 1 Seeding

1.3.6.1 Payment

Payment will include all labor and equipment required for soil testing, grading, and the furnishing and placement of the fertilizer, soil additives, and seeds in the designated areas.

1.3.6.2 Measurement

Seeding will be measured based on the amount of seeding applied in the accepted work.

1.3.6.3 Unit of Measure

Unit of Measure: Square foot.

1.3.7 Items No. 13, Transplanting of Trees

1.3.7.1 Payment

Payment will include all labor and equipment required for preparation of transplanting plan, excavating, backfilling, soil testing, soil testing, root pruning, furnishing and placement of top soil, soil amendments, mulch, soil conditioners, staking, and flagging required for the salvaging, maintaining and transplanting.

1.3.7.2 Measurement

Transplanting of trees will be measured based on the number of trees transplanted.

1.3.7.3 Unit of Measure

Unit of Measure: Each.

1.3.8 Item No. 14 through 16, Planting of Government Furnished Plants

1.3.8.1 Payment

The contractor will be required for soil testing, excavation, backfilling, staking, grading, and the placement of the fertilizer, soil additives, and Owner-Furnished planting material. Once the soils are ready for planting and the project's irrigation system(s) has been tested and is deemed functional, the plant contractor will be given control of the wetland water levels for plant installation and during the plant maintenance period (180 days). The contractor will install the plants per the construction drawings and specifications as well as provide a warranty. The accepted quantities of trees, shrubs and plants measured as described above will be paid for at the contract unit price bid for each for the pay items designated in the bidding schedule complete and in place. No measurement or direct payment will be made for plants selected for inspection and not planted or for the watering, care and protection of trees, shrubs and plants prior to the beginning of the landscape establishment period, tree stakes, rubber hose, wire, protective cages, pre-emergent herbicide and grass and weed removal, the cost being considered as included in the price of the contract bid items.

1.3.8.2 Measurement

Planting of Government Furnished Plants will be measured based on the number of plants of each type planted in the accepted work.

1.3.8.3 Unit of Measure

Unit of measure: Each.

1.3.9 Item No. 23, Maintenance Roads (by others) Asphaltic Concrete Final Lift

1.3.9.1 Payment

Payment includes all labor and equipment required for preparation and placement of tack coat and for preparation of the hot mix, compaction, grading, testing, and furnishing and placing the final pavement lift.

1.3.9.2 Measurement

Maintenance Roads will be measured based on the amount of surface installed in the accepted work.

1.3.9.3 Unit of Measure

Unit of measure: Square yard.

1.3.10 Item No. 24, Terrace Roads

1.3.10.1 Payment

Payment includes all labor and equipment required for the excavation, backfilling, compacting, and grading the Terrace Roads.

1.3.10.2 Measurement

Terrace roads will be measured based on the amount of surfacing installed in the accepted work.

1.3.10.3 Unit of Measure

Unit of Measure: Square yard.

1.3.11 Item No. 25, Access Road Asphaltic Concrete

1.3.11.1 Payment

Payment includes all labor and equipment required preparation of the hot mix, compaction, grading, testing, and furnishing and placing the aggregate, asphalt cement, joints for the access road.

1.3.11.2 Measurement

Access Road Asphaltic Concrete will be measured based on the amount of surfacing installed in the accepted work.

1.3.11.3 Unit of Measure

Unit of measure: Square yard.

1.3.12 Item No. 26, Soft Surface Trails

1.3.12.1 Payment

Payment includes all labor and equipment required for the excavation, backfilling, compacting, and grading the soft surface trail.

1.3.12.2 Measurement

Soft surface trail will be measured based on the amount of soft surface trail installed in the accepted work.

1.3.12.3 Unit of Measure

Unit of Measure: Square **yard**.

1.3.13 Item No. 27, Staging Area Access Control Gates

1.3.13.1 Payment

Payment includes all labor and equipment required for the excavation, backfilling, compacting, grading, and the furnishing and placement of the concrete, steel pipe, gabions, river rock, steel plate, I-Beam, logo, and lettering and all miscellaneous items required for complete Staging Area Access Control Gates, as shown on the Drawings.

1.3.13.2 Measurement

Staging Area Access Control Gates will be measured based on the number of Staging Area Access Control Gates constructed in the accepted work.

1.3.13.3 Unit of Measure

Unit of measure: Each.

1.3.14 Item No. 28 Maintenance Road Access Control Gate

1.3.14.1 Payment

Payment includes all labor and equipment required for the excavation, backfilling compacting, grading and the furnishing and placement of the concrete, steel pipe, gabions, river rock, steel plate, I-beam, logo and lettering and all miscellaneous items required for complete Maintenance Road Access Control Gates as shown on the Drawings.

1.3.14.2 Measurement

Maintenance Road Access Control Gates will be measured based on the number of Maintenance Road Access Control Gates constructed in the accepted work.

1.3.14.3 Unit of Measure

Unit of Measure: Each

1.3.15 Item No. 29 Terrace Road Access Control Gates

1.3.15.1 Payment

Payment includes all labor and equipment required for the excavation, backfilling compacting, grading and the furnishing and placement of the concrete, steel pipe, gabions, river rock, steel plate, I-beam, logo and lettering and all miscellaneous items required for complete Terrace Road Access Control Gates as shown on the Drawings.

1.3.15.2 Measurement

Terrace Road Access Control Gates will be measured based on the number of Terrace Road Access Control Gates constructed in the accepted work.

1.3.15.3 Unit of Measure

Unit of Measure: Each

1.3.16 Item No. 41, Option 5 Priority 2 Seeding

1.3.16.1 Payment

Payment will include all labor and equipment required for soil testing, grading, and the furnishing and placement of the fertilizer, soil additives, and seeds in the designated areas.

1.3.16.2 Measurement

Seeding will be measured based on the amount of seeding applied in the accepted work.

1.3.16.3 Unit of Measure

Unit of Measure: Square foot.

1.3.17 Item No. 44, Option No. 9: Additional 12 months of Plant Establishment Period

1.3.17.1 Payment

Payment includes all labor and equipment required to operate and maintain the landscaping and irrigation system for an additional plant establishment period starting at the end of the required initial 12 month plant establishment period **as outlined in Article 1.2.9**. As the plants establish themselves, the Contractor will keep the planted areas free from undesirable weed grown as specified in the Construction Documents. If plantings do not meet the specified coverage and survival criteria during the plant establishment period, the Contractor will replace the vegetation and replant as necessary until satisfactory stands of vegetation are realized.

1.3.17.2 Measurement

Plant establishment will be measured based on the number of months which services are provided.

1.3.17.3 Unit of Measure

Unit of measure: Months.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 02 - SITE WORK

SECTION 02371

WIRE MESH GABIONS

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 GENERAL REQUIREMENTS
- 1.3 SUBMITTALS
- 1.4 DESCRIPTION
- 1.5 DEFINITIONS
 - 1.5.1 Double twisted wire mesh Gabions
- 1.6 Government Testing and Studies
 - 1.6.1 Samples

PART 2 PRODUCTS

- 2.1 MATERIALS
 - 2.1.1 Double twisted wire mesh Gabions
 - 2.1.2 Alternative Wire Fasteners for Gabions
 - 2.1.2.1 Ring Fasteners
 - 2.1.3 Testing
 - 2.1.4 Stone Fill
 - 2.1.4.1 General
 - 2.1.4.2 Stone Quality
 - 2.1.4.3 Gradation
 - 2.1.5 Filter Material

PART 3 EXECUTION

- 3.1 MATERIAL DELIVERY
- 3.2 FOUNDATION PREPARATION
- 3.3 FILTER PLACEMENT
- 3.4 ASSEMBLY
 - 3.4.1 Double twisted wire mesh Gabions
- 3.5 LACING OPERATIONS
 - 3.5.1 Double Twisted Wire Mesh Gabions
- 3.6 INSTALLATION AND FILLING
 - 3.6.1 Double Twisted Wire Mesh Gabions
 - 3.6.2 Non-rectangular Shapes
- 3.7 CLOSING

-- End of Section Table of Contents --

SECTION 02371

WIRE MESH GABIONS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A 370	(1997a) Mechanical Testing of Steel Products
ASTM A 641/A 641M	(1998) Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A 764	(1995) Metallic Coated Carbon Steel Wire, Coated at Size and Drawn to Size for Mechanical Springs
ASTM A 974	(1997) Welded Wire Fabric Gabions and Gabion Mattresses (Metallic Coated or Polyvinyl Chloride (PVC) Coated)
ASTM A 975	(1997) Double-Twisted Hexagonal Mesh Gabions and Revet Mattresses (Metallic-Coated Steel Wire or Metallic-Coated Steel Wire With Poly(Vinyl Chloride) (PVC) Coating)
ASTM C 33	(1999a1) Concrete Aggregates
ASTM C 136	(2001) Sieve Analysis of Fine and Coarse Aggregates

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 144	(1992) Standard Test Method for Resistance of Rock to Freezing and Thawing
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1.2 GENERAL REQUIREMENTS

The work under this specification includes furnishing, assembling, filling and tying open wire mesh rectangular compartmented gabions placed on a prepared surface of filter material, as specified, and in accordance with the lines, grades, and dimensions shown or otherwise established in the field.

1.3 SUBMITTALS

Government approval is required for submittal with "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office

that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Samples

Double Twisted Wire Mesh Gabions

Alternative Wire Fasteners

Samples of the materials, used to fabricate the gabions or mattresses, shall be furnished to the Contracting Officer 60 days prior to assembly of units onsite so that testing may be performed by the Government in accordance with either ASTM A 974 or ASTM A 975 depending on which system is being furnished by the Contractor.

SD-06 Test Reports

Double Twisted Wire Mesh Gabions

Alternative Wire Fasteners

For each shipment of wire gabions or mattresses delivered to the site, the Contractor shall furnish the Contracting Officer, in duplicate, test reports or records that have been performed during the last year on all material contained within the shipment meets the composition, physical, and manufacturing requirements stated in this specification.

SD-07 Certificates

Stone Fill
Filter Material

A certificate or affidavit signed by a legally authorized official of the supplier of the stone fill and the supplier of the natural filter material that it meets the quality required and gradation limits specified.

1.4 DESCRIPTION

Gabions are double-twisted wire mesh containers of variable sizes, uniformly partitioned into internal cells, interconnected with other similar units, and filled with stone at the project site to form flexible, permeable, monolithic structures. Gabions shall be manufactured with all components mechanically connected at the production facility. The supply to the jobsite of unassembled individual wire mesh components (panels) forming gabions will not be permitted. Definitions of terms specific to this specification and to all materials furnished on the jobsite, with the exception of the rock to fill the baskets and the filter material, shall refer and be in compliance with ASTM A 975 for double twisted wire mesh Gabions.

1.5 DEFINITIONS

1.5.1 Double twisted wire mesh Gabions

Consists of double-twisted wire mesh, lacing wire, and stiffeners. Shall be produced from zinc-coated wire. Fasteners shall be of stainless steel wire.

1.6 Government Testing and Studies

1.6.1 Samples

Samples of materials used to fabricate the Gabions shall be furnished to the Contracting Officer 60 days prior to start of installation. Samples will be tested in accordance with specification. The Government reserves the right to test additional samples to verify the submitted test records at the Government's expense. When the first test results indicate that the fasteners do not meet the specified requirements, the additional test will be at the Contractor's expense. The fasteners will be rejected after two tests failing to meet the requirements.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Double twisted wire mesh Gabions

Double twisted wire mesh Gabions shall be manufactured with a non-raveling mesh made by twisting continuous pairs of wires through three half turns (commonly called double twisted) to form a hexagonal-shaped opening. Gabion sizes, wire diameters, mesh opening sizes, and tolerances shall comply with the requirements of ASTM A 975 (Tables 1, 3, 4, 5, 6, and Sections 9). Gabions shall meet the following test requirements:

Metallic coating - The coating weights shall conform to the requirements of ASTM A 641/A 641M, Class 3.

Wire Tensile Strength - The tensile strength of the wire used for the double twisted mesh, lacing wire, and stiffener, when tested in accordance with Test Methods and definitions ASTM A 370, shall be in accordance with the requirements of ASTM A 641/A 641M for soft temper wire.

Mesh strength and panel to panel joint strength - The minimum strength requirements of the mesh, selvedge wire to mesh connection, panel to panel connection, and punch test, when tested in accordance with ASTM A 975 Section 13.1, shall be as shown in Table 1. The strength values reported in lb/ft are referred to the unitary width of the specimen. The panel to panel test shall demonstrate the ability of the fastening system to achieve the required strength, and indicate the number of wire revolutions for the lacing wire or the ring spacing for ring fasteners used. The same number of wire revolutions or ring spacing shall be used in the field installation.

TABLE 1

Minimum Strength Requirements of Mesh and Connections

Test description	Gabions, metallic coated lb/ft
Tensile strength parallel to twist	3500
Tensile strength	1800

TABLE 1

Minimum Strength Requirements of Mesh and Connections

Test description	Gabions, metallic coated lb/ft
perpendicular to twist	
Connection to selvages	1400
Panel to panel (using lacing wire or ring fasteners)	1400
Test description	Gabions, metallic coated lb
Punch Test	6000

2.1.2 Alternative Wire Fasteners for Gabions

Subject to approval of the Contracting Officer, alternative fastening systems may be used in lieu of lacing wire. Alternative fasteners to lacing wire recommended for woven wire gabions and mattresses, according to ASTM A 975, are steel ring fasteners for metallic coated gabions and mattresses. Ring fasteners for woven wire gabions and mattresses shall comply with the minimum requirements indicated in paragraph Ring Fasteners below, and they shall develop a minimum panel to panel joint strength as indicated in TABLE 1. The Contractor shall provide a complete description of the fastener system and a description of a properly installed fastener, including Drawings or photographs if necessary. The Contractor shall provide test results that demonstrate that the alternative-fastening system meets the requirements of the specifications, according to the following criteria:

- a. That the proposed fastener system can consistently produce a panel to panel joint strength as indicated in the TABLE 1 for double twisted wire mesh gabions;
- b. That the proposed fastener system does not cause damage to the protective coating on the wire;
- c. That the Contractor has the proper equipment and trained employees to correctly install the fasteners;
- d. That proper installation can be readily verified by visual inspection.

Samples of wire fasteners with their certified test records shall be submitted at least 60 days in advance to the Contracting Officer for approval. The Government reserves the right to test additional samples to verify the submitted test records at the Government's expense. When the first test results indicate that the fasteners do not meet the specified requirements, the additional test will be at the Contractor's expense. The fasteners will be rejected after two tests failing to meet the requirements.

2.1.2.1 Ring Fasteners

The tensile strength of the zinc-coated steel wire, zinc-5% aluminum coated mischmetal alloy-coated steel wire and aluminum-coated steel wire used for fasteners shall be in accordance with the requirements of ASTM A 764, Type A, B, or C, Table 2 or Table 3. Any fastener system shall give the number of fasteners required to comply with TABLE 1, in accordance with ASTM A 975 (Section 13.1.2) for woven wire gabions and mattresses. Ring fasteners shall not be installed more than 4 inches apart. Each fastener type shall be closed and the free ends of the fastener shall overlap a minimum of 1 inch. The manufacturer or supplier shall state the number of fasteners required for all vertical and horizontal connections for single and multiple basket joining.

2.1.3 Testing

Test records made within one year by certified laboratories and Government agencies will be used to determine the acceptability of the fastening system. Samples of wire fasteners and samples of material for fabricating the gabions and mattresses with their certified test records shall be submitted at least 60 days in advance to the Contracting Officer for approval. The Government reserves the right to test additional samples to verify the submitted test records at the Government's expense. When the first test results indicate that the fasteners do not meet the specified requirements, the additional test will be at the Contractor's expense. The fasteners will be rejected after two tests failing to meet the requirements.

2.1.4 Stone Fill

2.1.4.1 General

For gabions, the ability to function properly depends upon their stability, which is partly depending upon the rocks filling them. Rock sizes should be chosen to prevent them from falling through the mesh of the gabions. The rock has also to withstand natural weathering processes during the life of the project that would cause it to breakdown to sizes smaller than the wire mesh opening dimensions. Rock to fill gabions shall be durable and of suitable quality to ensure permanence in the structure and climate in which it is to be used.

- a. Delivery. Rock shall be delivered to the work site in a manner to minimize its reduction in sizes (breakdown) during the handling of the rock, and be placed and secured within the assembled and interconnected gabion.
- b. Sources. The sources from which the Contractor proposes to obtain the material shall be selected well in advance of the time when the material will be required in the work. The inclusion of more than 5% by weight of dirt, sand, clay, and rock fines will not be permitted. Rock may be of a natural deposit of the required sizes, or may be crushed rock produced by any suitable method and by the use of any device that yields the required size limits chosen in TABLE 4.
- c. Properties. Rocks shall be Salt River rock and shall be hard, angular to round, durable and of such quality that they shall not disintegrate on exposure to water or weathering during the life of the structure.
- d. Non-listed Source. The Contractor may, as an option, propose to

furnish stone from one non-listed source. The Government may make such investigations and tests as necessary to determine whether acceptable stone can be produced from the proposed source. All investigations and tests determined as necessary by the Government to determine suitability of stone from an alternate source will be at the expense of the Contractor. Suitable samples of stone fill material shall be collected in the presence of a Government representative and submitted to the Contracting Officer for approval prior to delivery of any such material to the work site. Unless otherwise specified, all test samples shall be obtained and delivered at the Contractor's expense to the project site at least 60 days in advance of the time when placing of the stone-filled gabions is expected to begin. Suitable tests and/or service records will be used to determine the acceptability of the stone. In the event suitable test reports and service records are not available, as in the case of newly operated sources, the material may be subjected to petrography analysis, specific gravity, absorption, wetting and drying, freezing and thawing, and such other tests as may be considered necessary to demonstrate to the satisfaction of the Contracting Officer that the materials are acceptable for use in the work. All tests will be made by or under the supervision of the Government.

2.1.4.2 Stone Quality

Stone fill, crushed stone, shall meet the quality requirements of ASTM C 33, and freezing and thawing requirements of COE CRD-C 144 for the region of the United States in which the structure will be constructed.

2.1.4.3 Gradation

Gradation of stone for gabions shall be performed every 100 tons placed under this contract in accordance with ASTM C 136. Sizes of rock to fill gabions are chosen on the basis of the mesh sizes, the structure's thickness, and within the limits shown in TABLE 4. Within each range of sizes, the rock shall be large enough to prevent individual pieces from passing through the mesh openings. Each range of sizes may allow for a variation of 5% oversize rock by weight, or 5% undersize rock by weight, or both.

- a. Oversize Rock. In all cases, the sizes of any oversize rock shall allow for the placement of three or more layers of rock within each gabion compartment.
- b. Undersize Rock. In all cases, undersize rock shall be placed within the interior of the gabion compartment and shall not be placed on the exposed surface of the structure. There shall be a maximum limit of 5% undersize or 5% oversize rock, or both, within each gabion compartment. The required rock gradation is reported in Table 4.

TABLE 4
Required rock gradation for gabions

<u>Type of structure</u>	<u>Thickness (height) inch</u>	<u>Rock sizes inch</u>
Gabions	Less than 12	4 - 8
Gabions	12 or higher	4 - 12

2.1.5 Filter Material

Filter fabrics shall meet the provisions of Section 02373 GEOTEXTILE.

PART 3 EXECUTION

3.1 MATERIAL DELIVERY

Gabions shall be delivered with all components mechanically connected at the production facility. All gabions are supplied in the collapsed form, either folded or bundled or rolled, for shipping.

- a. Gabions shall be delivered to the jobsite labeled in bundles. Labels shall show the dimensions of the gabions included, the number of pieces and the color code.

3.2 FOUNDATION PREPARATION

After excavation or stripping, to the extent indicated on the Drawings or as directed by the Contracting Officer, all remaining loose or otherwise unsuitable materials shall be removed. All depressions shall be carefully backfilled to grade. If pervious materials are encountered in the foundation depressions, the areas shall be backfilled with free-draining materials. Otherwise, the depressions shall be backfilled with suitable materials from adjacent required excavation, or other approved source, and compacted to a density at least equal to that of the adjacent foundation. Any debris that will impede the proper installation and final appearance of the gabion layer shall also be removed, and the voids carefully backfilled and compacted as specified above. Immediately prior to placing the material, the Contracting Officer shall inspect the prepared foundation surface, and no material shall be placed thereon until that area has been approved.

3.3 FILTER PLACEMENT

Filter material shall be placed as shown on Drawings in a manner satisfactory to the Contracting Officer. Any damage to the foundation surface during the filter placement shall be repaired before proceeding with the work. Compaction of the filter materials will not be required, but it shall be finished to present a reasonably even surface free from mounds or windrows.

3.4 ASSEMBLY

3.4.1 Double twisted wire mesh Gabions

The gabions shall be opened and unfolded one by one on a flat, hard surface. Gabion units over 6 foot in length usually have an extra shipping fold, which must be removed. The sides, ends and diaphragms shall be lifted up into a vertical position to form an open box shape. The back and the front panels of the gabion shall be connected to the end panels and center diaphragms. The top corner of the end panels and center diaphragms have a selvedge wire extending approximately 4 inches out from the corner edge. The end panels and the diaphragms shall be raised to a vertical position and the selvedge wire shall be wrapped around the edge wire of the top and back panels.

3.5 LACING OPERATIONS

3.5.1 Double Twisted Wire Mesh Gabions

Either lacing wire or ring fasteners are permitted to lace double twisted wire mesh Gabions.

- a. When using lacing wire, a piece of wire 1.2 to 1.5 times the length of the edge to be laced shall be cut off. If the edge of the basket is 3 foot long, no more than 4 to 5 feet of wire should be used at a time to lace. For vertical joints, starting at the bottom end of the panel, the lacing wire shall be twisted and wrapped two times around the bottom selvedge and double and single loops shall be alternated through at intervals not bigger than 4 to 6 inches. The operation shall be finished by looping around the top selvedge wire. The use of pliers to assemble the units with lacing wire is normally recommended.
- b. When steel wire ring fasteners are used, the rings shall be installed at the top and bottom connections of the end and center diaphragms. The ring spacing shall be based on the minimum pull apart strength as specified in TABLE 1. In any case, the maximum ring spacing along the edges shall not exceed 6 inches. The use of either a mechanical or a pneumatic fastening tool for steel wire ring fasteners is required. Ring fasteners shall be galvanized, stainless steel or Zn-5% aluminum-mischmetal alloy coated.

3.6 INSTALLATION AND FILLING

Empty gabion units shall be assembled individually and placed on the approved surface to the lines and grades as shown or as directed, with the sides, ends, and diaphragms erected in such a manner to ensure the correct position of all creases and that the tops of all sides are level. All gabion units shall be properly staggered horizontally and vertically as shown in the construction Drawings. Finished gabion structures shall have no gaps along the perimeter of the contact surfaces between adjoining units. All adjoining empty gabion units shall be connected along the perimeter of their contact surfaces in order to obtain a monolithic structure. All lacing wire terminals shall be securely fastened. All joining shall be made through selvedge-to-selvedge or selvedge-to-edge wire connection; mesh-to-mesh or selvedge-to-mesh wire connection is prohibited except in the case where baskets are offset or stacked and selvedge-to-mesh or mesh-to-mesh wire connection would be necessary. As a minimum, a fastener shall be installed at each mesh opening at the location where mesh wire meets selvedge or edge wire.

- a. The initial line of basket units shall be placed on the prepared filter layer surface and adjoining empty baskets set to line and grade, and common sides with adjacent units thoroughly laced or fastened. They shall be placed in a manner to remove any kinks from the mesh and to a uniform alignment. The basket units then shall be partially filled to provide anchorage against deformation and displacement during the filling operation. The stone shall be placed in the units as specified in paragraph 2.1.4.3 Stone Fill, subparagraph Gradation.
- b. Undue deformation and bulging of the mesh shall be corrected prior to further stone filling. Care shall be taken, when placing the stone by hand or machine, to assure that the PVC coating on gabions will not be damaged. All visible faces shall be filled with some hand placement to ensure a neat and compact appearance and that the

void ratio is kept to a minimum.

- c. Gabions shall be uniformly overfilled by about 1 to 2 inches to compensate for future rock settlements. Gabions can be filled by any kind of earth-filling equipment, such as a backhoe, gradall, crane, etc. The maximum height from which the stones may be dropped into the baskets shall be 4 feet. If PVC coated materials are used, no work shall take place unless the ambient temperature is above 20 degrees F.

3.6.1 Double Twisted Wire Mesh Gabions

After the foundation has been prepared, the pre-assembled gabions shall be placed in their proper location to form the structure. Gabions shall be connected together and aligned before filling the baskets with rock. All connections (panel-to-panel) and basket-to-basket shall be already carried out as described in paragraph ASSEMBLY. Stone fill shall have a gradation of 4 to 12 inches, as described in paragraph Gradation, and shall be placed in 1 foot lifts. Cells shall be filled to a depth not exceeding 1 foot at a time. The fill layer should never be more than 1 foot higher than any adjoining cell. Stiffeners or internal cross ties shall be installed in all front and side of the gabions at 1/3 and 2/3 of the height for 3 feet or higher gabions, as the cell is being filled. Stiffeners shall be installed in the center of the cells. Internal cross ties, or alternatively the preformed stiffeners, shall be looped around three twisted wire mesh openings at each basket face and the wire terminals shall be securely twisted to prevent their loosening. The number of voids shall be minimized by using a well-graded stone in order to achieve a dense, compact stone fill. All corners shall be securely connected to the neighboring baskets of the same layer before filling the units. When more than one layer of gabions is required, in order for the individual units to become incorporated into one continuous structure, the next layer of gabions shall be connected to the layer underneath after this layer has been securely closed. Gabions shall be uniformly overfilled by about 1 to 2 inches to compensate for future rock settlements.

3.6.2 Non-rectangular Shapes

Gabion units can conform to bends up to a radius of curvature of 60 to 70 feet without alterations. Units shall be securely connected together first, and be placed to the required curvature, holding them in position by staking the units to the ground with hardwood pegs before filling. For other shapes, bevels and miters can be easily formed by cutting and folding the panels to the required angles.

3.7 CLOSING

Lids shall be tightly secured along all edges, ends and diaphragms in the same manner as described for assembling. Adjacent lids may be securely attached simultaneously. The panel edges shall be pulled to be connected using the appropriate closing tools where necessary. Single point leverage tools, such as crowbars, may damage the wire mesh and shall not be used. All end wires shall then be turned in.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 02 - SITE WORK

SECTION 02661

FLEXIBLE MEMBRANE LINING (FML)

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 DEFINITIONS
 - 1.2.1 Flexible Membrane Lining
 - 1.2.2 Film Tearing Bond
 - 1.2.3 Geomembrane
 - 1.2.4 Panel
 - 1.2.5 Sheet
 - 1.2.6 Watertight
- 1.3 SUBMITTALS
- 1.4 QUALIFICATIONS
 - 1.4.1 Testing Agency
 - 1.4.2 Manufacturer and Fabricator
 - 1.4.3 Installer
- 1.5 COORDINATION MEETINGS
- 1.6 DELIVERY, STORAGE, AND HANDLING
 - 1.6.1 Geomembrane
 - 1.6.2 Epoxy Adhesive
- 1.7 ENVIRONMENTAL REQUIREMENTS
- 1.8 SEQUENCING AND SCHEDULING

PART 2 PRODUCTS

- 2.1 GEOMEMBRANE

PART 3 EXECUTION

- 3.1 PREPARATION
 - 3.1.1 Geomembrane Inspection
 - 3.1.2 Subgrade Inspection
 - 3.1.3 Maintenance of Subgrade
- 3.2 SOIL STERILANT
- 3.3 WELDING UNITS
- 3.4 GEOMEMBRANE INSTALLATION
 - 3.4.1 Test Results
 - 3.4.2 Protection
 - 3.4.3 Placement
 - 3.4.4 Field Seams
- 3.5 PLACING PRODUCTS OVER GEOMEMBRANE
- 3.6 REPAIRING GEOMEMBRANE
- 3.7 FIELD QUALITY CONTROL
 - 3.7.1 Certification of Installation
 - 3.7.2 Testing
 - 3.7.3 In-Place Observation and Testing
 - 3.7.4 Field Testing Equipment
 - 3.7.5 Field Seam Sampling
 - 3.7.6 Field Seam Strength Sample Testing
 - 3.7.6.1 General
 - 3.7.6.2 Field Seam Acceptance Criteria:

- 3.7.6.3 Test Failure
- 3.7.7 Vacuum Box Testing of Geomembrane Welds
- 3.7.8 High Voltage Spark Testing of Fillet Welds
- 3.7.9 Air Channel Pressure Testing of Double Hot-Wedge Seam
- 3.8 MANUFACTURER'S SERVICES
- 3.9 CLEANUP
 - 3.9.1 Clean up work area as Work proceeds
- 3.10 GEOMEMBRANE INSTALLER'S CERTIFICATION OF SUBSURFACE ACCEPTABILITY

-- End of Section Table of Contents --

SECTION 02661

FLEXIBLE MEMBRANE LINING (FML)

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 413	(1982; R 1998) Rubber Property - Adhesion to Flexible Substrate
ASTM D 638	(1999) Tensile Properties of Plastics
ASTM D 792	(1998) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D 816	(2001) Standard Test Methods for Rubber Cements
ASTM D 1004	(1994a) Initial Tear Resistance of Plastic Film and Sheeting
ASTM D 4833	(2000) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 5199	(1999) Measuring Nominal Thickness of Geotextiles and Geomembranes
ASTM D 5641	(2001) Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber
ASTM D 6392	(1999) Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods

1.2 DEFINITIONS

1.2.1 Flexible Membrane Lining

Geomembrane as specified herein.

1.2.2 Film Tearing Bond

Failure in ductile mode of one bonded sheet, by testing, prior to complete separation of bonded area.

1.2.3 Geomembrane

Essentially impermeable geosynthetic composed of one or more layers of polyolefin materials fusion bonded into single-ply integral sheet.

1.2.4 Panel

Piece of geomembrane composed of two or more sheets seamed together.

1.2.5 Sheet

Seamless piece of geomembrane.

1.2.6 Watertight

Geomembrane installation free of flaws and defects that will allow passage of water and gases, liquids, and solids to be contained under anticipated service conditions.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Geomembrane

Geomembrane sheet layout with proposed size, number, position, and sequence of sheet placement, and location of field seams.

SD-04 Samples

Field Seam Sampling

SD-07 Certificates

Geomembrane

Factory test results.

Certified calibrations, manufacturer's product data, and test procedures, and 5 year warranty against manufacturer and installation defects.

Geomembrane Installer's Certification of Subsurface Acceptability

Form attached at end of this section.

Manufacturer's Services

Include panel and sheet numbers, seaming equipment and operator identification, temperature and speed setting of equipment, date seamed, identity and location of each repair, cap strip, penetration, boot and sample taken from installed geomembrane for testing.

1.4 QUALIFICATIONS

1.4.1 Testing Agency

Certified to perform work for as specified, and 5 years' experience in field of geomembrane testing. Calibrated instruments and equipment, and documented standard procedures for performing specified testing.

1.4.2 Manufacturer and Fabricator

Successfully manufactured minimum of 10 million square feet of each type of geomembrane material specified for applications similar to Project.

1.4.3 Installer

Successfully installed minimum of 1 million square feet of each type of geomembrane product specified in applications similar to Project.

1.5 COORDINATION MEETINGS

Meet at least once prior to commencing each of the following activities:

- a. Submission of Submittals.
- b. Manufacture of geomembrane sheets.
- c. Fabrication of panels.
- d. Installation of geomembrane.

Attendees

- a. Contractor's designated quality control representative.
- b. Contracting Officer.
- c. Representatives of geomembrane installer.
- d. Others requested by Contracting Officer.

Topics

- a. Specifications and Drawings.
- b. Submittal requirements and procedures.
- c. Schedule for beginning and completing geomembrane installation.
- d. Training for installation personnel.
- e. Installation crew size.
- f. Establishing geomembrane marking system, to include sheet identification, defects, and satisfactory repairs, to be used throughout Work.

Seam Installation and Testing Demonstration: Performed by geomembrane installer, for each type of seam required.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Geomembrane

Individually package each sheet and protect from damage during shipment. Mark each package with identification of material type, size, and weight.

1.6.2 Epoxy Adhesive

Storage Temperature

- a. Control temperature above 60 degrees F and dispose of cartridges if shelf life has expired.
- b. If stored at temperatures below 60 degrees F, test adhesive prior to use to determine if adhesive meets specified requirements.

1.7 ENVIRONMENTAL REQUIREMENTS

Do not install geomembrane or perform seaming under the following conditions, unless it can be demonstrated to satisfaction of Contracting Officer that performance requirements can be met under these conditions:

- a. Air temperature is less than 35 degrees F or more than 90 degrees F.
- b. Relative humidity is more than 90 percent.
- c. Raining or wind is excessive.

Do not place granular materials on geomembrane when ambient temperature is less than 35 degrees F, unless it can be demonstrated to satisfaction of Contracting Officer that materials can be placed without damage.

1.8 SEQUENCING AND SCHEDULING

Factory test results must be acceptable to the Contracting Officer prior to shipment of geomembrane.

Before placing geomembrane on soil surfaces, prepare subgrade as specified in Section 02300 EARTHWORK.

PART 2 PRODUCTS

2.1 GEOMEMBRANE

Composition: Linear low-density polyethylene (LLDPE) containing no plasticizers, fillers, extenders, reclaimed polymers, or chemical additives, except following:

- a. Approximately 2 percent by weight of carbon black to resin for ultraviolet resistance.
- b. Antioxidants and heat stabilizers, not to exceed 1.5 percent total by weight, may be added as required for manufacturing.

Furnish in rolled single-ply continuous sheets with no factory seams.

Sheet Thickness: Minimum values determined in accordance with ASTM D 5199, 40 mils.

Sheet Width: Minimum 22 feet.

Roll Length: Longest that will be manageable and reduce field seams.

Meet manufacturer's most recent published specifications and required minimum LLDPE geomembrane values in this table.

Minimum Physical Properties for LLDPE Geomembrane

Property	Required Value	Test Method
Specific Gravity	0.91 to 0.94, g/cc	ASTM D 792, Method A-1

Smooth-Surface, LLDPE Minimum Properties, Each Direction

Tensile Stress at Break	3.8 lb/in-width/mil thickness, min.	ASTM D 638
Elongation at Break	800%, min.	
Thickness, Nominal, plus or minus 10%	40 mils	ASTM D 5199
Puncture Resistance	1.30 lb/mil thickness	ASTM D 4833
Tear Resistance	0.55 lb/mil thickness	ASTM D 1004, Die C
Bonded Seam Strength in Shear	1.5 lb/in-width/mil thickness, min. and FTB	ASTM D 816, Method B
Bonded Seam Strength in Peel	1.2 lb/in.-width/mil thickness, min. and FTB	ASTM D 413, Method A

Extrudate for Fusion Welding of LLDPE Geomembranes: Formulated from same resin as geomembrane and shall meet applicable physical property requirements.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Geomembrane Inspection

During unwrapping visually inspect and mark each imperfection for repair.

3.1.2 Subgrade Inspection

Do not place geomembrane until condition of subgrade or geosynthetics installed is acceptable to Contracting Officer.

3.1.3 Maintenance of Subgrade

Maintain in smooth, uniform, and compacted condition as specified in Section 02300 EARTHWORK, during installation of geomembrane.

3.2 SOIL STERILANT

Apply to prepared subgrade beneath liner and handle in strict accordance with manufacturer's recommendations.

3.3 WELDING UNITS

- a. Single or double hot-wedge fusion seam welding.
- b. Extrusion welding systems.
- c. Hot-air welding is not acceptable.

3.4 GEOMEMBRANE INSTALLATION

3.4.1 Test Results

Do not install geomembrane or seam unless Contractor can demonstrate successful performance and test results showing seams meet strength specifications.

3.4.2 Protection

- a. Do not use geomembrane surfaces as work area for preparing patches, storing tools and supplies, or other uses. Use protective cover as work surface, if necessary.
- b. Instruct workers about requirements for protection of geomembrane, such as, handling geomembrane material in high winds, handling of equipment, and walking on geomembrane surfaces. Shoes of personnel walking on geomembrane shall be smooth bonded sole or be covered with smooth type of overboot. Prohibit smoking, eating, or drinking in vicinity of geomembrane, placing heated equipment directly on geomembrane, or other activities that may damage geomembrane.
- c. Do not operate equipment without spark arrestors in vicinity of geomembrane material nor place generators or containers of flammable liquid on geomembranes.
- d. Protect from vehicle traffic and other hazards.
- e. Keep free of debris during placement.
- f. Prevent uplift, displacement, and damage by wind.
- g. Only small rubber-tired equipment, with maximum tire inflation pressure of 5 pounds per square inch, shall be allowed directly on geomembrane, unless otherwise approved by Contracting Officer. Demonstrate that equipment can be operated without damaging geomembrane.

3.4.3 Placement

- a. Miscellaneous products required for completion of geomembrane installation shall be in accordance with this Specification and geomembrane manufacturer's recommendations.

- b. Reduce field seaming to minimum. Horizontal seams on slopes will not be acceptable. Seams parallel to toe shall be at least 5 feet from toe. Align rough-sided sheets in manner that maximizes their frictional capabilities along slope.
- c. Prevent wrinkles, folds, or other distress that can result in damage or prevent satisfactory alignment or seaming. Provide for factors such as expansion, contraction, overlap at seams, anchorage requirements, seaming progress, and drainage.
- d. Temporarily weight sheets with sandbags to anchor or hold them in position during installation. Use continuous holddowns along edges to prevent wind flow under sheet.

Bag Fabric: Sufficiently close knit to preclude fines from working through bags.

Bags: Contain not less than 40 nor more than 60 pounds of sand having 100 percent passing No. 8 screen and shall be securely closed after filling to prevent sand loss.

Do not use tires or paper bags, whether or not lined with plastic. Burlap bags, if used, shall be lined with plastic.

Immediately remove damaged or improperly sealed bags from work area, and clean up spills.

- e. Anchor perimeter of geomembrane as shown or as otherwise approved by the Contracting Officer. Anchor and seal geomembrane to structures, pipes, and other types of penetrations as shown.
- f. Place overlying soil cover immediately following completion of geomembrane installation and field testing as acceptable to the Contracting Officer.

3.4.4 Field Seams

- a. Wipe sheet contact surfaces clean to remove dirt, dust, moisture, and other foreign materials and prepare contact surfaces in accordance with seaming method accepted by the Contracting Officer.
- b. Lap sheet edges to form seams. Adjust edges to be seamed and temporarily anchor to prevent wrinkling and shrinkage.
- c. Seams shall not go through a boot. Locate seams minimum of 2 feet from boot.
- d. Avoid seam intersections involving more than three thicknesses of geomembrane material. Offset seam intersections at least 2 feet. Extend seams through anchor trench to sheet edges.
- e. Seal seam "T" intersections by removing excess material and extrusion welding lap joint.
- f. Seam sheets together, using fusion-extrusion or hot-wedge welding system, equipment, and techniques.
- g. Capping of Field Seams: Use 8-inch wide (minimum) cover strip of

same thickness as geomembrane (and from same roll, if available). Position strip over center of field seam and weld to geomembrane using fillet weld each side, including copper wire as described above for spark testing.

3.5 PLACING PRODUCTS OVER GEOMEMBRANE

- a. Prior to placing material over geomembrane, notify Contracting Officer. Do not cover installed geomembrane until after Contracting Officer provides authorization to proceed.
- b. Place, spread and compact materials as specified in Section 02300 EARTHWORK.
- c. Do not place granular materials on geomembrane when typical height of wrinkles is less than 2 inches and spacing between wrinkles is greater than 10 feet.
- d. Do not place soil materials in manner that will cause wrinkles to fold over or become confined to form a vertical ridge.
- e. Place soil materials when liner is cool and contracted and wrinkles are minimized.
- f. If tears, punctures, or other geomembrane damage occurs during placement of overlying products, remove overlying products as necessary to expose damaged geomembrane, and repair damage as specified in paragraph REPAIRING GEOMEMBRANE.
- g. Geomembrane installer shall remain available during placement of overlying products to repair geomembrane if damaged.

3.6 REPAIRING GEOMEMBRANE

- a. Geomembrane surface showing injury due to scuffing, penetration by foreign objects, or distress from rough subgrade shall be replaced or covered and sealed with an additional layer of geomembrane material of proper size.
- b. Repair damage or rejected seams with pieces of flat and unwrinkled geomembrane material free from defects and seams. Patches shall be tightly bonded on completion of repair Work.
- c. Patch shall be neat in appearance and of size 6 inches larger in all directions than area to be repaired. Round corners of patch to minimum 1-inch radius.
- d. Prepare contact surfaces and seam patch in accordance with paragraph Field Seams.

Pull and hold flat receiving surface in area to be patched.

Seal each patch by extrusion welding continuous bead along edge, with no free edge remaining.

Vacuum box test each patch on completion.

3.7 FIELD QUALITY CONTROL

3.7.1 Certification of Installation

Prior to starting geomembrane installation and daily thereafter for installation of geomembrane on the subgrade surface, geomembrane installer shall certify in duplicate that surface upon which geomembrane shall be installed and installation process for the geomembrane is acceptable, on form located at end of section.

3.7.2 Testing

Identify each test by date of sample, date of test, sample location, name of individual who performed test, standard test method used, list of departures from standard test methods, at minimum.

3.7.3 In-Place Observation and Testing

- a. Visually inspect geomembrane sheets, seams, anchors, seals, and repairs for defects as installation progresses and again on completion.
- b. Depending on seam welding equipment used, test each seam and repair using vacuum testing device, spark testing device, or air channel pressure test for double wedge welded seams.
- c. Perform testing in presence of the Contracting Officer.

3.7.4 Field Testing Equipment

- a. Tensiometer:

Motor driven with jaws capable of traveling at measured rate of 2 inches per minute.

Equipped with gauge which measures force in unit pounds exerted between jaws.
- b. Vacuum Box

Conform to ASTM D 5641.
- c. High Voltage Spark Detector

Set at 20,000 volts.

3.7.5 Field Seam Sampling

- a. Verify that seaming equipment and operators are performing adequately. Produce test seam samples at beginning of each shift for each seaming crew. In addition, if seaming has been suspended for more than 1/2 hour, or if breakdown of seaming equipment occurs, produce test seam samples prior to resuming seaming.
- b. Sample Size: 12 inches wide plus seam width, and 30 inches long.
- c. Nondestructive Sampling:

For boots and seams that cannot be otherwise tested, insert copper wire for spark test at edge of overlapping sheet in extrudate of weld prior to filet welding. Position to within 1/8 inch of sheet

edge.

Frequency: Minimum one Sample per 500 feet of field seam or portion thereof, and minimum one Sample per seaming crew per 4-hour work period.

Produce Samples using same materials, equipment, personnel, and procedures as field seams made at time of work in progress and under same conditions.

d. Destructive Sampling:

Frequency: Determined by the Contracting Officer.

Remove Samples from field seams at locations selected by the Contracting Officer.

Repair field seams in accordance with repair procedures specified in these Specifications.

e. Sample Identification:

Number, date, and identify each sample as to personnel making seam and location of sample or location of field seam Work in progress at time Sample is made.

Mark location of Sample, or location of field seam in progress at time sample is made, on panel/sheet layout Drawing.

f. Contractor shall conform with the following testing requirements for nondestructive and destructive seam tests used to define quality of field seams:

Perform shear and peel testing on portion of sample as specified hereinafter using approved field tensiometer.

Send portion of sample by overnight service to approved Independent Testing Agency for verification of field test results.

Archive a portion of sample for potential verification testing later.

Independent Testing Agency shall provide preliminary test results by facsimile or other means no later than 24 hours after Samples have been received from the Contractor, unless otherwise approved by the Contracting Officer. Certified test results shall be provided no more than 7 days after Samples have been received from Contractor.

g. Conform to ASTM D 6392 and this Specification.

Seam testing for geomembrane includes strength tests, vacuum box testing, high voltage spark tests, air channel pressure tests, and probing.

3.7.6 Field Seam Strength Sample Testing

3.7.6.1 General

- a. Test each sample for seam peel and tensile strength.
- b. Save test samples, including specimens tested, until notified by Contracting Officer relative to their disposal.
- c. Each sample that fails under test shall be shipped immediately by express delivery to Contracting Officer for determination of corrective measures required.

3.7.6.2 Field Seam Acceptance Criteria:

Seam strength equal to 90 percent of that of parent material. Parent material shall be tested in accordance with ASTM D 638.

- a. Bonded Shear Strength of LLDPE:
 1. In Shear: Minimum 1.5 pounds per inch per mil thickness as determined by ASTM D 6392 and ASTM D 816, Method B.
 2. In Peel: Minimum 1.2 pounds per inch per mil thickness as determined by ASTM D 6392 and ASTM D 413, Method A.

3.7.6.3 Test Failure

If sample fails, entire field seam from which it was taken shall be considered a failure and shall be rejected due to nonconformance with specification requirements. Comply with following corrective measures:

- a. For nondestructive sample failure, rerun field weld test using same sample. If that test passes, Contracting Officer may assume error was made in first test and accept field seam. If second test fails, cap each field seam represented by failed sample and submit new test Sample made during capping procedure.
- b. Destructive Sample Failure: Rerun field weld test using new sample from same seam. If that test passes, Contracting Officer may assume error was made in first test and accept field seam. If second test fails, either cap field seam between two previous passed seam test locations that include failed seam or take another sample on each side of failed seam location (10 feet minimum), and test both. If both pass, cap field seam between two locations. If either fails, repeat process of taking samples for test. Each field seam shall be bounded by two passed test locations prior to acceptance.

3.7.7 Vacuum Box Testing of Geomembrane Welds

- a. Vacuum box test each of these types of welds: Fillet, extrusion lap, and single hot-wedge fusion lap.
- b. Testing Procedures: Conforming to ASTM D 5641.

3.7.8 High Voltage Spark Testing of Fillet Welds

- a. Provide each seam to be tested with copper wires properly embedded in seam as shown and with provisions for electrical grounding to test equipment.
- b. Pass spark tester along length of seam containing copper wire.

- c. Presence of a visible spark along tested seam shall be evidence of a faulty seam.
- d. Mark faulty areas for repair and retesting.

3.7.9 Air Channel Pressure Testing of Double Hot-Wedge Seam

- a. Insert needle with gauge in air space between welds. Pump air into space to 30 psi and hold for 5 minutes.
- b. At end of 5 minutes, depressurize seam by placing needle hole in air space between welds at opposite end of seam and observe gauge.
- c. Seam is acceptable if seam maintains at least 27 psi during 5-minute hold and pressure drops within 30 second of depressurization.
- d. Seam is acceptable if seam maintains a minimum of 27 psi. If pressure drops below 27 psi during test period, or does not drop during 30-second depressurization period, repair needle holes and retest seam by same procedure or vacuum box test along entire length of seam.
- e. Vacuum box test entire length of seam if second air pressure test fails.

If no bubbles appear in vacuum box, lower weld will be considered defective and upper seam is acceptable.

If bubbles appear in vacuum box, repair each defective area by extrusion welding and test again by vacuum box.

- f. As alternative to vacuum box testing, apply soap solution to exposed seam edge while maintaining required air channel test pressure.

If bubbles appear, mark, trim unbonded edge, and extrusion weld defective areas.

If no bubbles appear and test pressure cannot be maintained, leak is judged to be in bottom or second seam.

- g. If leak is judged to be in bottom seam, cap strip length of seam tested.
- h. Mark and repair needle holes.

3.8 MANUFACTURER'S SERVICES

Provide authorized representative of geomembrane manufacturer onsite for technical supervision and assistance during the following:

- a. Preparation and inspection of surfaces on which geomembrane is to be placed.
- b. Inspection of geomembrane prior to installation.
- c. Installation of geomembrane.

- d. Placement of cover over installed geomembrane.
- e. Provide a 5 year warranty against any manufacturer and installation defects.

3.9 CLEANUP

3.9.1 Clean up work area as Work proceeds

Take particular care to ensure that no trash, tools, and other unwanted materials are trapped beneath geomembrane and that scraps of geomembrane material are removed from Work area prior to completion of installation.

3.10 GEOMEMBRANE INSTALLER'S CERTIFICATION OF SUBSURFACE ACCEPTABILITY

GEOMEMBRANE INSTALLER'S CERTIFICATION OF ACCEPTABILITY

Geomembrane installer, _____
for Project, hereby certify that supporting surfaces are acceptable for
installation of geomembrane, undersigned having personally inspected
condition of prepared surfaces, inspection of geomembrane prior to
installation, installation of geomembrane, and placement of cover materials
over installed geomembrane. This certification is for areas shown on
Attachment or defined as follows:

Condition of supporting surfaces in defined area meets or exceeds minimum
requirements for installation of geomembrane.

Signed: _____
(Representative of Geomembrane Installer)

Officer of the Firm

Date: _____

Witness: _____

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 11 - EQUIPMENT

SECTION 11214

SUPPLY WELL PUMPS

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 GENERAL REQUIREMENTS
 - 1.2.1 Standard Products
 - 1.2.2 Nameplates
 - 1.2.3 Verification of Dimensions
- 1.3 SUBMITTALS
- 1.4 DELIVERY AND STORAGE

PART 2 PRODUCTS

- 2.1 PUMP AND DRIVER REQUIREMENTS
 - 2.1.1 Type of Installation
 - 2.1.2 Pump Drivers
- 2.2 PUMP PERFORMANCE
- 2.3 VERTICAL TURBINE PUMP SYSTEM
 - 2.3.1 Discharge Head
 - 2.3.1.1 Pump Driver
 - 2.3.2 Water-Lubricated Column and Shaft Assembly
 - 2.3.2.1 Lubrication
 - 2.3.3 Pump Bowl Assembly
 - 2.3.3.1 Pump Bowls
 - 2.3.3.2 Impellers
 - 2.3.3.3 Pump Shafts
 - 2.3.3.4 Bearings
 - 2.3.4 Suction Bell and Strainer
- 2.4 EQUIPMENT APPURTENANCES
 - 2.4.1 Attachments
 - 2.4.2 Pre-Lubrication Tank
 - 2.4.3 Shop Painting
 - 2.4.4 Spare Parts

PART 3 EXECUTION

- 3.1 INSTALLATION
 - 3.1.1 General
 - 3.1.2 Supply Well Pump
- 3.2 PAINTING AND FINISHING
- 3.3 TESTING
 - 3.3.1 Factory Pump Test
 - 3.3.2 Field Equipment Test
 - 3.3.2.1 Correct Installation of Appurtenances
 - 3.3.2.2 Deficiencies
- 3.4 MANUFACTURER'S FIELD SERVICES
- 3.5 FIELD TRAINING
- 3.6 POSTED INSTRUCTIONS

-- End of Section Table of Contents --

SECTION 11214

SUPPLY WELL PUMPS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASME INTERNATIONAL (ASME)

ASME B1.1 (1989) Unified Inch Screw Threads (UN and UNR Thread Form)

ASTM INTERNATIONAL (ASTM)

ASTM F 593 (2002) Stainless Steel Bolts, Hex Cap Screws, and Studs

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA E101 (1988) Vertical Turbine Pumps - Line Shaft and Submersible Types

1.2 GENERAL REQUIREMENTS

1.2.1 Standard Products

The vertical turbine well pumps and associated equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 5 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

1.2.2 Nameplates

Each major item of equipment shall have the manufacturer's name, address, type or style, model, serial number, and catalog number on a plate secured to the item of equipment. Pumps and motor shall also have identical nameplates affixed in a conspicuous place to the pumphouse wall or discharge piping. In addition, the nameplate for the pump shall show the capacity in gallons per minute at rated head in feet and speed in revolutions per minute. Nameplate for each electric motor shall show the horsepower, speed in revolutions per minute, full load current, voltage, frequency, phases, time rating, maximum ambient temperature, insulation class code letter, and service factor.

1.2.3 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the fields and shall advise the Contracting Officer of

any discrepancy before performing the work.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation

Detail drawings consisting of a complete list of equipment and materials. Detail drawings containing complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-03 Product Data

Vertical Turbine Pumping Units; G, RE

Manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions. Curves shall show head capacity, horsepower demand and pump performance efficiency over the entire operating range of the pump(s).

Spare Parts

Spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than 3 months prior to the date of beneficial occupancy. Data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after 1 and 3 year(s) of service.

Vertical Turbine Pump System; G, RE

Proposed diagrams, instructions, and other sheets, prior to posting. Diagrams shall include details showing equipment dimensions, size, and locations of connections and weights of associated equipment. Submit sufficient hydraulic computations to substantiate pump selection and demonstrate that the selected pump can meet the project design and operating requirements as specified.

SD-06 Test Reports

Testing; G

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion

and testing of the installed system. Each test report shall indicate the final position of controls, test data sheets, performance test logs, certified by a professional Engineer.

SD-10 Operation and Maintenance Data

Vertical Turbine Pumping Units; G

Submit 10 complete copies of operating manual outlining the step-by-step procedures required for system startup, operation and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Ten complete copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include simplified wiring, layout, and control diagrams of the system as installed.

1.4 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Manufacturer shall deliver all spare parts at one time with each item properly labeled by part number.

PART 2 PRODUCTS

2.1 PUMP AND DRIVER REQUIREMENTS

2.1.1 Type of Installation

The work shall include furnishing, installing, and testing line shaft and vertical turbine pumping units and their appurtenances of supply well locations RSSW-3, RSSW-4, RSSW-5, and RSSW-6. Pumps, piping, valves, fittings, and instrumentation shall be installed at each supply well location. Line shaft lubrication shall be water. Supply well pumps have been sized using well information provided by URS, "Draft Report Drilling, Installation, and Testing of Rio Salado Water Supply Wells RSSW-3 through RSSW-6", March 10, 2003. Contractor shall obtain the latest version from the USACE and verify pump selection using data from the latest version available at time of pump installation.

2.1.2 Pump Drivers

Pumps shall have the type of drive units indicated.

2.2 PUMP PERFORMANCE

Pumps shall be capable of discharging quantities of water at maximum pump speed and total pump head with the minimum efficiency indicated. The sound level produced by each pump shall not exceed **70 dB when measured at distance of 10 feet.**

2.3 VERTICAL TURBINE PUMP SYSTEM

Line shaft vertical turbine pumps shall be constructed in accordance with AWWA E101 except as modified. Pumps shall be designed for flanged discharge and the pump setting or location of the pump suction shall be as indicated. A suction bell as determined by the pump manufacturer shall be

provided below the lowermost bowl.

2.3.1 Discharge Head

Discharge head shall be of the fabricated steel type with a minimum 60,000 psi tensile strength. The discharge shall have a working pressure of not less than 275 psi and incorporate a 150 ANSI discharge flange. Complete discharge head shall be hydrostatically tested to a minimum of 412 psi. A product lubricated stuffing box containing at least five rings of packing and one lantern ring shall be provided. Packing shall be compressed around shaft by an adjustable two-piece gland. Dual bypass tubing shall be included for proper packing lubrication and cooling. The discharge head stuffing box area shall also include a drain which will be piped back to the wet well. Discharge head to be designed to include leakless configuration. Discharge head shall incorporate an integral air separation chamber, allowing air to be discharged through an air release line mounted on top of head. Stuffing box bushing shall be SAE 660 cast iron.

The head shaft shall be of the two piece type, 416 stainless steel and shall be turned and ground. The pump manufacturer shall include a method for adjusting the impeller running clearance at the top of the head shaft. Adequate space shall exist to couple the head shaft and the line shaft above the stuffing box. Coupling shall be extra heavy duty AISI 416 stainless steel with a minimum service factor of 2 to 1.

2.3.1.1 Pump Driver

RSSW-3, RSSW-4, and RSSW-6 shall be equipped with constant speed motors. RSSW-5 shall be equipped with an adjustable frequency drive. All pump motors shall be equipped to accept adjustable frequency drives, whether or not these drives are required for this project.

- a. Vertical Hollow Shaft Motors: Motor(s) for production well pump shall be of the vertical hollow shaft high thrust design. Motor shall have a TEFC enclosure, 1.15 service factor, and class F insulation. Motors shall be wound for the starting configuration as called out in the technical data sheet. Design pump brake horsepower shall not exceed 87% of motor horsepower exclusive of service factor. Maximum pump run out horsepower shall not be greater than motor rating exclusive of service factor. Motor shall be rated for continuous duty and be designed to carry the maximum thrust load of the pump and will have B10 bearing life of no less than 5 years. Motors shall be inverter duty, rated and tagged for VFD service, proper ambient temperature and proper altitude per motor manufacturers recommendations.
- b. Motors shall be squirrel-cage induction motors having normal-starting-torque and low-starting-current characteristics, and shall be of sufficient size so that the nameplate horsepower rating will not be exceeded throughout the entire published pump characteristic curve. Motor bearings shall provide smooth operations under the conditions encountered for the life of the motor. Adequate thrust bearing shall be provided in the motor to carry the weight of all rotating parts plus the hydraulic thrust and shall be capable of withstanding upthrust imposed during pump starting and under variable pumping head conditions specified. Motors shall be rated 460 volts, 3 phase, 60 Hz and such rating stamped on the nameplate.

- c. Motor Space Heater: The pump station manufacturer shall provide on each pump motor a 120 volt, single phase space heater of ample size to prevent condensation from occurring within the motor during non-operating periods. The space heater shall be de-energized when the motor is running.

2.3.2 Water-Lubricated Column and Shaft Assembly

Each section of the discharge column shall consist of a column pipe, line shaft with hardened journal surfaces, bearing spiders with bearings spaced not more than 10 feet on centers, and line shaft and discharge column pipe couplings. Line shaft bearings shall be rubber and shall be held in place by bronze or other noncorrodible metal bearing retainers.

2.3.2.1 Lubrication

Lubrication of line shaft pumps shall be furnished by the water being pumped.

2.3.3 Pump Bowl Assembly

Pump bowl assembly shall include the pump bowl, pump impeller, and the pump shaft and bearings and may be of multistage configuration.

2.3.3.1 Pump Bowls

Bowls shall be bronze and shall have integrally-cast vanes with smooth, streamlined water passageways. The pump bowls shall be lined with porcelain enamel. Suction bowl shall contain a bronze bearing permanently packed with nonsoluble grease and fitted with a sand collar to serve as the bottom bearing of the pump shaft. Casing wearing rings of bronze shall be installed for pumps with enclosed impellers.

2.3.3.2 Impellers

Impellers shall be carefully finished with smooth water passageways and shall not load the prime mover beyond the nameplate rating over the entire performance range of the pump. Impellers shall be of the enclosed or semiopen type and shall be constructed of bronze. Wear rings shall be installed on enclosed impellers. Impellers shall be statically and dynamically balanced.

2.3.3.3 Pump Shafts

Shafts shall be of 416 stainless steel capable of transmitting the required thrust in either direction and the total torque of the unit.

2.3.3.4 Bearings

Intermediate bowl bearings shall be water lubricated bronze or fluted rubber. Top bowl bearings and suction case bearings shall be grease packed bronze or water-lubricated bronze. Grease in grease-packed bearings shall be nonwater-soluble hydraulic type permanently sealed against loss. Grease-packed bearings shall be provided with sand caps to prevent intrusion of abrasive particles.

2.3.4 Suction Bell and Strainer

Suction bell length shall be recommended by manufacturer. Suction strainer

shall be of the basket type, fabricated from stainless steel.

2.4 EQUIPMENT APPURTENANCES

2.4.1 Attachments

All necessary bolts, nuts, washers, bolt sleeves, and other types of attachments for the installation of the equipment shall be furnished with the equipment. Bolts shall be Type 316 stainless steel and conform to the requirements of ASTM F 593 and nuts shall be hexagonal of the same quality as the bolts used. Threads shall be clean-cut and shall conform to ASME B1.1.

2.4.2 Pre-Lubrication Tank

Provide one pre-lubrication tank per pump. Tank shall be a minimum of 55-gallons with base that can be anchored to a concrete pedestal. Tank shall be equipped with a minimum of the following nozzles:

- a. 3-inch level element NPT nozzle on top.
- b. 2-inch overflow NPT nozzle on top.
- c. 1-inch drain NPT nozzle on side at base.
- d. 1-inch fill NPT nozzle on side at base.
- e. 1 1/2-inch pre-lube NPT nozzle on side at base.

Nozzles shall be oriented as shown on Drawings. Tank shall fit and be securely anchored to pad as shown on Drawings.

2.4.3 Shop Painting

All motors, pump casings, and similar parts of equipment customarily finished in the shop shall be given coats of paint filler and enamel, or other acceptable treatment customary with the manufacturer and suitable for the intended service. Ferrous surfaces obviously not to be painted shall be given a shop coat of grease or other suitable rust-resistant coating.

2.4.4 Spare Parts

Manufacturer shall furnish one set of stuffing box packing, lantern ring, bearing, o-rings and gaskets for each pump.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 General

Each pump shall be installed in accordance with the written instruction of the manufacturer and under the direct supervision of the manufacturer's representative and the impellers shall be set by the manufacturer's representative.

3.1.2 Supply Well Pump

The supply well pump base shall be designed and fabricated to provide

proper structural support for all attached equipment. The base shall supply sufficient rigidity to withstand the stresses of reasonable and competent transportation to site, off loading, installation, and operation.

3.2 PAINTING AND FINISHING

Unless otherwise specified all exposed ferrous metal not factory finished shall be painted as specified in Section 09971 EXTERIOR COATING OF EQUIPMENT. No factory finished equipment or appurtenances shall be painted except that damaged factory finishes shall be retouched in an acceptable manner with paint obtained from the manufacturer. Nameplates shall not be covered with paint but shall be cleaned and legible at completion of the work.

3.3 TESTING

3.3.1 Factory Pump Test

Factory pump performance test shall be made in conformance with AWWA E101 for the following:

- a. Running test.
- b. Sample calculation from test readings.
- c. Shop inspection.
- d. Hydrostatic test of bowl assembly.
- e. Hydrostatic test of discharge head.

3.3.2 Field Equipment Test

After installation of the pumping units and appurtenances is complete, operating tests shall be carried out to assure that the pumping installation operates properly. The Contractor shall make arrangements to have the manufacturer's representatives present when field equipment tests are made. Each pumping unit shall be given a running field test in the presence of the Contracting Officer for a minimum of 2 hours with each combination of electric motor. Each pumping unit shall be operated at its rated capacity or such other point on its head-capacity curve selected by the Contracting Officer. The Contractor shall provide an accurate and acceptable method of measuring the discharge flow. Each pump motor assembly shall be operated for a minimum of 4 hours at a point of maximum horsepower indicated on the pump head-capacity curve or such other point on the curve selected by the Contracting Officer. Provide test data on pump performance and motor performance including power draws at each performance point.

The Contractor shall conduct a sound level reading at a distance no more than 1000 feet from each supply well pump. The average noise level measured at 1000 feet shall not exceed 55 dB when measured on an "A" weighted sound level meter and according to the procedures of the Environmental Protection Agency. The results of all field equipment tests shall be detailed in the test reports.

Contractor shall coordinate with pump manufacturer and controls programmer for proper operation of pre-lubrication system. Pump manufacturer shall certify operation of system upon completion of field testing.

3.3.2.1 Correct Installation of Appurtenances

Tests shall assure that the units and appurtenances have been installed correctly, that there is no objectionable heating, vibration, or noise from any parts, and that all manual and automatic controls function properly.

3.3.2.2 Deficiencies

If any deficiencies are revealed during any tests, such deficiencies shall be corrected and the tests shall be reconducted.

3.4 MANUFACTURER'S FIELD SERVICES

The Contractor shall obtain the services of a manufacturer's representative experienced in the installation, adjustment, and operation of the equipment specified. The representative shall supervise the installing, adjusting, and testing of the equipment. Manufacturer's representative shall provide a minimum of 6 hours service and testing time per pump.

3.5 FIELD TRAINING

Contractor shall conduct a training course for the maintenance and operating staff. The training period of 8 hours normal working time shall start after the system is functionally complete but before the final acceptance tests. The training shall include all of the items contained in the operating and maintenance instructions as well as demonstrations of routine maintenance operations. The Contractor shall notify the Contracting Officer at least two weeks prior to such training.

3.6 POSTED INSTRUCTIONS

Framed instructions in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 13 - SPECIAL CONSTRUCTION

SECTION 13405

PROCESS CONTROL

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 CONTROL SYSTEM DESCRIPTION
 - 1.2.1 Control System General Requirements
 - 1.2.2 Control System Operation
 - 1.2.3 Interface with Existing Control System Points
 - 1.2.4 Symbols, Definitions, and Abbreviations
- 1.3 ENVIRONMENTAL CONDITIONS
- 1.4 SUBMITTALS
- 1.5 EQUIPMENT REQUIREMENTS
 - 1.5.1 Materials and Equipment
 - 1.5.2 Nameplates

PART 2 PRODUCTS

- 2.1 GENERAL REQUIREMENTS
- 2.2 MONITORING AND CONTROL PARAMETERS
 - 2.2.1 Transmitter
 - 2.2.2 Liquid Service
 - 2.2.3 Flow Measuring Devices
 - 2.2.3.1 Magnetic Flowmeter
 - 2.2.4 Level Instrumentation
 - 2.2.4.1 Conductance Electrode Switch(es)
 - 2.2.4.2 Submersible Hydrostatic Level Sensor
 - 2.2.5 Pressure Instrumentation
 - 2.2.5.1 Pressure Gauges
- 2.3 PROGRAMMABLE LOGIC CONTROLLER (PLC)
 - 2.3.1 PLC General Requirements
- 2.4 PLC SOFTWARE
 - 2.4.1 Control Sequences and Control Loops
 - 2.4.2 Resident Application Software
- 2.5 SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEM (SCADA) COMPUTER SYSTEM
 - 2.5.1 SCADA General Requirements
- 2.6 CONTROL PANELS
 - 2.6.1 Components
 - 2.6.1.1 Enclosures
 - 2.6.1.2 Standard Indicator Light
 - 2.6.1.3 Selector Switches
 - 2.6.1.4 Push Buttons
 - 2.6.1.5 Relays
 - 2.6.1.6 Relays, Long Distance Signal Transmission
 - 2.6.1.7 Signal Isolators
 - 2.6.1.8 Digital Indicators
 - 2.6.1.9 Terminal Blocks
 - 2.6.1.10 Alarm Horns
 - 2.6.2 Panel Assembly

- 2.6.3 Electrical Requirements
- 2.6.4 Grounding
- 2.6.5 Convenience Outlet
- 2.6.6 Panel Interior Light
- 2.6.7 Heating System
- 2.7 DATA COMMUNICATION REQUIREMENTS
- 2.8 FACTORY TEST
 - 2.8.1 Factory Test Setup
 - 2.8.2 Factory Test Procedure
 - 2.8.3 Factory Test Report

PART 3 EXECUTION

- 3.1 EQUIPMENT INSTALLATION REQUIREMENTS
 - 3.1.1 Installation
 - 3.1.1.1 Isolation, Penetrations of Buildings and Clearance from Equipment
 - 3.1.1.2 Device Mounting
 - 3.1.2 Sequences of Operation
- 3.2 INSTALLATION OF EQUIPMENT
 - 3.2.1 Control Panels
 - 3.2.2 Flow Measuring Device
 - 3.2.2.1 Electromagnetic flowmeters
 - 3.2.3 Level Instruments
 - 3.2.3.1 Conductance Electrodes
 - 3.2.3.2 Submersible Hydrostatic Level Sensor
 - 3.2.4 Pressure Instruments
 - 3.2.5 Instrument Shelters
 - 3.2.6 Output Devices
 - 3.2.7 Enclosures
 - 3.2.8 Transformers
- 3.3 WIRE, CABLE AND CONNECTING HARDWARE
 - 3.3.1 Metering and Sensor Wiring
 - 3.3.1.1 Power Line Surge Protection
 - 3.3.1.2 Sensor and Control Wiring Surge Protection
 - 3.3.1.3 Grounding
- 3.4 SOFTWARE INSTALLATION
- 3.5 FIELD TESTING AND ADJUSTING EQUIPMENT
 - 3.5.1 Testing, Adjusting and Commissioning
 - 3.5.2 Performance Verification Test (PVT)
 - 3.5.3 Endurance Test
 - 3.5.3.1 Phase I (Testing)
 - 3.5.3.2 Phase II (Assessment)
 - 3.5.3.3 Exclusions
- 3.6 MANUFACTURER'S FIELD SERVICES
- 3.7 INSTRUMENTATION AND CONTROL SYSTEM
- 3.8 FIELD TRAINING
 - 3.8.1 Preliminary Operator Training
 - 3.8.2 Additional Operator Training
 - 3.8.3 Maintenance Training
 - 3.8.4 Specialized Training
 - 3.8.4.1 Flow Meter Training

-- End of Section Table of Contents --

SECTION 13405

PROCESS CONTROL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced and are referred to in the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1 (1995) Code for Electricity Metering

ASME INTERNATIONAL (ASME)

ASME FM (1971; Sixth Edition) Fluid Meters Their Theory and Application

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.90 (1989; R 1994) Relays and Relay Systems Associated with Electric Power Apparatus

IEEE C62.41 (1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits

IEEE Std 100 (1997) IEEE Standard Dictionary of Electrical and Electronic Terms

IEEE Std 142 (1991) IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1 (1993) Industrial Control and Systems

NEMA ICS 2 (1997) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC

NEMA ICS 4 (1997) Industrial Control and Systems Terminal Blocks

NEMA 250 (1997) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST SP 250 (1995) Calibration Service Users Guide

UNDERWRITERS LABORATORIES (UL)

UL 508 (1999) Industrial Control Equipment

UL 1059 (1993; 3rd Edition) Terminal Blocks

1.2 CONTROL SYSTEM DESCRIPTION

The process instrumentation and control system shall be used to monitor and control the operation of process equipment as specified and in accordance with the sequence of control and control schematics shown on the Drawings. The control system shall provide for operator interaction, overall control system supervision, and process equipment control and monitoring. The Contractor shall provide hardware configured and sized to support expansion as specified and shown on the Drawings.

1.2.1 Control System General Requirements

The control system shall consist of field instrumentation and new panels that provide local control of pumps for supply wells 3, 4, 5, and 6. The new panels shall facilitate remote control of the pumps from the existing control system. As part of this project, the control system supplier shall modify existing applications software and existing control system components provided under previous projects. **The existing control system will be Allen Bradley Controllogix platform.**

Each new control panel shall facilitate remote control of its well pump from its associated existing reservoir site. Each well pump shall also be monitored and controlled from the existing NE 7th Avenue Reservoir master site. Many associated components have been installed in previous projects.

Such components include reservoir control panels and Remote Telemetry Units (RTUs), as well as a radio communication subsystem. As part of previous projects, application software has also been developed to monitor and control the pumps for wells 3, 4, 5, and 6.

As part of this project, each of the four new well pump control panels shall interface with the existing reservoir control panels using relays suitable for long-distance signal transmission.

Each new control panel shall include components and relay logic necessary to control a pre-lubrication sequence for its respective well pump. Prior to the start of the well pump, the sequence supplies water to lubricate the pump shaft. If a fail of the pre-lubrication sequence is sensed, disable the well pump until manually reset.

Applications software developed in previous projects to monitor and control each well pump shall be modified as necessary to meet the functional requirements as found in the WSMR Phase Contract Documents, and that are also shown on the Drawings. The control system supplier shall furnish all equipment, both hardware and software, required to re-configure the existing applications software.

In particular, provide new applications software to monitor and control Well Pump 5. This well pump can supply water to either the NE 7th Ave or the Central Avenue reservoir. Provide applications software for several

modes of automatic operation. In Auto Mode 1, Well Pump 5 supplies the Central Avenue Reservoir and replaces Well Pump 2 when it is out-of-service. Well Pump 5 is manually assigned by the operator to replace Well Pump 2. In this mode, the speed of the pump drive is adjusted to maintain constant reservoir level using proportional and integral feedback control.

In Auto Mode 2, as with Auto Mode 1, Well Pump 5 supplies the Central Avenue Reservoir and replaces Well Pump 2 when it is out-of-service. Well Pump 5 is manually assigned by the operator to replace Well Pump 2. In this mode, the speed of the pump drive is adjusted to maintain the reservoir level within a normal operating band. As level rises, the pump speed increases in linear proportion to level.

In Auto Mode 3, as with Auto Modes 1 and 2, Well Pump 5 supplies the Central Avenue Reservoir. This mode is appropriate when demand is high at the Central Avenue Reservoir. In this Mode, Well Pump 2 is the Lead pump and Well Pump 5 is the Lag Pump. The speed of Well Pump 2 is adjusted to maintain reservoir level within a normal operating band. If level falls below the normal operating band, then Well Pump 5 starts and its speed is adjusted in concert in Well Pump 2.

In Auto Mode 4, Well Pump 5 supplies the NE 7th Avenue Reservoir. In this mode, the pump operates at constant speed. The pump starts on a falling level and stops on a higher rising level.

As part of this project, in near real time, the Contractor shall fully test the remote monitoring and control of each well pump from its associated reservoir and also from the master site reservoir; i.e., the NE 7th Avenue Reservoir. The basis of testing shall be the functional requirements that are found in the WSMR Phase Contract Documents, and that are also included herein.

The Contractor shall obtain a complete set of as-built documentation of the existing control system. Such as-built documentation will facilitate the Contractor in connecting the new panels to the existing control system and will assist the Contractor in performing the test activities described above.

1.2.2 Control System Operation

The control system provided under this specification is an analog system. It shall interface with an existing control system that includes long-distance signal transmission relays and programmable logic controllers at the reservoir sites. At the NE 7th Ave Reservoir master site, the existing control system also provides supervisory control of operational sequences for well pumps and panels provided under this Contract. Instruments and process equipment provided under this Contract shall interface with the existing control system. Data input to the existing control system shall be obtained by instruments and process equipment provided as part of this Contract. All required setpoints, settings, alarm limits, and sequences of operation shall be as per the database/ settings tables or sequences of operation shown on the WSMR Phase Drawings, as well as these Contract Drawings. During startup, the Contractor shall modify the above parameters as necessary for proper operation. The Contractor shall test the sequence of operations described above in near-real time using real process variables.

1.2.3 Interface with Existing Control System Points

The Contractor shall interface Contractor-furnished components with the existing Input/Output (I/O) points of the existing control system. The existing I/O points are listed in the I/O Summary Table shown on the Drawings. Such Contractor-furnished components include field instruments, status lights, selector switches, control panels, pump Motor Control Centers (MCCs) and pump Adjustable Frequency Drives (AFDs). Each existing analog output (AO), analog input (AI), digital output (DO) and digital input (DI) represents a "point" that the Contractor shall interface with Contractor-furnished components. The Contractor shall also verify the existing I/O by reviewing as-built documentation of previous projects.

Several additional I/O points may be required to meet the functional requirements, even though these I/O points have not been specified in previous projects. The Contractor shall provide these additional I/O points. The Contractor may use spare points furnished under previous projects. If spare points are not available, the Contractor shall provide the required I/O modules. The Contractor shall provide all additional required internal panel wiring.

1.2.4 Symbols, Definitions, and Abbreviations

Symbols, definitions, and engineering unit abbreviations shall conform to IEEE Std 100, as applicable.

1.3 ENVIRONMENTAL CONDITIONS

Capacity and design of the air moving equipment and accessories shall be suitable for 24-hour full load service and shall meet the following criteria.

a. Location

Latitude	33.43.
Longitude	112.02.
Altitude (above MSL)	1106 ft.
Seismic parameters	1.

b. Heating Degree Days 488.

c. Winter Design Temperatures

Outside Air (Ventilation)	108 (99%).
Outside Air (Heat Loss)	107 (97.5%).
Inside Air Temperature	75 degrees F.

d. Cooling Degree Days 34,521.

e. Summer Design Temperatures

Outside Air (Ventilation)	108 DB (1%).
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Outside Air (Ventilation) 70 MCWB (1%).
 Outside Air (Heat Minimum) 31 DB (2.5%).
 Outside Air (Heat Minimum) 34 (2.5%).
 Inside Air Temperature 70 degrees F.

f. Contaminants: dust.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330, SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation; G, RE
 Wiring; G, RE

Detail Drawings containing complete piping, wiring, schematic, flow diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Piping and Instrumentation (P&ID) Drawings (prepared using industry recognized device symbols, clearly defined and describing piping designations to define the service and materials of individual pipe segments and instrument tags employing Instrument Society of America suggested identifiers).

Drawings shall include, as appropriate: product specific catalog cuts; a drawing index; a list of symbols; a series of Drawings for each control system using abbreviations, symbols, nomenclature and identifiers as shown; valve schedules.

SD-03 Product Data

Instrumentation and Control System; G, RE

Manufacturer's descriptive and technical literature, performance charts and installation instructions. Product specific catalog cuts shall be in booklet form, indexed to the unique identifiers, and shall consist of data sheets that document compliance with the specification. Where multiple components are shown on a catalog cut, the application specific component shall be marked.

Meters and Sensors; G, RE

Manufacturer's descriptive and technical literature, catalog cuts, performance charts and installation instructions.

Training Manual; G, RE

Instruction manual within 180 days of Notice to Proceed.

Performance Verification Test (PVT); G, RE

The performance verification test procedure; it shall refer to the actions and expected results to demonstrate that the control system performs in accordance with the sequence of control. A list of the equipment to be used during the testing shall be included. The list shall also include manufacturer's name, model number, equipment function, the date of the latest calibration and the results of the latest calibration.

Factory Test Procedure; G, RE

Documentation containing factory test methods and procedures.

SD-06 Test Reports

Factory Test Report; G, RE
 Testing, Adjusting and Commissioning; G, RE
 Performance Verification Test(PVT); G, RE
 Endurance Test; G, RE

Test results in report format.

SD-07 Certificates

Sensor and Control Wiring; G, RE

Certified test results for surge protection.

Testing of Ground Rods; G, RE

Certification stating that the test was performed in accordance with IEEE Std 142.

SD-10 Operation and Maintenance Data

Instrumentation and Control System; G, RE

Six complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown. The instructions shall include layout, wiring and control diagrams of the system as installed. The instructions shall include the manufacturer's name, model number, service manual, parts list and a brief description of all equipment and their basic operating features.

Six complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs and trouble shooting guides.

1.5 EQUIPMENT REQUIREMENTS

1.5.1 Materials and Equipment

Materials and equipment shall be standard unmodified products of a manufacturer regularly engaged in the manufacturing of such products. Units of the same type of equipment shall be products of a single manufacturer. Items of the same type and purpose shall be identical and supplied by the same manufacturer, unless replaced by a new version approved by the Government.

1.5.2 Nameplates

Each major component of equipment shall have the manufacturer's name and address, and the model and serial number in a conspicuous place. Laminated plastic nameplates shall be provided for equipment devices and panels furnished. Each nameplate shall identify the device, such as pump "P-1" or valve "VLV-402". Labels shall be coordinated with the schedules and the process and instrumentation Drawings. Laminated plastic shall be 1/8 inch thick, white with black center core. Nameplates shall be a minimum of 1 by 3 inches with minimum 1/4 inch high engraved block lettering. Nameplates for devices smaller than 1 by 3 inches shall be attached by a nonferrous metal chain. All other nameplates shall be attached to the device.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

Equipment located outdoors, not provided with climate controlled enclosure, shall be capable of operating in the ambient temperature range indicated in paragraph ENVIRONMENTAL CONDITIONS, unless otherwise specified. Electrical equipment will conform to Section 16050 BASIC ELECTRICAL MATERIALS AND METHODS. Equipment and wiring must be in accordance with NFPA 70, with proper consideration given to environmental conditions such as moisture, dirt, corrosive agents, and hazardous area classification.

2.2 MONITORING AND CONTROL PARAMETERS

The control system shall be complete including Meters and Sensors, field preamplifiers, signal conditioners, offset and span adjustments, amplifiers, transducers, transmitters, control devices, engineering units conversions and algorithms for the applications; and shall maintain the specified end-to-end process control loop accuracy from sensor to display and final control element. Control equipment shall be powered by a 120 vAc, single phase, 60 Hz power source, with local transformers included as needed for signal transmission and subsystem operation. Connecting conductors shall be suitable for installed service. Enclosures shall be rated for NEMA 4X.

2.2.1 Transmitter

Unless indicated otherwise, each sensor shall be provided with a transmitter, selected to match the sensor. Except where specifically indicated otherwise on the Drawings, the transmitter shall be provided with a four digit or analog visual display of the measured parameter and shall provide a 4 to 20 mA_{dc} output signal proportional to the level of the measured parameter. Accuracy shall be plus or minus 1 percent of full scale reading with output error not exceeding plus or minus 0.5 percent of full scale. Transmitter shall be located where indicated, mounted integrally with the sensor, pipe mounted, wall mounted or installed in the control panel. The distance between the sensor and transmitter shall not exceed the manufacturer's recommendation. Field preamplifiers and signal conditioners shall be included when necessary to maintain the accuracy from sensor to the programmable logic controller or recorder.

2.2.2 Liquid Service

Sensors and meters in liquid service shall be rated for continuous duty service at fluid approach velocities from 2.5 ft/s to 10 ft/s with

correspondingly higher constriction velocities over a fluid temperature range from 32 degrees F to 105 degrees F at pressures up to 150 psi gage.

2.2.3 Flow Measuring Devices

2.2.3.1 Magnetic Flowmeter

Magnetic flowmeter shall be non-intrusive and shall measure fluid flow through the use of a self generated magnetic field. The magnetic flow element shall be encapsulated in type 300 stainless steel. Flowmeter shall be capable of measuring clean or dirty flow up to a maximum flow velocity of 10 fps. The metering tube shall be constructed of 316 stainless steel. The maximum pressure drop across the meter and appurtenances shall be 5 psi at the maximum flow rate.

2.2.4 Level Instrumentation

Pressure taps shall incorporate appropriate snubbers. Relays and housing shall be intrinsically safe or explosion proof as required by the NFPA hazard rating for compatibility with the contents of the tank or sump.

2.2.4.1 Conductance Electrode Switch(es)

Conductance electrodes for use in liquid systems shall consist of electrode(s), electrode holder, relays, relay enclosure, and cabling. Electrode holder shall be 316 stainless steel of mounting type suitable for the application. Electrodes shall be rod type constructed of 316 stainless steel, unless otherwise noted. Length shall be as required for the noted setpoints. Provide quantity of electrodes as required to monitor the noted setpoints. In addition, provide a grounding electrode. Relays shall be solid state and housed in a NEMA 7, explosion-proof enclosure. For each noted setpoint, provide at least one set of SPDT contacts. For each rod-type electrode, provide a PVC sheath and a spacer. Provide all required interconnecting cable.

2.2.4.2 Submersible Hydrostatic Level Sensor

The sensor shall be submersible and shall provide continuous level measurement of liquid by sensing hydrostatic head. The sensor shall include the sensor itself, interconnecting cable, a sensor termination enclosure and ancillaries. Zero reference value and process range shall be as noted. Accuracy shall be at least 0.1 percent of full scale. Long term stability shall typically be plus or minus 0.1 percent full scale / year. Operating temperature range shall be between minus 4 degrees F and plus 140 degrees F. The sensor shall be protected against overpressure up to 4 times working pressure. Sensor shall include silicon sensing element and titanium or 316 stainless steel pressure module assembly. Provide interconnecting cable of required length with integral vent tube. Sensor termination enclosure shall be rated NEMA 4X, and shall include a desiccant module and micro filter. Provide a 2-inch pipe mounting kit.

2.2.5 Pressure Instrumentation

Pressure taps shall incorporate appropriate snubbers.

2.2.5.1 Pressure Gauges

Sensing element of the pressure gauge shall be Bourdon tube. Pressure gauge accuracy shall be plus or minus 0.50 percent of full scale. Scale

range shall be as noted. Dial diameter shall be 4-1/2-inch. Gauge front shall be liquid-filled with glycerin. Case material shall be black phenolic plastic with a phosphor-bronze element. Provide gauge with a brass pulsation dampener. Socket shall be brass. Case type shall be solid front. Process connection shall be lower stem mounting with a 1/2-inch NPT threaded connection.

2.3 PROGRAMMABLE LOGIC CONTROLLER (PLC)

2.3.1 PLC General Requirements

PLCs shall not be provided for this project. The Contractor shall provide PLC parts and shall modify the existing PLC hardware as necessary to facilitate connection of all components provided under this Contract with the existing control system. The Contractor shall furnish all tools required for these modifications. If required, provide any additional I/O modules.

2.4 PLC SOFTWARE

The PLC operating system software and applications software have been developed as part of the previous project. As part of this project, the Contractor shall modify the existing PLC and Operator Interface Unit applications software as required to meet the functional requirements. The Contractor shall obtain as-built documentation of the control system to facilitate this effort. As a minimum, the Contractor shall furnish a Portable Tester/Workstation and Communication and Programming Device to facilitate these programming modifications.

Portable Tester/Workstation: A portable tester/workstation shall be provided and shall be connectable to any PLC. The portable tester/workstation shall consist of a portable computer with a nominal 10 inch active color matrix liquid crystal display, capable of displaying up to 256 colors at a minimum resolution of 640 x 480 pixels, 64 bit microprocessor operating at a minimum of 200 MHz. The portable tester/workstation shall have, as a minimum, 8 GB hard drive, 32 megabytes of memory, integral pointing device, serial and parallel ports, color VGA video port for an external color monitor, 3.5 inch floppy disk drive, modem, PCMCIA type 3 slot, rechargeable battery, battery charger and a compatible network adapter. The portable tester/workstation shall be provided with the proper cables, connectors, adapters and software required to connect to and be compatible with the PLCs. Connection may be made directly to the PLCs or to the communications network. The tester/workstation shall be capable of performing all workstation functions contingent on proper password level.

Communication and Programming Device: A hand-held communication and programming device shall be provided. The communication and programming device shall connect to the PLC directly for readout of variables, override, control, servicing, troubleshooting and adjustment of control parameters. The device shall be provided with all necessary cables, connectors and adapters to allow connection to the PLC. The device shall communicate in English language for inquiry, reporting and programming purposes.

2.4.1 Control Sequences and Control Loops

Existing specific functions, which have been configured in a previous project, are noted in the control sequence table that is included as a

Drawing. The Contractor shall verify these functions by reviewing as-built documentation. As dictated by actual field conditions encountered during startup, the Contractor shall modify the existing specific functions as required.

2.4.2 Resident Application Software

The Contractor shall modify existing resident applications PLC programs to achieve the sequences of operation, parameters, constraints, and interlocks necessary to provide control of the process systems connected to the control system. Test all existing and modified PLC software in real time using real process variables.

2.5 SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEM (SCADA) COMPUTER SYSTEM

2.5.1 SCADA General Requirements

The existing control system includes a SCADA portion that allows operations staff to monitor and provide supervisory control of all well and reservoir sites from a master site. The master site is the NE 7th Ave reservoir. The existing control system also includes a development version of SCADA server software. It is assumed that the Contractor will be allowed use of this development software. If necessary, re-configure existing computer graphic screens to achieve the desired control sequences. Test all existing and modified SCADA graphics in real time using real process variables. In addition and as necessary, modify additional SCADA outputs such as trend displays and reports.

The Contractor may elect to re-configure the existing computer graphic screens offline using the Contractor's own computers. Such computers shall have video drives similar to the runtime machines. This is to prevent scalability problems.

An auto-dialer has been provided as part of the previous project. Modify its software as necessary to automatically dial critical alarms to several phone numbers assigned by the Owner. Configure telephone numbers to be called and their order of calling.

2.6 CONTROL PANELS

2.6.1 Components

2.6.1.1 Enclosures

The enclosure for each control panel shall conform to the requirements of NEMA 250 for the types specified. Finish color shall be the manufacturer's standard, unless otherwise indicated. Damaged surfaces shall be repaired and refinished using original type finish. Enclosures for installation in mechanical equipment rooms shall be Type 4; those for installation in clean, dry indoor occupied space may be Type 1; other locations shall be as otherwise specified or shown. Enclosures for equipment installed outdoors shall be Type 4 or as shown. Enclosures for installation in a corrosive environment shall be Type 4X and shall be constructed of stainless steel. Painted steel shall not be allowed for use in a corrosive environment. Enclosure shall be provided with a single, continuously hinged exterior door with print pocket, 3-point latching mechanism and key lock and a single, continuously hinged interior door.

2.6.1.2 Standard Indicator Light

Indicator lights shall comply with NEMA ICS 1, NEMA ICS 2 and UL 508. Lights shall be heavy duty, round and shall mount in a 0.875 inch mounting hole. Lights shall be NEMA 4X, watertight and corrosion-resistant, unless otherwise noted. Indicator lights shall be LED type and shall operate at 120 vAc or 24 vDc. Long life bulbs shall be used. Indicator light shall be provided with a legend plate labeled as shown on the Drawings. Lens color shall be as indicated on the Drawings. Lights shall be push to test (lamp) type.

2.6.1.3 Selector Switches

Selector switches shall comply with NEMA ICS 1, NEMA ICS 2 and UL 508. Selector switches shall be heavy duty, round and shall mount in a 0.875 inch mounting hole. Selector switches shall be NEMA 4X, watertight and corrosion-resistant, unless otherwise noted. The number of positions shall be as indicated on the Drawings. Switches shall be non-illuminated. Switches shall be rated for 600 volts, 10 amperes continuous. Selector switches shall be provided with a legend plate labeled as shown on the Drawings. Where indicated or required, dual auxiliary contacts shall be provided for the automatic position to provide position sensing at the central station or workstation. Auxiliary contacts shall be rated for 120 vAc, 1A as a minimum. Where indicated on the Drawings, switches shall be key operated. All keys shall be identical.

2.6.1.4 Push Buttons

Push buttons shall comply with NEMA ICS 1, NEMA ICS 2 and UL 508. Push buttons shall be heavy duty, round and shall mount in a 0.875 inch mounting hole. Push buttons shall be NEMA 4X, watertight and corrosion-resistant, unless otherwise noted. The number and type of contacts shall be as indicated on the Drawings or required by the Sequence of Control. Push buttons shall be rated for 600 volts, 10 amperes continuous. Push buttons shall be provided with a legend plate labeled as shown on the Drawings.

2.6.1.5 Relays

Relays shall comply with IEEE C37.90. Relays shall be as required by the Sequence of Operations. Relay coil shall be 120 vAc and shall be provided with matching mounting socket. Power consumption shall not be greater than 3 watts.

2.6.1.6 Relays, Long Distance Signal Transmission

Relays suitable for long-distance signal transmission shall be solid state and shall be liquid epoxy-filled. Input to output isolation shall be 4000 volts minimum. Turn-on and turn-off times shall be ½ cycle maximum. Relays shall have zero voltage turn-on with an allowable signal voltage of 32 volts DC. Signal pick-up and drop-out voltages shall be 3 Vdc and 1 Vdc, respectively. Nominal signal input resistance shall be 1000 ohms. Relays shall be able to withstand a 1-cycle surge of 110 amps. Contact ratings shall be 10 amps at 120-volts AC.

2.6.1.7 Signal Isolators

Each isolator shall provide three-way isolation of a 4-20 mA DC input signal, the 4-20 mA DC output signal, and the external power supply. Include an isolator-mounting bracket. Provide three-way isolation for common mode voltages up to 250 Vac or 354V DC of ground on a continuous

basis. Unit shall be able to withstand 1500 Vac dielectric strength test for 60 seconds without breakdown. Accuracy shall be plus or minus 0.1 percent of output span. Unit shall be capable of operating over a temperature range of minus 13 degrees F to plus 185 degrees F. Input impedance shall be 75 ohms. Output shall drive loads of at least 650 ohms. Power shall be 120 Vac.

2.6.1.8 Digital Indicators

Each digital indicator shall provide a 4-digit LED display of an analog signal. Unit shall be front panel mounted and rated NEMA 4X. Indicator shall operate over a temperature range of zero to 65 degrees Centigrade. Accuracy shall be 0.05 percent of calibrated span with a display update rate of less than 5 seconds. Process input shall be field selectable between plus or minus 20 mA DC and plus or minus 10 V DC. Decimal point shall be configurable up to 3 decimal places. LED digits shall be nominally 1/2-inch high. Input impedance for the current range shall nominally be 50 ohms.

2.6.1.9 Terminal Blocks

Terminal blocks shall comply with NEMA ICS 4 and UL 1059. Terminal blocks for conductors exiting control panels shall be two-way type with double terminals, one for internal wiring connections and the other for external wiring connections. Terminal blocks shall be made of bakelite or other suitable insulating material with full deep barriers between each pair of terminals. A terminal identification strip shall form part of the terminal block and each terminal shall be identified by a number in accordance with the numbering scheme on the approved wiring diagrams.

2.6.1.10 Alarm Horns

Alarm horns shall be provided where indicated on the Drawings. Horns shall be vibrating type and shall comply with UL 508. Horns shall provide 100 dB at 10 feet. Exterior mounted horns shall be weather proof by design or shall be mounted in a weather proof enclosure that does not reduce the effectiveness of the horn.

2.6.2 Panel Assembly

Control panels shall be factory assembled and shipped to the jobsite as a single unit. Panels shall be fabricated as indicated and devices shall be mounted as shown or required. Each panel shall be fabricated as a bottom-entry connection point for control system electrical power, control system wiring and radio transmission cable.

2.6.3 Electrical Requirements

Each panel shall be powered by a dedicated 120 volts AC sized as recommended by the equipment manufacturer, and a disconnect switch located inside the panel. Wiring shall terminate inside the panel on terminal blocks. Electrical work shall be as specified in Section 16050 BASIC ELECTRICAL MATERIALS AND METHODS and as shown on the Drawings.

2.6.4 Grounding

Control panel enclosures shall be equipped with a solid copper ground bus or equivalent. The ground bus shall be securely anchored to the enclosure so as to effectively ground the entire structure. Clamp-type terminals

sized large enough to carry the maximum expected current shall be provided on the ground bus for grounding cables. Where a definite circuit ground is required, a single wire not less than #10 AWG shall run independently to the panel ground bus and shall be fastened to the ground bus with a bolted terminal lug. Cases of instruments, relays and other devices shall be effectively grounded through the enclosures steel structure unless otherwise indicated. Insulated wiring having a continuous rated current of not less than the circuit fuse rating shall be used for grounding. Grounding terminals of power receptacles shall be solidly grounded to the panel enclosure.

2.6.5 Convenience Outlet

A 120 volt ac, 20 amp, ground fault interruption (GFI) type duplex convenience outlet shall be provided inside the panel. The outlet circuit shall be separate from the panel power circuit.

2.6.6 Panel Interior Light

Each control panel shall be provided with a 40 watt fluorescent light. The light shall be operated by a manual on-off switch mounted on the interior door of the enclosure. The light shall be powered by the same circuit as the convenience outlet.

2.6.7 Heating System

Where indicated, control panel(s) shall be provided with a thermostatically controlled electric heater capable of maintaining an enclosure temperature of 40 degrees F when continuously exposed to an ambient temperature of 20 degrees F.

2.7 DATA COMMUNICATION REQUIREMENTS

Control system data communications shall support the specified functions and control system configuration shown on the Drawings.

2.8 FACTORY TEST

The control system shall be tested at the factory prior to shipment. Certification of a comprehensive Y2K compliance testing program is required. Written notification of planned testing shall be given to the Government at least 21 days prior to testing, and in no case shall notice be given until after the Contractor has received written Government approval of the test procedures.

At the factory, test each well control panel. Simulate all signal interfaces with existing panels that are part of the existing control system.

2.8.1 Factory Test Setup

The Contractor shall assemble and integrate the factory test setup as specified to prove that performance of the system satisfies all requirements of this project, including system communications requirements, in accordance with the approved test procedures. The factory test shall take place during regular daytime working hours on weekdays. Equipment used shall be the same equipment that is to be delivered to the site. The factory test setup shall include the following:

Factory Test

control panel	not less than two control panels: at least one of each type used in the system plus at least one per DTS type
test set	one of each type
portable tester	one of each type
communications circuits	one of each type and speed to be utilized in the proposed system including bridges, modems, encoder/decoders, transceivers and repeaters.
surge protection equipment	for power, communications, I/O functions and networks
I/O functions	sufficient to demonstrate the I/O capability and system normal operation
software	software required for proper operation of the proposed system including application programs and sequences of operation

2.8.2 Factory Test Procedure

Test procedures shall define the tests required to ensure that the system meets technical, operational, and performance requirements. The test procedures shall define location of tests, milestones for the tests, and identify simulation programs, equipment, personnel, facilities, and supplies required. The test procedures shall provide for testing all control system capabilities and functions specified and shown. The procedures shall cover actual equipment and sequences to be used by the Contractor for the specified project and shall consist of detailed instructions for test setup, execution, and evaluation of test results. The test reports shall document results of the tests. Reports shall be delivered to the Government within 7 days after completion of each test. Surge testing need not be conducted if the Contractor can provide acceptable documented proof that such testing has been satisfactorily demonstrated to the Government with identical surge protection applied. The procedures shall include the following:

Test Procedure

equipment	block diagram
hardware and software	descriptions
commands	operator commands
I/O functions	test database points with failure modes
passwords	required for each operator access level
each type of digital and analog point in the test database	description

Test Procedure

test equipment	list
surge protection	circuit diagrams
inputs required (I/O point values and status) and corresponding expected results of each set of input values	for each application program
default values	for the application program inputs not implemented or provided for in the contract documents for the application programs to be tested.

2.8.3 Factory Test Report

Original copies of data produced during the factory test, including results of each demonstration procedure, shall be delivered to the Government at the conclusion of the test, prior to Government approval of the factory test. The report shall be arranged so that commands, responses, and data acquired are correlated to allow logical interpretation of the data.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION REQUIREMENTS

3.1.1 Installation

The Contractor shall install system components and appurtenances in accordance with the manufacturer's instructions and shall provide necessary interconnections, services, and adjustments required for a complete and operable system. Instrumentation and communication equipment and cable grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation. The Contractor shall adjust or replace devices not conforming to the required accuracies. Factory sealed devices shall be replaced (rather than adjusted). Wiring in exposed areas, including low voltage wiring, shall be installed in metallic raceways or EMT conduit as specified in Section 16110 RACEWAYS. Wiring in air plenum areas installed without conduit shall be plenum-rated per NFPA 70.

3.1.1.1 Isolation, Penetrations of Buildings and Clearance from Equipment

Dielectric isolation shall be provided where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exteriors shall be made watertight. Holes in concrete, brick, steel and wood walls shall be drilled or core drilled with proper equipment; conduits installed through openings shall be sealed with materials which are compatible with existing materials. Openings shall be sealed with materials which meet the requirements of NFPA 70. Installation shall provide clearance for control-system maintenance. Control system installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.1.1.2 Device Mounting

Devices shall be installed in accordance with manufacturers' recommendations and as shown. Control devices to be installed in piping

shall be provided with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Any deviations shall be documented by the Contractor and submitted to the Government for approval prior to mounting.

Damaged insulation shall be replaced or repaired after devices are installed to match existing work. Damaged galvanized surfaces shall be repaired by touching up with zinc paint.

3.1.2 Sequences of Operation

The Contractor shall study the operation and sequence of equipment controls, as a part of the conditions report, and note any deviations from the described sequences of operation. The sequence of operations are provided by the existing control system as shown on the Drawings. The Contractor shall verify these sequence of operations by reviewing as-built documentation of the existing control system. The Contractor shall make necessary adjustments to make the equipment operate in an optimum manner and shall fully document changes made.

3.2 INSTALLATION OF EQUIPMENT

The Contractor shall install equipment as specified, as shown and as required in the manufacturer's instructions for a complete and fully operational control system.

3.2.1 Control Panels

Control panels shall be located as indicated on the Drawings. Devices located in the control panels shall be as shown on the Drawings or as needed to provide the indicated control sequences.

3.2.2 Flow Measuring Device

Fluid flow instruments shall be installed in accordance with ASME FM, unless otherwise indicated in the specification. The minimum straight unobstructed piping for the flowmeter installation shall be 10.0 pipe diameters upstream and 5.0 pipe diameters downstream. Meters for gases and vapors shall be installed in vertical piping, and meters for liquids shall be installed in horizontal piping, unless otherwise recommended by the manufacturer or indicated in the specifications.

3.2.2.1 Electromagnetic flowmeters

Electromagnetic flowmeters shall be installed in accordance with the manufacturer's published instructions.

3.2.3 Level Instruments

3.2.3.1 Conductance Electrodes

Switches shall be installed in accordance with manufacturer's published instructions. For multiple electrodes, provide spacers to enhance support.

3.2.3.2 Submersible Hydrostatic Level Sensor

Submersible hydrostatic level sensors shall be installed in accordance with the manufacturer's published instructions.

3.2.4 Pressure Instruments

Pressure sensors and pressure transducers shall be verified by calibration.

All pressure taps shall incorporate appropriate snubbers. Pressure sensors and pressure switches shall have valves for isolation, venting, and taps for calibration. Pressure switches and pressure transducers installed on liquid or steam lines shall have drains. Pressure transducers, differential pressure sensors and differential pressure switches shall have nulling valves. Pressure switches shall be adjusted to the proper setpoint and shall be verified by calibration. Switch contact ratings and duty shall be selected for the application.

3.2.5 Instrument Shelters

Instrument shelters shall be installed in the location shown with the bottom 4.0 feet above the supporting surface using legs and secured rigidly to minimize vibrations from winds. Instrument shelters shall be oriented with door facing North. Instruments located in shelters shall be mounted in the 3-dimensional center of the open space of the shelter.

3.2.6 Output Devices

Output devices (transducers, relays, contactors, or other devices) which are not an integral part of the control panel, shall be mounted in an enclosure mounted adjacent to the control panel, unless otherwise shown. Where H-O-A and/or override switches on the Drawings or required by the control sequence, the switches shall be installed so that the control system controls the function through the automatic position and other controls work through the hand position.

3.2.7 Enclosures

All enclosure penetrations shall be from the bottom of the enclosure, and shall be sealed to preclude entry of water using a silicone rubber sealant.

3.2.8 Transformers

Transformers for control voltages below 120 vAc shall be fed from the nearest power panel or motor control center, using circuits provided for the purpose. The Contractor shall provide a disconnect switch on the primary side and a fuse on the secondary side. Transformers shall be enclosed in a steel cabinet with conduit connections.

3.3 WIRE, CABLE AND CONNECTING HARDWARE

3.3.1 Metering and Sensor Wiring

Metering and sensor wiring shall be installed in accordance with the requirements of ANSI C12.1, NFPA 70, Section 16120, CONDUCTORS.

3.3.1.1 Power Line Surge Protection

Control panels shall be protected from power line surges. Protection shall meet the requirements of IEEE C62.41. Fuses shall not be used for surge protection.

3.3.1.2 Sensor and Control Wiring Surge Protection

Digital and analog inputs shall be protected against surges induced on control and sensor wiring. Digital and analog outputs shall be protected

against surges induced on control and sensor wiring installed outdoors and as shown. Fuses shall not be used for surge protection. Surge protection devices located external of panels shall be housed in NEMA 4 enclosures. The inputs and outputs shall be tested in both the normal and common mode using the following two waveforms: The first waveform shall be 10 microseconds by 1000 microseconds with a peak voltage of 1500 volts and a peak current of 60 amperes. The second waveform shall be 8 microseconds by 20 microseconds with a peak voltage of 1000 volts and a peak current of 500 amperes.

3.3.1.3 Grounding

Each surge protection device located within a panel enclosure shall be grounded to the panel ground bus by means of a dedicated ground wire. The ground wire shall be not less than #10 AWG and shall be fastened to the ground bus with a bolted terminal lug. Each surge protection device located outside a building shall be grounded to the local ground rod by means of a # 6 AWG bare solid copper ground. Each surge protection device located indoors but external of a panel shall be grounded to the nearest ground bus by means of a #6 AWG bare solid copper ground. Grounding to conduits is not acceptable.

3.4 SOFTWARE INSTALLATION

The Contractor shall adjust, tune, debug, and commission all existing software and parameters for controlled systems to assure proper operation in accordance with the sequences of operation and database tables. Existing software is that associated with the existing control system, and includes PLC, OIU, and SCADA software.

3.5 FIELD TESTING AND ADJUSTING EQUIPMENT

The Contractor shall provide personnel, equipment, instrumentation, and supplies necessary to perform site testing. The Government will witness the PVT, and written permission shall be obtained from the Government before proceeding with the testing. Original copies of data produced, including results of each test procedure, during PVT shall be turned over to the Government at the conclusion of each phase of testing prior to Government approval of the test. The test procedures shall cover actual equipment and functions specified for the project. The test procedures shall cover all existing control functions related to this project. These existing control functions must be tested in near-real time with real process variables and actual process equipment.

3.5.1 Testing, Adjusting and Commissioning

After successful completion of the factory test as specified, the Contractor will be authorized to proceed with the installation of the system equipment, hardware, and software. Once the installation has been completed, the Contractor shall test, adjust, and commission each control loop and system in accordance with NIST SP 250 and shall verify proper operation of each item in the sequences of operation, including hardware and software. The Contractor shall calibrate field equipment, including control devices, adjust control parameters and logic (virtual) points including control loop setpoints, gain constants, constraints, and verify data communications before the system is placed online. Testing of Ground Rods installed by the Contractor shall be as specified in IEEE Std 142. The Contractor shall calibrate each instrumentation device connected to the control system control network by making a comparison between the reading

at the device and the display at the workstation, using a standard at least twice as accurate as the device to be calibrated. The Contractor shall check each control point within the control system control network by making a comparison between the control command at the central station and field-controlled device. The Contractor shall deliver trend logs/graphs of all points showing to the Government that stable control has been achieved.

Points on common systems shall be trended simultaneously. One log shall be provided showing concurrent samples taken once a minute for a total of 4 hours. The Contractor shall verify operation of systems in the specified failure modes upon Control system network failure or loss of power, and verify that systems return to control system control automatically upon a resumption of control system network operation or return of power. The Contractor shall deliver a report describing results of functional tests, diagnostics, calibrations and commissioning procedures including written certification to the Government that the installed complete system has been calibrated, tested, adjusted and commissioned and is ready to begin the PVT. The report shall also include a copy of the approved PVT procedure.

3.5.2 Performance Verification Test (PVT)

The Contractor shall prepare test procedures for the PVT. The test procedure shall describe all tests to be performed and other pertinent information such as specialized test equipment required and the length of the PVT. The test procedures shall cover all existing control functions related to this project. These existing control functions must be tested in near-real time with real process variables and actual process equipment. The test procedures shall explain, in detail, step-by-step actions and the expected results, to demonstrate compliance with all the requirements of the Drawings and this specification. The test procedure shall be site specific and based on the inputs and outputs, required calculated points and the sequence of control. The Contractor shall demonstrate that the completed Control system complies with the contract requirements. All physical and functional requirements of the project including communication requirements shall be demonstrated and shown. The Contractor shall demonstrate that each system operates as required in the sequence of operation. The PVT as specified shall not be started until after receipt by the Contractor of written permission by the Government, based on the Contractor's written report including certification of successful completion of testing, adjusting and commissioning as specified, and upon successful completion of training as specified. Upon successful completion of the PVT, the Contractor shall deliver test reports and other documentation as specified to the Government.

3.5.3 Endurance Test

The Contractor shall use the endurance test to demonstrate the overall system reliability of the completed system. The endurance test shall be conducted in phases. The endurance test shall not be started until the Government notifies the Contractor in writing that the PVT is satisfactorily completed, training as specified has been completed, outstanding deficiencies have been satisfactorily corrected, and that the Contractor has permission to start the endurance test. The Contractor shall provide an operator to man the system 8 hours per day during daytime operations, including weekends and holidays, during Phase I endurance testing, in addition to any Government personnel that may be made available. The Government may terminate testing at any time when the system fails to perform as specified. Upon termination of testing by the Government or by the Contractor, the Contractor shall commence an assessment period as described for Phase II. Upon successful completion of

the endurance test, the Contractor shall deliver test reports and other documentation, as specified, to the Government prior to acceptance of the system.

3.5.3.1 Phase I (Testing)

The test shall be conducted 24 hours per day, 7 days per week, for 7 consecutive calendar days, including holidays, and the system shall operate as specified. The Contractor shall make no repairs during this phase of testing unless authorized by the Government in writing.

3.5.3.2 Phase II (Assessment)

After the conclusion of Phase I, the Contractor shall identify failures, determine causes of failures, repair failures, and deliver a written report to the Government. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which testing should be resumed. After delivering the written report, the Contractor shall convene a test review meeting at the job site to present the results and recommendations to the Government. The meeting shall not be scheduled earlier than 5 business days after receipt of the report by the Government. As a part of this test review meeting, the Contractor shall demonstrate that failures have been corrected by performing appropriate portions of the performance verification test. The Government reserves the right to cancel the test review meeting if no failures or deficiencies occur during the Phase I testing. If the Government chooses to do so, the Contractor will be notified in writing. Based on the Contractor's report and the test review meeting, the Government will determine if retesting is necessary and the restart point. The Government reserves the right to require that the Phase I test be totally or partially rerun. The Contractor shall not commence any required retesting until after receipt of written notification by the Government. After the conclusion of any retesting which the Government may require, the Phase II assessment shall be repeated as if Phase I had just been completed.

3.5.3.3 Exclusions

The Contractor will not be held responsible for failures resulting from the following: Outage of the main power supply in excess of the capability of any backup power source, provided that the automatic initiation of all backup sources was accomplished and that automatic shutdown and restart of the control system performed as specified. Failure of a Government furnished communications link, provided that the PLC automatically and correctly operates in the stand-alone mode as specified, and that the failure was not due to Contractor furnished equipment, installation, or software. Failure of existing Government owned equipment, provided that the failure was not due to Contractor furnished equipment, installation, or software.

3.6 MANUFACTURER'S FIELD SERVICES

The Contractor shall obtain the services of a manufacturer's representative experienced in the installation, adjustment, and operation of the equipment specified. The representative shall supervise the installing, adjusting, and testing of the equipment.

3.7 INSTRUMENTATION AND CONTROL SYSTEM

Control Drawings, reproducible, with corresponding CADD files, shall be

provided for equipment furnished and for interfaces to equipment at each respective equipment location. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation and procedures for safely starting and stopping the system manually shall be prepared in typed form, reproducible, with corresponding word processor files and posted beside the diagrams. Diagrams and instructions shall be submitted prior to posting.

3.8 FIELD TRAINING

Field training oriented to the specific system shall be provided for designated personnel. A copy of the training manual for each trainee plus two additional copies shall be delivered to the Contracting Officer. Manuals shall include an agenda, the defined objectives for each lesson, and a detailed description of the subject matter for each lesson. The Contractor shall furnish audiovisual equipment and other training supplies and materials. Copies of the audiovisuals shall be delivered with the printed training manuals. The Government reserves the right to videotape training sessions for later use. A training day is defined as 8 hours of classroom instruction, excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. Approval of the Contractor's training schedule shall be obtained from the Government at least 30 days before the training.

3.8.1 Preliminary Operator Training

Prior to the start of field testing, preliminary operator training shall be taught at the project site for 1 training day. Upon completion of this course, each student, using appropriate documentation, should be able to perform elementary operations with guidance and describe the general hardware architecture and functionality of the system. This course shall include: general system architecture; functional operation of the system, including workstations; operator commands; application programs, control sequences, and control loops; database entry and modification; reports generation; alarm reporting; diagnostics; and historical files.

3.8.2 Additional Operator Training

Following the field testing, additional classroom training for operators shall be taught for 1 training day; individual instruction sessions of 4-hour periods in the morning (or afternoon) of the same weekday and an additional 1 day classroom session for answering operator questions. Individual instruction shall consist of "hands-on" training under the constant monitoring of the instructor. Classroom training shall include instruction on the specific hardware configuration of the installed control system and specific instructions for operating the installed system. The Contractor shall schedule activities during this period so that the specified amount of time on the equipment will be available for each student. The final session will address specific topics that the students need to discuss and to answer questions concerning the operation of the system. Upon completion of the course, the students should be fully proficient in system operation and have no unanswered questions regarding operation of the installed control system. Each student should be able to start the system, operate the system, recover the system after a failure and describe the specific hardware architecture and operation of the system and be fully proficient in all system operations. The Contractor shall report the skill level of each student at the end of this course.

3.8.3 Maintenance Training

Following the endurance test, a minimum period of one training day shall be provided by a factory representative or a qualified Contractor trainer for ten designated personnel on maintenance of the equipment. The training shall include: physical layout of each piece of hardware, calibration procedures, preventive maintenance procedures, schedules, troubleshooting, diagnostic procedures and repair instructions.

3.8.4 Specialized Training

Following the maintenance training, a minimum period of one, total training day(s) shall be provided by a factory representative or a qualified Contractor trainer for ten people on the input devices.

3.8.4.1 Flow Meter Training

Each type of flow meter, to include calibration, maintenance and testing of flow elements and transducers.

-- End of Section --