

**NPDES PERMIT APPLICATION  
FORM 1**

ARKANSAS DEPARTMENT OF ENERGY AND ENVIRONMENT  
DIVISION OF ENVIRONMENTAL QUALITY - OFFICE OF WATER QUALITY  
5301 Northshore Drive  
North Little Rock, AR 72118-5317  
[www.adeg.state.ar.us/water](http://www.adeg.state.ar.us/water)

**PURPOSE OF THIS APPLICATION**

- INITIAL PERMIT APPLICATION FOR NEW FACILITY
- INITIAL PERMIT APPLICATION FOR EXISTING FACILITY
- MODIFICATION OF EXISTING PERMIT
- REISSUANCE (RENEWAL) OF EXISTING PERMIT
- MODIFICATION AND CONSTRUCTION OF EXISTING PERMIT
- CONSTRUCTION PERMIT

**SECTION A- GENERAL INFORMATION**

1. Legal Applicant Name (The permit will be issued under this name. This is the entity that controls and is responsible for operations and compliance.):

City of Mountain View

Note: The legal name of the applicant must be identical to the name listed with the Arkansas Secretary of State.

2. Operator Type: Private  Municipality  State  Federal  Partnership  Corporation  Other

State of Incorporation: Arkansas

3. Facility Name: Mountain View Wastewater Treatment Plant

4. Is the legal applicant identified in number 1 above the owner of the facility?  Yes  No

5. NPDES Permit Number (If Applicable): AR0020117

6. NPDES General Permit Number (If Applicable): ARG640093

7. NPDES General Storm Water Permit Number (If Applicable): ARR00

8. Permit Numbers and/or names of any permits issued by ADEQ or EPA for an activity located in Arkansas that is presently held by the applicant or its parent or subsidiary corporation which are not listed above:

<u>Permit Name</u>	<u>Permit Number</u>	<u>Held by</u>
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9. Give driving directions to the wastewater treatment plant with respect to known landmarks:

Travel West from Mountain View on AR Hwy. 66 approximately 1.5 miles to Westwood Ave. Turn right (north) on Westwood Ave. and travel approximately 0.25 miles to the WWP located at 340 Westwood Ave.

10. Facility Physical Location: (Attach a map with location marked; street, route no. or other specific identifier)

Street: 340 Westwood Ave.

City: Mountain View County: Stone State: AR Zip: 72560

11. Facility Mailing Address for permit, DMR, and invoice (Street or Post Office Box):

Name: City of Mountain View WWTP Title: \_\_\_\_\_  
Street: 311 W. Main St. P.O. Box P.O. Box 360  
City: Mountain View State: AR Zip: 72560  
E-mail address\*: waterdepartment@cityofmtnview.com Fax: 870-269-9158

\* Is emailing all documents (permit, letters, DMRs, invoices, etc.) acceptable to the applicant?  Yes  No

12. Neighboring States Within 20 Miles of the permitted facility (Check all that apply):

Oklahoma  Missouri  Tennessee  Louisiana  Texas  Mississippi

13. Indicate applicable Standard Industrial Classification (SIC) Codes and NAICS codes for primary processes (See Item #3 of the instructions for assistance in determining the correct SIC and NAICS Codes):

4952 SIC Facility Activity under this SIC or NAICS:  
221320 NAICS \_\_\_\_\_

14. Design Flow: 0.73 (existing) 0.95 (proposed) MGD Highest Monthly Average of the last two years Flow: 1.77 (May 2019) MGD

15. Is the outfall equipped with a diffuser?  Yes  No

16. Responsible Official (as described on the last page of this application):

Name: Roger Gardner Title: Mayor  
Address: P.O. Box 360 Phone Number: 870-269-3804  
E-mail Address: mayor@cityofmtnview.com  
City: Mountain View State: AR Zip: 72560

17. Cognizant Official (Duly Authorized Representative of responsible official as described on the last page of this application):

Name: Jackie Craig Title: WWTP Operator  
Address: P.O. Box 360 Phone Number: 870-213-7222  
E-mail Address: waterdepartment@cityofmtnview.com  
City: Mountain View State: AR Zip: 72560

18. Name, address and telephone number of active consulting engineer firm (If none, so state):

Contact Name: C. Kyle Breckenridge  
Company Name: CWB Engineers, Inc.  
Address: 1915 Hwy 25 B Phone Number: 501-362-3744  
E-mail Address: kbreckenridge@cwbenigneers.com  
City: Heber Springs State: AR Zip: 72543

19. Wastewater Operator Information

Wastewater Operator Name: Jackie Craig License number: 007092  
Class of municipal wastewater operator: I  II  III  IV   
Class of industrial wastewater operator: Basic  Advanced

**SECTION B: FACILITY AND OUTFALL INFORMATION**

1. Facility Location (All information must be based on the **front door (gate)** location of the facility). A topographic map must be submitted. See Item #5 of the instructions for additional details.:

Lat: 35 ° 51 ' 59.48 " Long: 92 ° 08 ' 53.83 "

2. Outfall Information (If more than two outfalls, add additional pages)

Outfall 001

End-of-Pipe

Location: Latitude: 35 ° 52 ' 1.54 " Longitude: 92 ° 08 ' 47.01 "

Monitoring

Location: Latitude: 35 ° 52 ' 1.36 " Longitude: 92 ° 08 ' 47.74 "

Description of outfall location: Pipe outfall into Hughes Creek

Name of Receiving Stream (i.e. an unnamed tributary of Mill Creek, thence into Mill Creek; thence into Arkansas River):  
Hughes Creek, thence to Tubbs Creek, thence to Lick Fork Creek, thence to Sylamore Creek, thence to White River

Type of Treatment system (Include all components of the treatment system and attach the process flow diagram):  
Headworks basket screen, extended aeration oxidation ditch, final clarifier, UV disinfection

How are effluent samples collected?  
Auto-sampler pulls from post aeration basin

How is flow measured, i.e., v-notch weir, totalizing meter, Parshall flume, etc.?  
Parshall Flume with Ultra-sonic level detection

Outfall

End-of-Pipe

Location: Latitude: \_\_\_\_\_ ° \_\_\_\_\_ ' \_\_\_\_\_ " Longitude: \_\_\_\_\_ ° \_\_\_\_\_ ' \_\_\_\_\_ "

Monitoring

Location: Latitude: \_\_\_\_\_ ° \_\_\_\_\_ ' \_\_\_\_\_ " Longitude: \_\_\_\_\_ ° \_\_\_\_\_ ' \_\_\_\_\_ "

Description of outfall location: \_\_\_\_\_

Name of Receiving Stream (i.e. an unnamed tributary of Mill Creek, thence into Mill Creek; thence into Arkansas River):  
\_\_\_\_\_  
\_\_\_\_\_

Type of Treatment system (Include all components of the treatment system and attach the process flow diagram):  
\_\_\_\_\_  
\_\_\_\_\_

How are effluent samples collected?

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How is flow measured, i.e., v-notch weir, totalizing meter, Parshall flume, etc.?

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3. Is the proposed or existing facility located above the 100-year flood level?  Yes  No

NOTE: FEMA Map must be included with this application. Maps can be ordered at [www.fema.gov](http://www.fema.gov) .

If "No", what measures are (or will be) used to protect the facility? \_\_\_\_\_

4. Population for Municipal and Domestic Sewer Systems: 3,800
5. Backup Power Generation for Treatment Plants

Are there any permanent backup generators? Yes  No

If Yes, how many? 1 Total Horsepower (hp)? 490

If no, check one of the following.

- Portable generator is available.
- The WWTP does not require power to operate.
- Operations at the facility will cease if power is not available.
- The WWTP has sufficient capacity to hold influent until power is restored.
- Other, please explain \_\_\_\_\_



**SECTION C – WASTE STORAGE AND DISPOSAL INFORMATION**

1. Solids/Sludge Disposal Method (Check as many as are applicable):

**Solids are not produced at this facility.**

**Landfill:**

Landfill Site Name Cherokee Sanitary Landfill ADEQ Solid Waste Permit No. 299-S1

**Land Application:** ADEQ State Permit No. \_\_\_\_\_

**Septic tank:** Arkansas Department of Health Permit No.: \_\_\_\_\_

**Distribution and Marketing:** Facility receiving sludge:

Name: \_\_\_\_\_ Address: \_\_\_\_\_

City: \_\_\_\_\_ State: \_\_\_\_\_ Zip: \_\_\_\_\_ Phone: \_\_\_\_\_

Rail:  Pipe:  Other: \_\_\_\_\_

**Subsurface Disposal** (Lagoon for which the sole purpose is storing sludge):

Location of lagoon \_\_\_\_\_ How old is the lagoon? \_\_\_\_\_

Surface area of lagoon: \_\_\_\_\_ Acre Depth: \_\_\_\_\_ ft Does lagoon have a liner?  Yes  No

**Incineration:** Location of incinerator \_\_\_\_\_

**Remains in Treatment Lagoon(s):**

How old is the lagoon(s)? \_\_\_\_\_ Has sludge depth been measured?  Yes  No

If Yes, Date measured? \_\_\_\_\_ Sludge Depth? \_\_\_\_\_ ft If No, When will it be measured? \_\_\_\_\_

Has sludge ever been removed? Yes  No  If Yes, When was it removed? \_\_\_\_\_

**Other** (Provide complete description): \_\_\_\_\_

**SECTION D - WATER SUPPLY**

Water Sources which are downstream of the outfall location, i.e., those which could be affected by the discharge from this facility (check as many as are applicable):

**None**

**Private Well** - Distance from Discharge point:  Within 5 miles  Within 50 miles

**Municipal Water Utility** (Specify City): Mountain View

Distance from Discharge point:  Within 5 miles  Within 50 miles

**Surface Water**- Name of Surface Water Source: White River

Distance from Discharge point:  Within 5 miles  Within 50 miles

Lat: 35 ° 55 ' 30.24 " Long: 92 ° 05 ' 30.48 "

**Other** (Specify): \_\_\_\_\_

Distance from Discharge point:  Within 5 miles  Within 50 miles

## SECTION E: TRUST FUND REQUIREMENTS AND DISCLOSURE STATEMENT

1. Ark. Code Ann. § 8-4-203(b)(1)(A) forbids the Arkansas Department of Energy and Environment – Division of Environmental Quality (DEQ) from issuing, modifying, renewing, or transferring a permit for a nonmunicipal domestic sewage treatment works without the applicant first fulfilling the trust fund requirements set forth in that section. Ark. Code Ann. § 8-4-203(b)(1)(B) defines “nonmunicipal domestic sewage treatment works” as a device or system operated by an entity other than a city, town, or county that treats, in whole or in part, waste or wastewater from humans or household operations and must continually operate to protect human health and the environment despite a permittee’s failure to maintain or operate the device or system. NDSTW’s can include, but are not limited to:

- Sewer Improvement Districts;
- Subdivisions,
- Mobile Home Parks,
- Property Owner’ Associates,
- RV parks, and
- Apartments

**Exclusions** Excluded from this application’s Section E.1. requirements for trust fund contribution fees are:

- State or federal facilities,
- Schools,
- Universities and colleges,
- Public facilities boards and public water authorities,
- Entities that continuously operate due to a connection with a city, town, or county, and
- Commercial or industrial entity that treats domestic sewage from its operations and does not accept domestic sewage from other entities or residences.

The trust fund form may be obtained from the DEQ web site at:

<http://www.adeg.state.ar.us/water/permits/npdes/individual/pdfs/ndstw-trust-fund-certification-form.pdf>

2. Disclosure Statement:

Ark. Code Ann. 8-1-106 requires that applicants for any type of permit or transfer of any permit, license, certification or operational authority issued by the DEQ file a Disclosure Statement with their application unless exempt for doing so under Ark. Code Ann. §8-1-106(b)(2). The filing of a Disclosure Statement is mandatory. No application can be considered administratively complete without a completed Disclosure Statement unless that facility is exempt. Publicly traded companies may submit the most recent 10k and 10Q filings to the Securities and Exchange Commission in lieu of the Disclosure Statement. The form may be obtained from the ADEQ web site at:

[https://www.adeg.state.ar.us/ADEQ\\_Disclosure\\_Statement.pdf](https://www.adeg.state.ar.us/ADEQ_Disclosure_Statement.pdf)

**SECTION F – INDUSTRIAL ACTIVITY**

1. Does an effluent guideline limitation promulgated by EPA ([Link to a Listing of the 40 CFR Effluent Limit Guidelines](#)) under Section 304 of the Clean Water Act (CWA) apply to your facility?

YES  (Answer questions 2 and 3)      NO

2. What Part of 40 CFR? \_\_\_\_\_

3. What Subpart(s)? \_\_\_\_\_

4. Give a brief description of all operations at this facility including primary products or services (attach additional sheets if necessary):

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5. Production: (projected for new facilities)

Product(s) Manufactured (Brand name)	Last 12 Months		Highest Production Year of Last 5 Years	
	lbs/day*		lbs/day*	
	Highest Month	Days of Operation	Monthly Average	Days of Operation

\* These units could be off-lbs, lbs quenched, lbs cleaned/etched/rinsed, lbs poured, lbs extruded, etc.



No.	Dilution (e.g., Cooling Water)	Average Flow (GPD)	Maximum Flow (GPD)	Type of Discharge (batch, continuous, none)

If batch discharge occurs or will occur, indicate: [New facilities may estimate.]

Number of batch discharges: \_\_\_\_\_ per day      Average discharge per batch: \_\_\_\_\_ (GPD)

Time of batch discharges \_\_\_\_\_ at \_\_\_\_\_  
(days of week)                      (hours of day)

Flow rate: \_\_\_\_\_ gallons/minute      Percent of total discharge: \_\_\_\_\_

3. Do you have, or plan to have, automatic sampling equipment or continuous wastewater flow metering equipment at this facility?

Current:	Flow Metering	<input type="checkbox"/> Yes	Type: _____	<input type="checkbox"/> No	N/A	<input type="checkbox"/>
	Sampling Equipment	<input type="checkbox"/> Yes	Type: _____	<input type="checkbox"/> No	N/A	<input type="checkbox"/>
Planned:	Flow Metering	<input type="checkbox"/> Yes	Type: _____	<input type="checkbox"/> No	N/A	<input type="checkbox"/>
	Sampling Equipment	<input type="checkbox"/> Yes	Type: _____	<input type="checkbox"/> No	N/A	<input type="checkbox"/>

If yes, please indicate the present or future location of this equipment on the sewer schematic and describe the equipment below:

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4. Are any process changes or expansions planned during the next three years that could alter wastewater volumes or characteristics?

Yes     No      (If no, skip Question 5)

5. Briefly describe these changes and their effects on the wastewater volume and characteristics:

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## SECTION H -TECHNICAL INFORMATION

Technical information to support this application shall be furnished in appropriate detail to understand the project. Information in this Part is required for obtaining a **construction permit** or for **modification** of the treatment system.

1. Describe the proposed construction activity. Include the types of control equipment to be installed along with their methods of operation and control efficiency.

Work includes rehabilitation of the existing headworks basket screen, oxidation ditch, final clarifier, and UV disinfection system

In addition, a redundant final clarifier is planned for construction, along with installation of launder covers on the existing clarifier, and UV channel covers on the UV structure

2. One set of construction plans and specifications, approved (signed and stamped) by a **Professional Engineer** (PE) registered in **Arkansas**, must be submitted as follows:
  - a. The plans must show flow rates in addition to pertinent dimensions so that detention times, overflow rates, and loadings per acre, etc. can be calculated.
  - b. Specifications and complete design calculations.
  - c. All treated wastewater discharges should have a flow measuring device such as a weir or Parshall flume installed after the final treatment unit. Where there is a significant difference between the flow rates of the raw and treated wastewater, a flow measuring device should be provided both before and after treatment.
3. If this application includes a construction permit disturbing five or more acres, a storm water construction permit must be obtained by submitting a notice of intent (NOI) to DEQ.

## SECTION I: SIGNATORY REQUIREMENTS

### Cognizant Official (Duly Authorized Representative)

40 CFR 122.22(b) states that all reports required by the permit, or other information requested by the Director, shall be signed by the applicant (or person authorized by the applicant) or by a duly authorized representative of that person. A person is a duly authorized representative only if:

- (1) the authorization is made in writing by the applicant (or person authorized by the applicant);
- (2) the authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity responsibility, or an individual or position having overall responsibility for environmental matters for the company.

The applicant hereby designates the following person as a Cognizant Official, or duly authorized representative, for signing reports, etc., including Discharge Monitoring Reports (DMR) required by the permit, and other information requested by the Director:

Signature of Cognizant Official: Jackie E Craig Date: 5-14-21  
Printed name of Cognizant Official: Jackie Craig  
Official title of Cognizant Official: WWTP Operator Telephone Number: 870-213-7222

### Responsible Official

The information contained in this form must be certified by a responsible official as defined in the "signatory requirements for permit applications" (40 CFR 122.22).

Responsible official is defined as follows:

**Corporation**, a principal officer of at least the level of vice president

**Partnership**, a general partner

**Sole proprietorship**: the proprietor

**Municipal, state, federal, or other public facility**: principal executive officer, or ranking elected official.

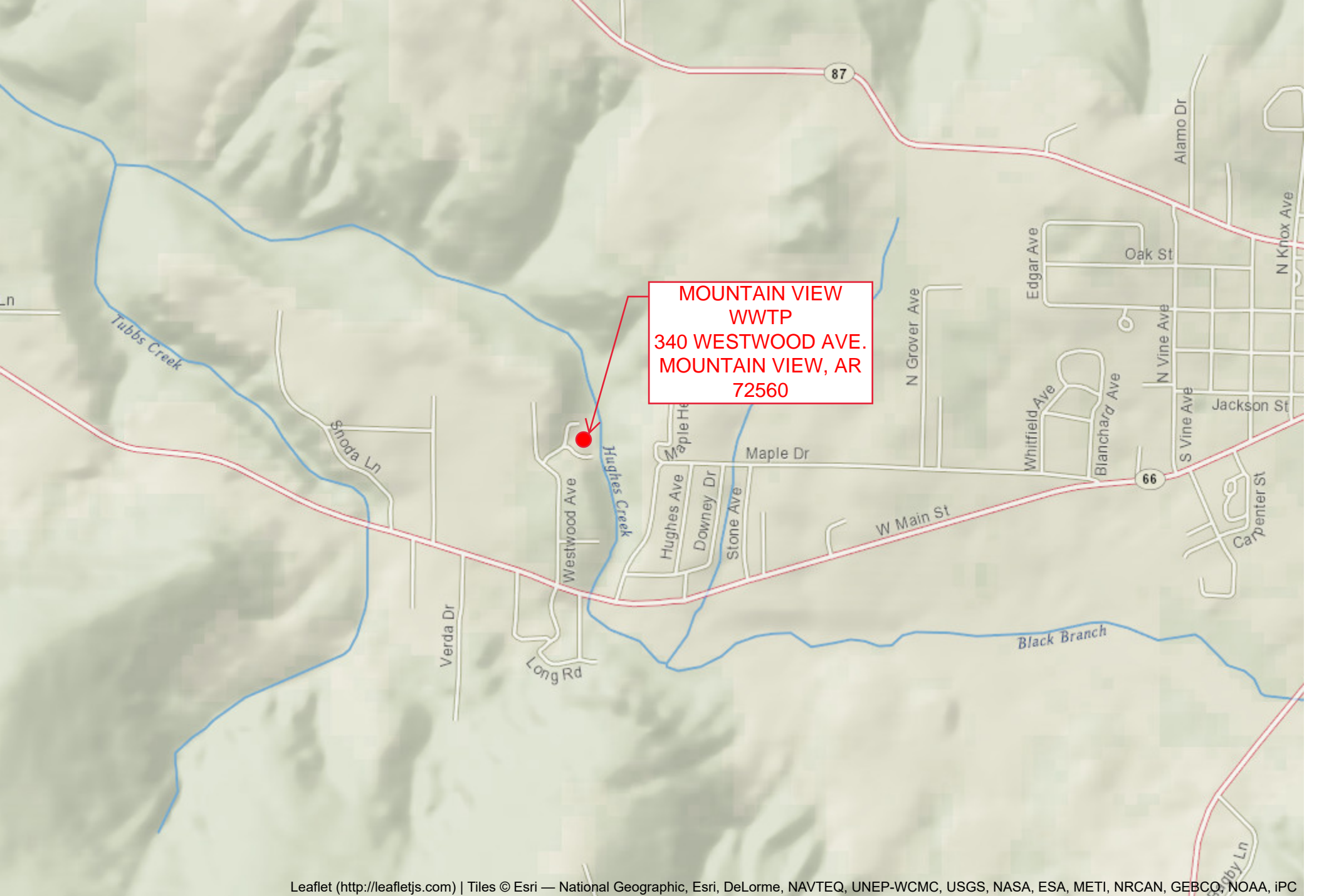
"By my signature below, I certify that the cognizant official designated above is qualified to act as a duly authorized representative under the provisions of 40 CFR 122.22(b)." NOTE: If no duly authorized representative is designated in this section, the Division considers the applicant to be the responsible official for the facility and only reports, etc., signed by the applicant will be accepted by the Division.

"By my signature below, I certify that, if this facility is a corporation, it is registered with the Secretary of State in Arkansas. Please provide the full name of the corporation if different than that listed in Section A above."

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment for knowing violations. I further certify under penalty of law that all analyses reported as less than detectable in this application or attachments thereto were performed using the EPA approved test method having the lowest detection limit for the substance tested."

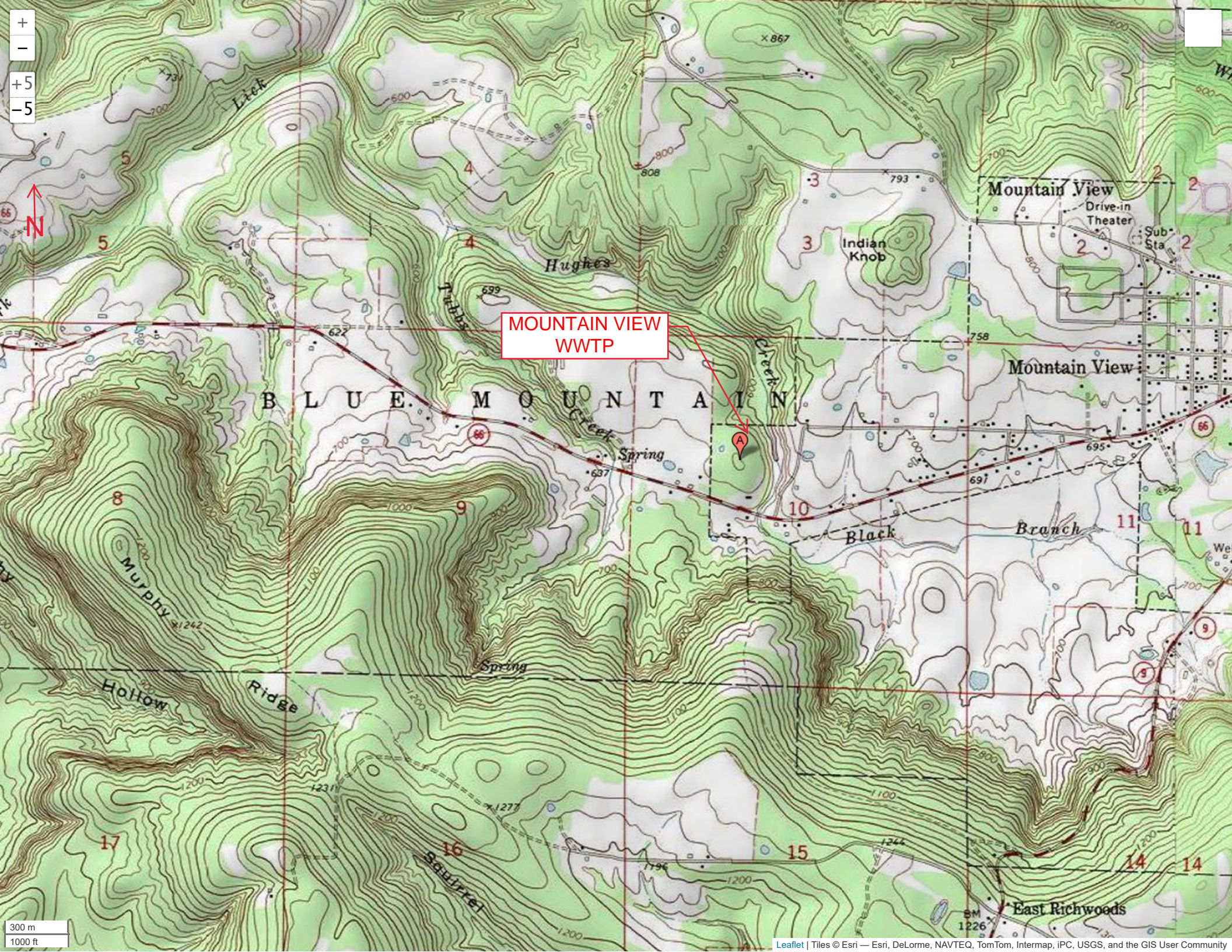
Signature of Responsible Official: Roger Gardner Date: 5-14-21  
Printed name of Responsible Official: Roger Gardner  
Official title of Responsible Official: Mayor Telephone Number: 870-269-3804





**MOUNTAIN VIEW  
WWTP**  
340 WESTWOOD AVE.  
MOUNTAIN VIEW, AR  
72560

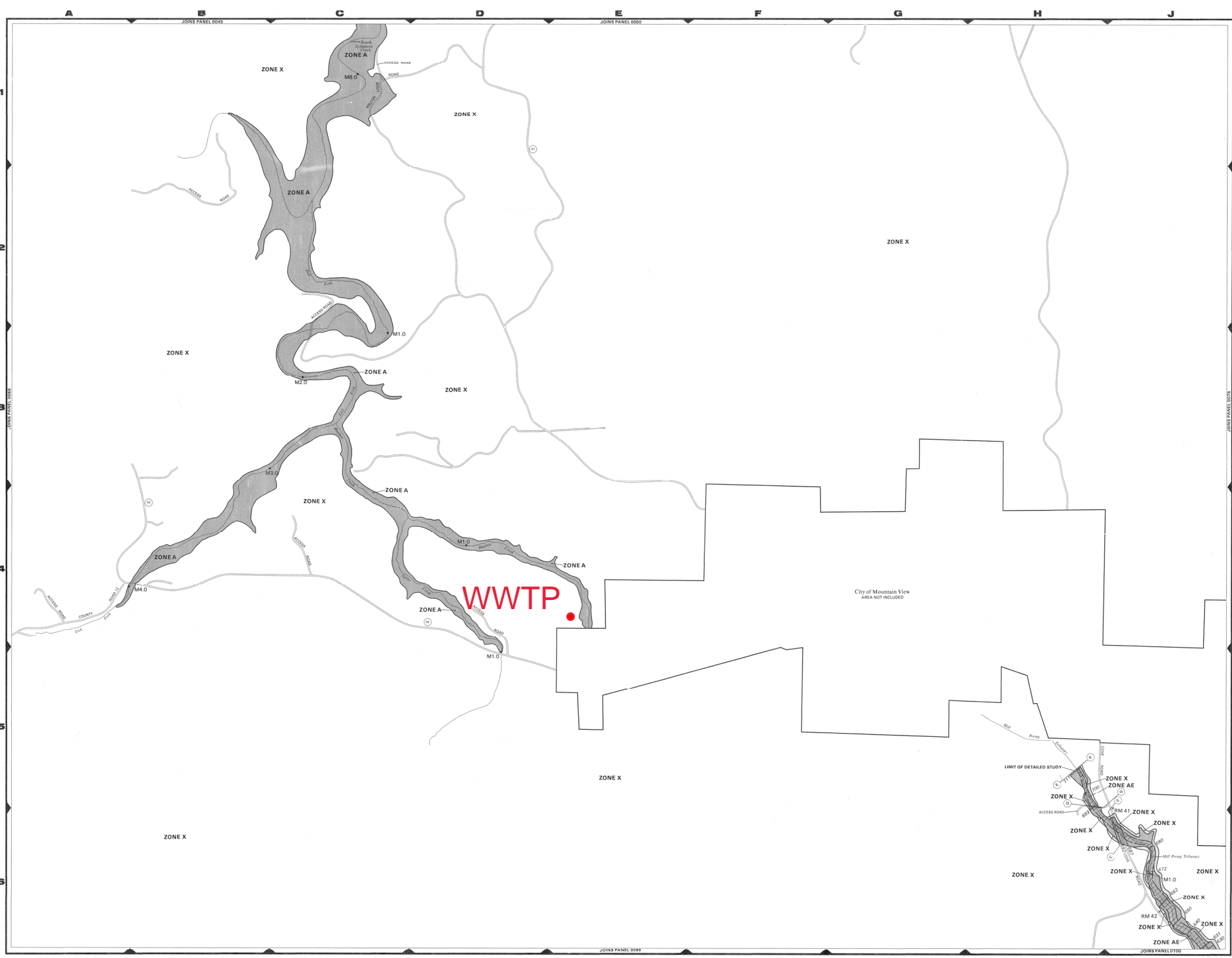




MOUNTAIN VIEW  
WWTP

300 m  
1000 ft





### LEGEND

**SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD**

- ZONE A** No base flood elevations determined.
- ZONE AE** Base flood elevations determined.
- ZONE A1** Flood depths of 1 to 3 feet (average area of inundation); base flood elevations determined.
- ZONE A99** To be protected from 100-year flood by future flood protection system under construction; no base elevations determined.
- ZONE V** Coastal flood with velocity hazard factor applied; no base flood elevations determined.
- ZONE VE** Coastal flood with velocity hazard factor applied; base flood elevations determined.

**FLOODWAY AREAS IN ZONE AE**

- ZONE X** Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with damage ratio less than 0.10; no base elevations determined; areas not protected by levees from 100-year flood.
- ZONE D** Areas determined to be outside 500-year flood plain.

**OTHER AREAS**

- ZONE X** Areas determined to be outside 500-year flood plain.
- ZONE D** Areas in which flood hazards are undetermined.

**BOUNDARIES**

- Flood Boundary
- Floodway Boundary
- Zone Boundary
- Boundary Dividing Special Flood Hazard Areas and Ordinary High Water
- Coastal Base Flood Elevation Within Special Flood Hazard Zones

**SYMBOLS**

- 513 — Base Flood Elevation Line; Elevation in Feet
- (D) Cross Section Line
- (E) Base Flood Elevation in Feet Where Ordinary High Water
- RM 41 Elevation Reference Mark
- M1.5 River Mile
- K River Mile

\*Referenced to the National Geodetic Vertical Datum of 1929

### NOTES

This map is to be used in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, nor does it indicate the actual depth of flood water or the actual damage to property. Flood insurance rates are based on the actual flood hazard shown on this map. Flood insurance rates shown may differ significantly from those developed by the National Weather Service for hurricane evacuation planning.

Certain areas not in Special Flood Hazard Areas may be protected by flood control structures.

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic computations using the open channel flow equations of the Federal Emergency Management Agency.

Floodway widths in some areas may be too narrow to show to scale. Floodway widths are provided in the Flood Insurance Study Report.

Elevation reference marks are described in the Flood Insurance Study Report.

Coastal base flood elevations apply only landward of 0.0 MCHVZ.

Coastal base flood elevations shown on this map include the effects of wave action.

For adjusting map panels see separately printed Map Index.

**MAP REPOSITORY**  
County Courthouse, Mountain View, Arkansas 72660 (Maps available for reference only, not for distribution).

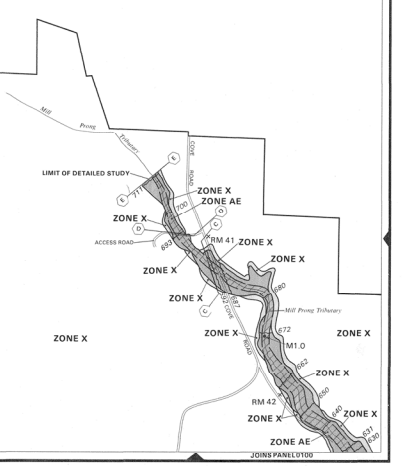
**INITIAL IDENTIFICATION**

- JULY 16, 1987 FLOOD HAZARD BOUNDARY MAP REVISIONS: NONE
- FLOOD INSURANCE RATE MAP EFFECTIVE: JULY 16, 1987
- FLOOD INSURANCE RATE MAP REVISIONS:

Refer to Flood Insurance Rate Map Effective date shown below to determine when actuarial rates apply to structures in zones where elevations or depths have been established.

To determine if Flood Insurance is available, contact an Insurance agent or call the National Flood Insurance Program at (800) 438-6620.

**APPROXIMATE SCALE**  
1" = 1000 FEET



**NATIONAL FLOOD INSURANCE PROGRAM**

**FIRM**  
FLOOD INSURANCE RATE MAP

**STONE COUNTY, ARKANSAS UNINCORPORATED AREAS**

PANEL 70 OF 140  
(SEE MAP INDEX FOR PANELS NOT PRINTED)

PANEL LOCATION

**COMMUNITY-PANEL NUMBER**  
050465 0070 A

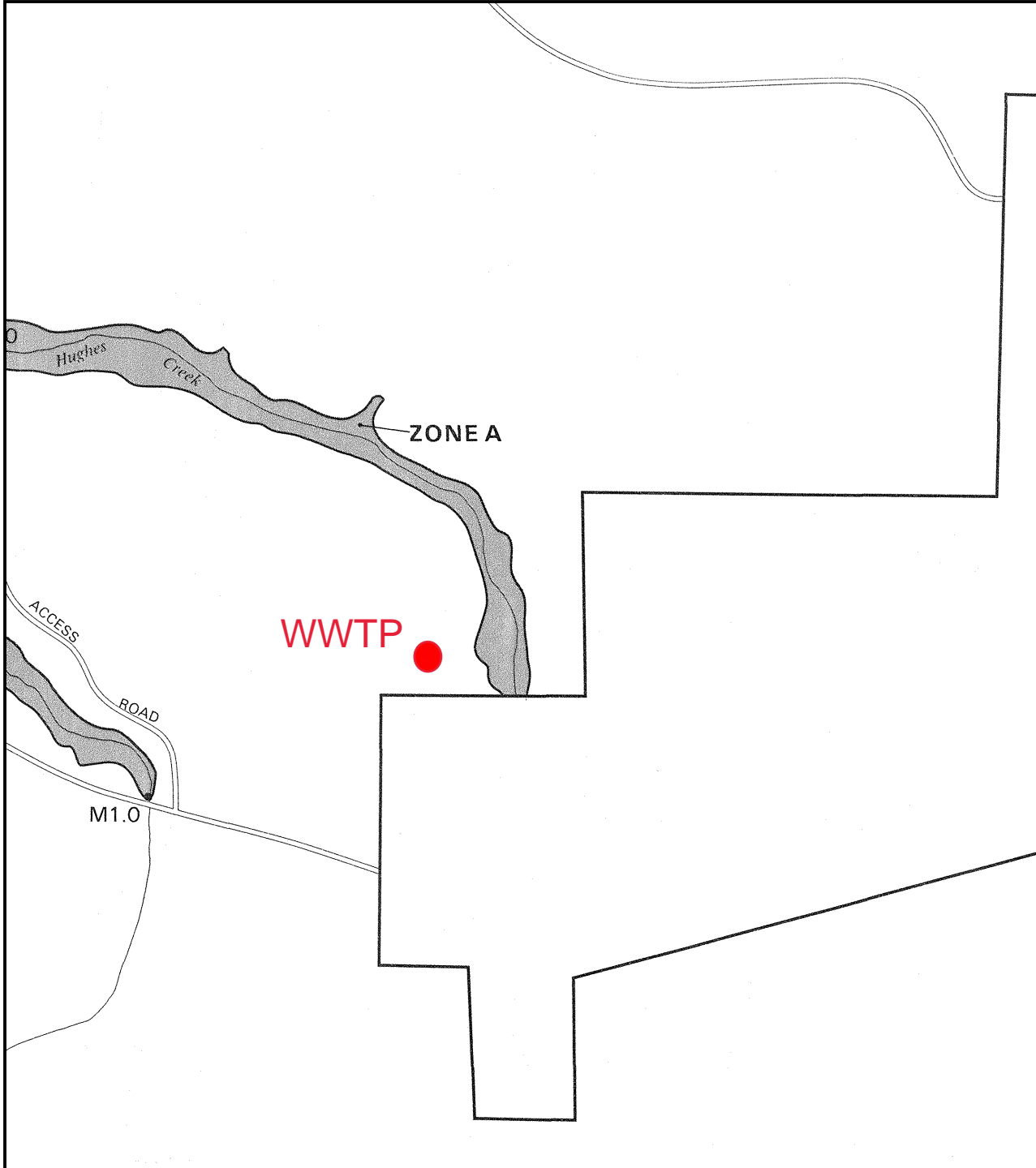
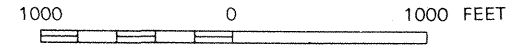
**EFFECTIVE DATE:**  
JULY 16, 1987

Federal Emergency Management Agency

agent or call the National Flood Insurance Program at (800) 638-6620.



APPROXIMATE SCALE

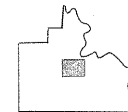


NATIONAL FLOOD INSURANCE PROGRAM

**FIRM**  
FLOOD INSURANCE RATE MAP

STONE COUNTY,  
ARKANSAS  
UNINCORPORATED AREAS

PANEL 70 OF 140  
(SEE MAP INDEX FOR PANELS NOT PRINTED)



PANEL LOCATION

COMMUNITY-PANEL NUMBER  
050465 0070 A

EFFECTIVE DATE:  
JULY 16, 1987



Federal Emergency Management Agency

Tributary

ZONE X

ZONE X

650

640

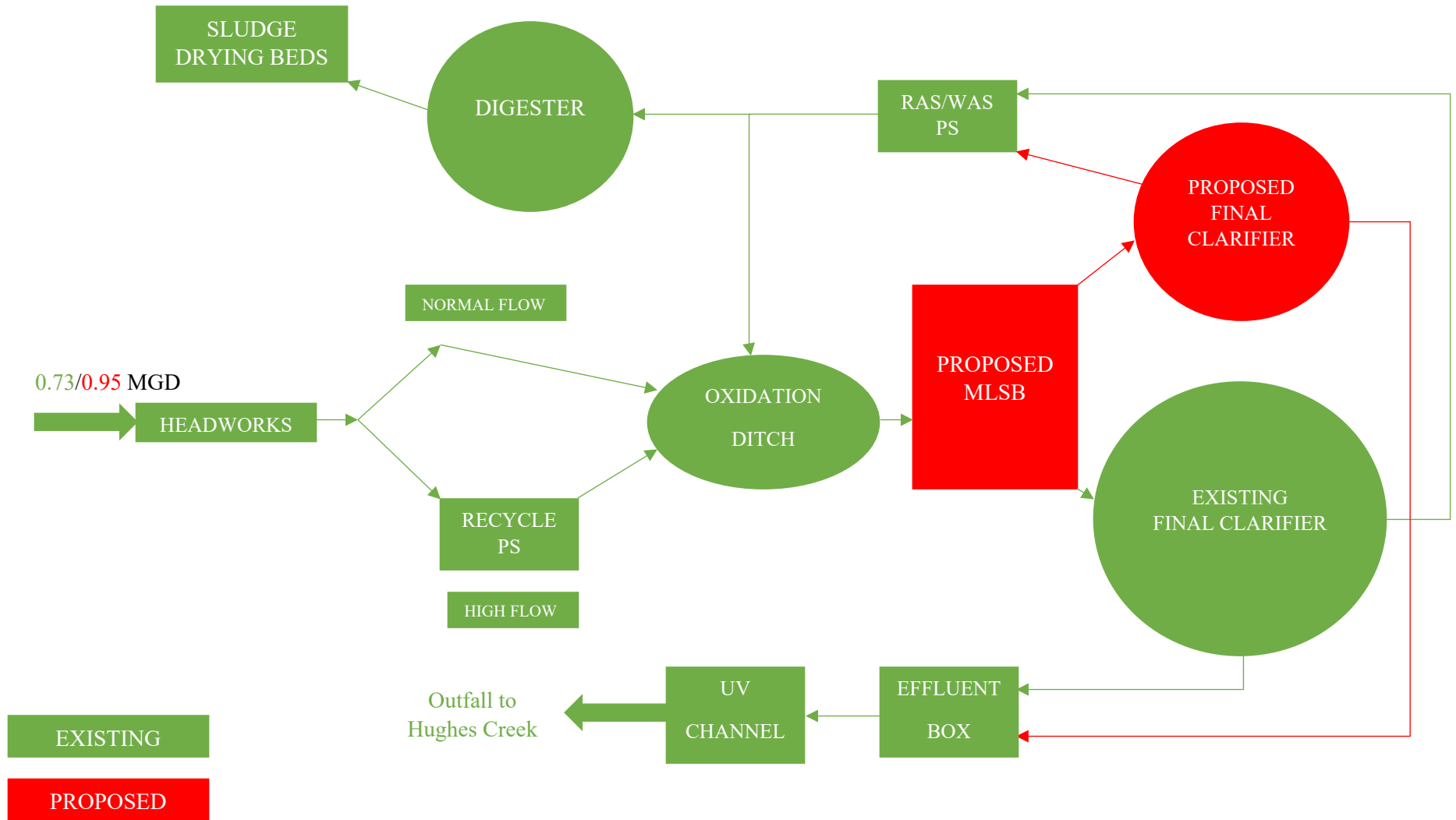
ZONE X

631

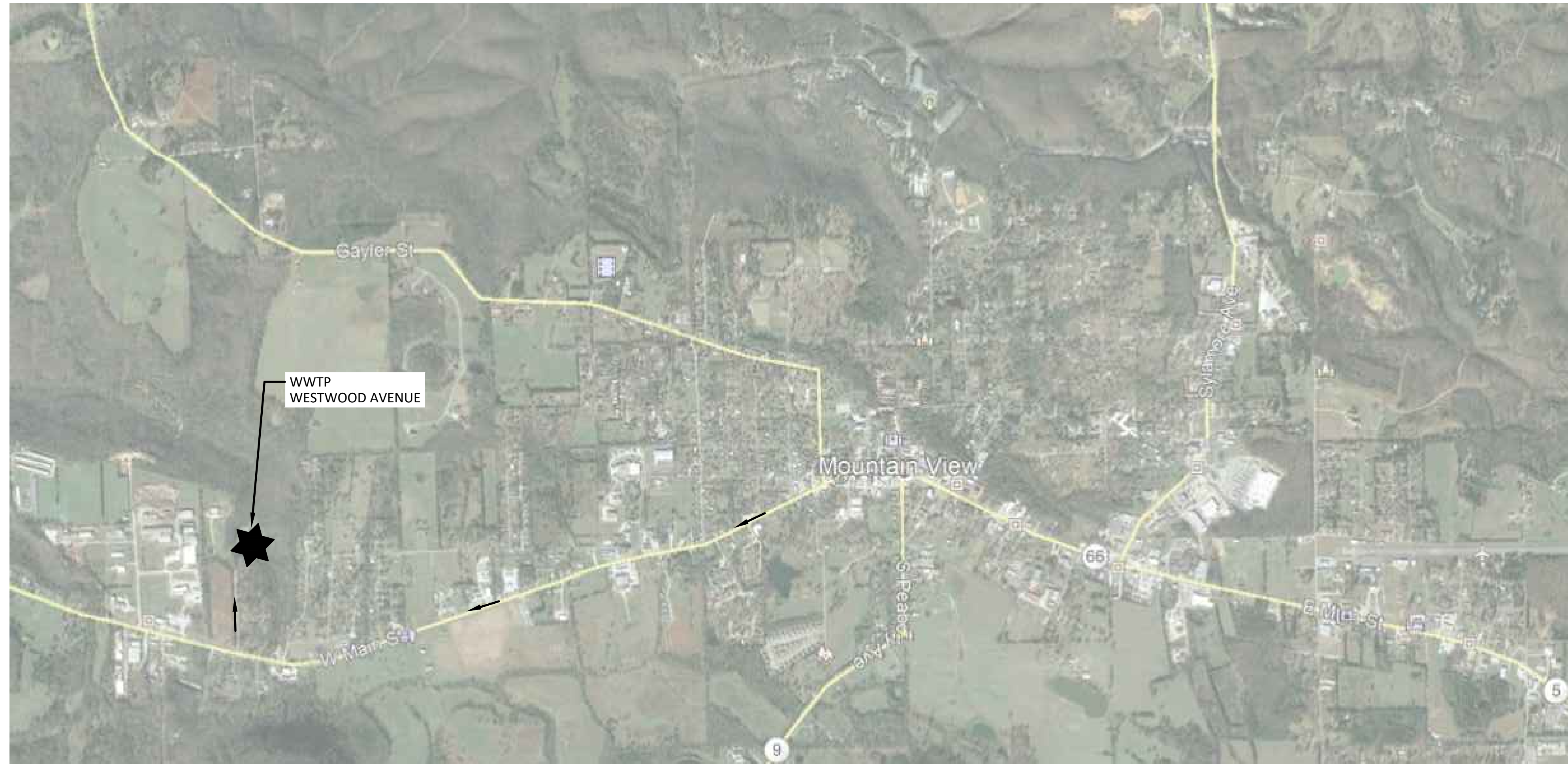
630

This is an official FIRMette showing a portion of the above-referenced flood map created from the MSC FIRMette Web tool. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For additional information about how to make sure the map is current, please see the Flood Hazard Mapping Updates Overview Fact Sheet available on the FEMA Flood Map Service Center home page at <https://msc.fema.gov>.

# Mountain View WWTP Flow Schematic



# CITY OF MOUNTAIN VIEW, AR WASTE WATER TREATMENT PLANT IMPROVEMENTS



**CWB ENGINEERS, INC.**  
**CWB PROJECT #: 20-018**

**CWB**  
*Engineers, Inc.*

*-Designing a Better Arkansas-*

1915 Highway 25B  
Heber Springs  
AR 72543

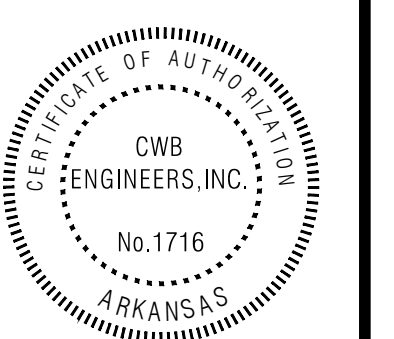
phone: (501) 362-3744  
cell: (501) 766-9832  
email: kbreckenridge@cwbenigneers.com

COVER	CITY OF MOUNTAIN VIEW
SCALE: NTS	SCALE: NTS
DATE: MAY 2021	DATE: MAY 2021
PROJECT: 20-018	PROJECT: 20-018
SHEET	CITY OF MOUNTAIN VIEW
OWNER	CITY OF MOUNTAIN VIEW
PROJECT	WWTP IMPROVEMENTS
LOCATION	MOUNTAIN VIEW, AR



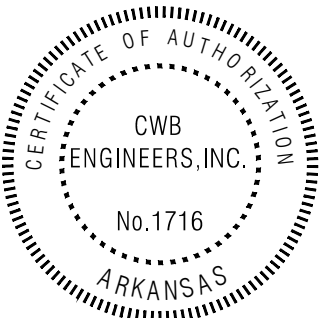
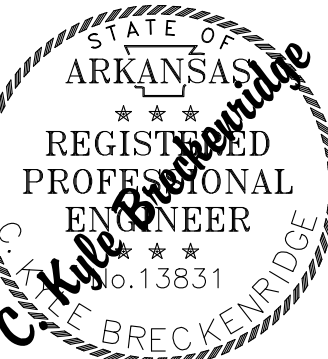
Arkansas One Call



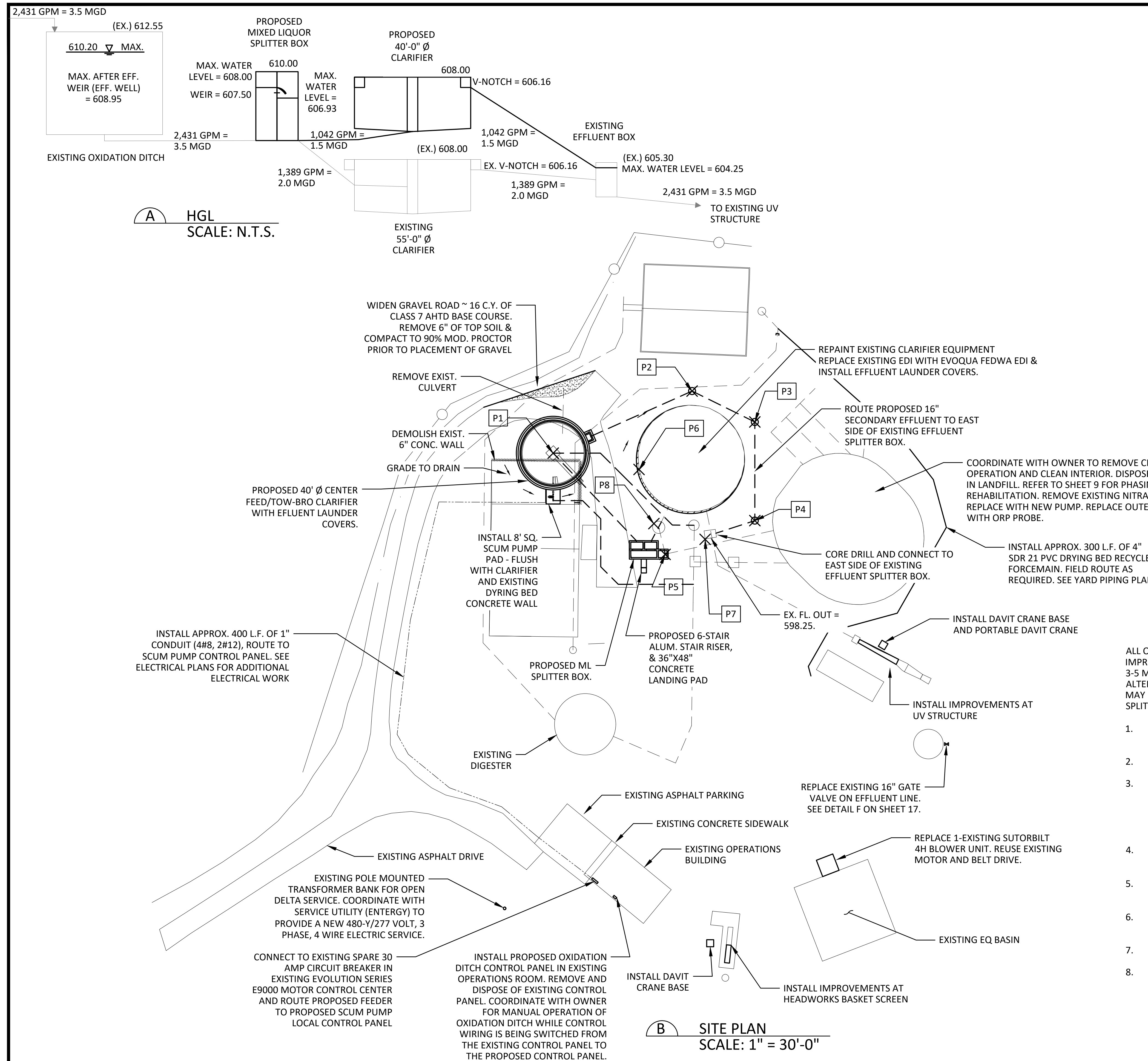
Know what's below.  
Call before you dig.



5/12/21

SHEET #	TITLE	GENERAL NOTES:																					
<p>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19</p>	<p>COVER TOC &amp; GENERAL NOTES HGL &amp; SITE PLAN YARD PIPING PLAN FINISHED GRADING PLAN CLARIFIER EFFLUENT PLAN &amp; PROFILE HEADWORKS IMPROVEMENTS MIXED LIQUOR SPLITTER BOX PLANS OXIDATION DITCH REHABILITATION CLARIFIER PLAN CLARIFIER STRUCTURAL PLAN CLARIFIER DETAILS EXISTING CLARIFIER REHABILITATION UV IMPROVEMENTS GENERAL DETAILS 1 GENERAL DETAILS 2 GENERAL DETAILS 3 GENERAL DETAILS 4 CLARIFIER ELECTRICAL PLAN</p>	<p>1. ALL CONSTRUCTION POINTS SHOWN ON THE SITE PLAN ARE IN NAD-83 STATE PLANE COORDINATES.</p> <p>2. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS IN THE FIELD BEFORE STARTING THE WORK. THE ENGINEER SHALL BE NOTIFIED OF ANY DISCREPANCIES BETWEEN THE DIMENSIONS SHOWN ON THE DRAWINGS AND THE FIELD CONDITIONS.</p> <p>3. COORDINATE AND VERIFY ALL MECHANICAL AND ELECTRICAL EQUIPMENT ANCHORAGE INTO STRUCTURAL CONCRETE PRIOR TO CONCRETE PLACEMENT. NO ANCHORAGE SYSTEM SHALL CAUSE DAMAGE TO THE STRUCTURAL CONCRETE.</p> <p>4. ALL EXCAVATION IS UNCLASSIFIED. NO ADDITIONAL PAYMENT WILL BE WARRANTED REGARDLESS OF MATERIAL ENCOUNTERED. NO BLASTING WILL BE ALLOWED.</p> <p>5. MAINTAIN GROUNDWATER LEVEL A MIN. OF 2 FT. BELOW THE BOTTOM OF ALL STRUCTURAL EXCAVATIONS FOR THE DURATION OF THE CONSTRUCTION OR UNTIL STRUCTURE FLOTATION IS NO LONGER A CONCERN.</p> <p>6. NO BACKFILL SHALL BE PLACED AGAINST ANY STRUCTURAL CONCRETE UNTIL THE MATERIAL HAS REACHED THE SPECIFIED DESIGN STRENGTH.</p> <p>7. DO NOT CAST CONCRETE ADJACENT TO EXISTING CONCRETE THAT IS LESS THAN 48 HOURS OLD.</p> <p>8. ALL EXTERIOR CONCRETE SHALL BE ENTRAINED WITH AIR PER THE SPECIFICATIONS.</p> <p>9. STRUCTURAL CONCRETE SHALL HAVE A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 4,500 PSI.</p> <p>10. ALL EXPOSED CORNERS OF CONCRETE SHALL HAVE A 3/4" CHAMFER.</p> <p>11. THE CONTRACTOR MUST COORDINATE WITH THE OWNER BEFORE SCHEDULING ANY EXISTING PROCESS TO STOP OR NEW PROCESS TO BEGIN.</p> <p>12. THE SITE IS LESS THAN 5 ACRES AND QUALIFIES FOR AUTOMATIC COVERAGE UNDER THE CONSTRUCTION STORMWATER GENERAL PERMIT. INSTALL AND MAINTAIN SILT FENCES, DITCH CHECKS, AND OTHER BEST MANAGEMENT PRACTICES TO MITIGATE ANY STORMWATER RUN-OFF FROM THE SITE. POST THE NOC AND SWPPP IN A READILY ACCESSIBLE LOCATION AT THE JOB SITE. CONTRACTOR IS RESPONSIBLE FOR MAINTAINING ALL BEST MANAGEMENT PRACTICES AND INSPECTION FORMS AS REQUIRED BY THE GENERAL PERMIT.</p> <p>13. IF REQUIRED BY ADEQ, THE CONTRACTOR SHALL OBTAIN COVERAGE IN THE UTILITY'S NAME AND SUBMIT A NOTICE OF COVERAGE OR NOTICE OF INTENT, STORMWATER POLLUTION PREVENTION PLAN, PERTINENT FEES, AND OTHER REQUIREMENTS OF THE CONSTRUCTION GENERAL PERMIT.</p> <p>14. THE CONTRACTOR SHALL FURNISH ONE COMPLETE SET OF CONSTRUCTION DRAWINGS APPROPRIATELY MARKED-UP TO REFLECT ACTUAL "AS-BUILT" ELEVATIONS, DIMENSIONS, LOCATIONS, ETC. TO BE SUBMITTED WITH THE CONTRACTOR'S AFFIDAVIT AT THE CLOSE OF THE PROJECT.</p> <p>15. THE CONTRACTOR SHALL SUBMIT A WORK PLAN AT THE PRE-CONSTRUCTION MEETING TO DEMONSTRATE TO THE OWNER AND ENGINEER THAT THE CONTRACTOR HAS ADEQUATELY THOUGHT-OUT AND PLANNED THE MEANS AND METHODS OF CONSTRUCTION AND THEIR INTERFACE WITH THE EXISTING FACILITIES IN ORDER TO MAINTAIN THE TREATMENT CAPABILITIES.</p>	<div style="text-align: center;">  <p><b>CWB Engineers, Inc.</b> -Designing a Better Arkansas-</p> <p>phone: (501) 362-3744 cell: (501) 766-9832 email: kbreckenridge@cwbenigneers.com</p> </div> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 25%; text-align: center;">TOC &amp; NOTES</td> <td style="width: 25%; text-align: center;">SCALE: NTS</td> <td style="width: 25%; text-align: center;">DATE: MAY 2021</td> <td style="width: 25%; text-align: center;">PROJECT: 20-018</td> </tr> <tr> <td style="text-align: center;">SHEET</td> <td style="text-align: center;">CITY OF MOUNTAIN VIEW</td> <td style="text-align: center;">WWTP IMPROVEMENTS</td> <td style="text-align: center;">MOUNTAIN VIEW, AR</td> </tr> <tr> <td style="text-align: center;">OWNER</td> <td colspan="3"></td> </tr> <tr> <td style="text-align: center;">PROJECT</td> <td colspan="3"></td> </tr> <tr> <td style="text-align: center;">LOCATION</td> <td colspan="3"></td> </tr> </table> <div style="text-align: center;"> <p>Arkansas One Call</p>  <p>Know what's below. Call before you dig.</p>  <p>CERTIFICATE OF AUTHORIZATION CWB ENGINEERS, INC. No. 1716 ARKANSAS</p>  <p>STATE OF ARKANSAS REGISTERED PROFESSIONAL ENGINEER No. 13631 C. KYLE BRECKENRIDGE 5/12/21</p> </div> <div style="text-align: center; font-size: 24pt; font-weight: bold;">2</div>	TOC & NOTES	SCALE: NTS	DATE: MAY 2021	PROJECT: 20-018	SHEET	CITY OF MOUNTAIN VIEW	WWTP IMPROVEMENTS	MOUNTAIN VIEW, AR	OWNER				PROJECT				LOCATION			
TOC & NOTES	SCALE: NTS	DATE: MAY 2021	PROJECT: 20-018																				
SHEET	CITY OF MOUNTAIN VIEW	WWTP IMPROVEMENTS	MOUNTAIN VIEW, AR																				
OWNER																							
PROJECT																							
LOCATION																							





Point Table				
Point #	Northing	Easting	Description	Elevation
P1	558465.13	1268685.58	CENTER	
P2	558500.54	1268764.85	PR. MH#1	RIM = 605.30
P3	558482.91	1268800.64	PR. MH#2	RIM = 605.30
P4	558426.62	1268800.64	PR. MH#3	RIM = 605.30
P5	558407.49	1268749.54	EX. 90° BEND	APPROXIMATE LOCATION
P6	558454.26	1268735.40	EX. ELEV.	TOC = 607.65
P7	558416.16	1268772.30	EX. ELEV.	GND = 605.27
P8	558425.55	1268743.77	EX. ELEV.	TOC = 607.82
AR-NORTH STATE PLANE COORDINATES				

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**SITE PLAN**  
 CITY OF MOUNTAIN VIEW  
 WWTW IMPROVEMENTS  
 MOUNTAIN VIEW, AR

**SHEET**  
 OWNER  
 PROJECT  
 LOCATION

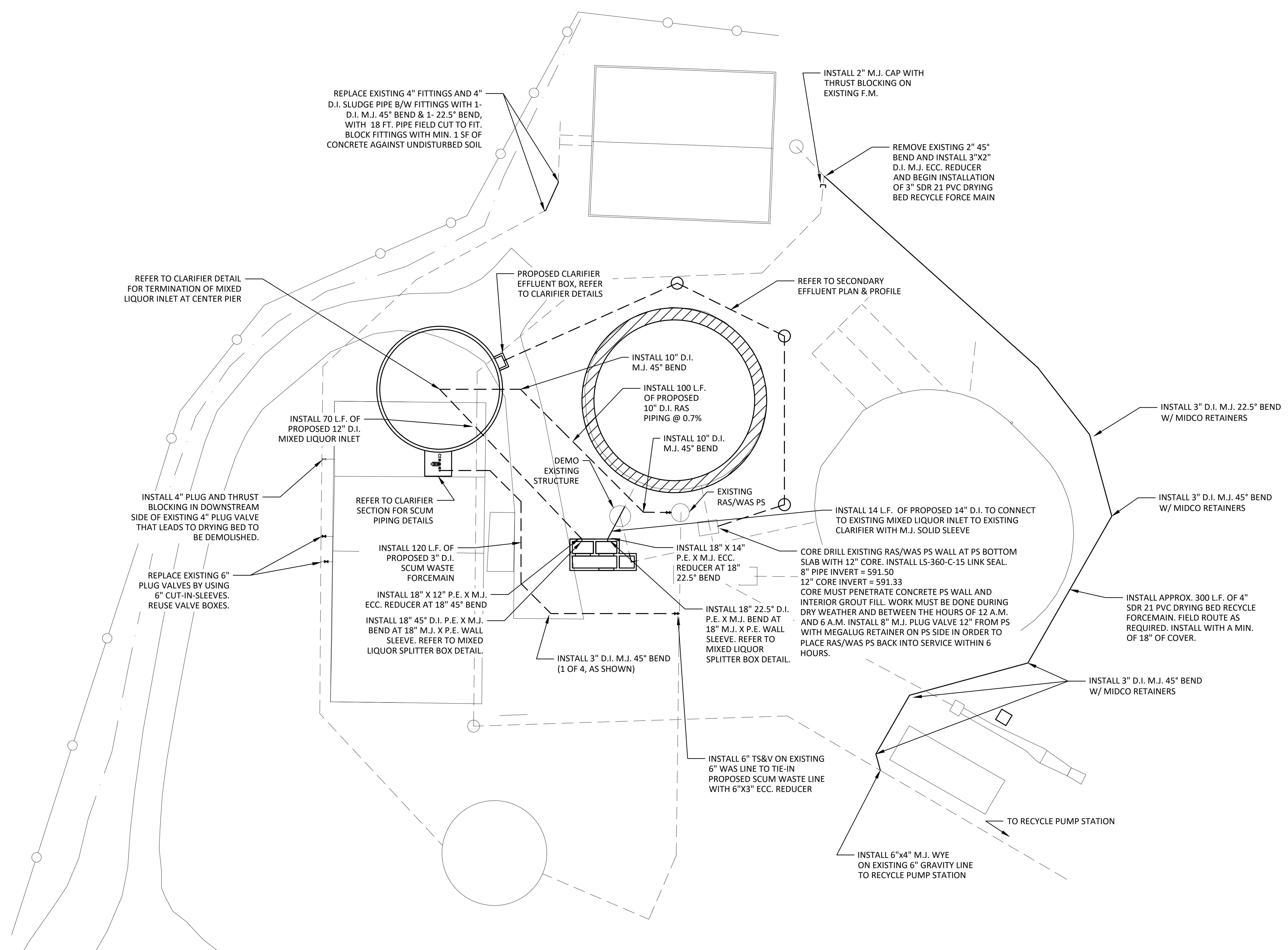
SCALE: 1:30  
 DATE: MAY 2021  
 PROJECT: 20-018

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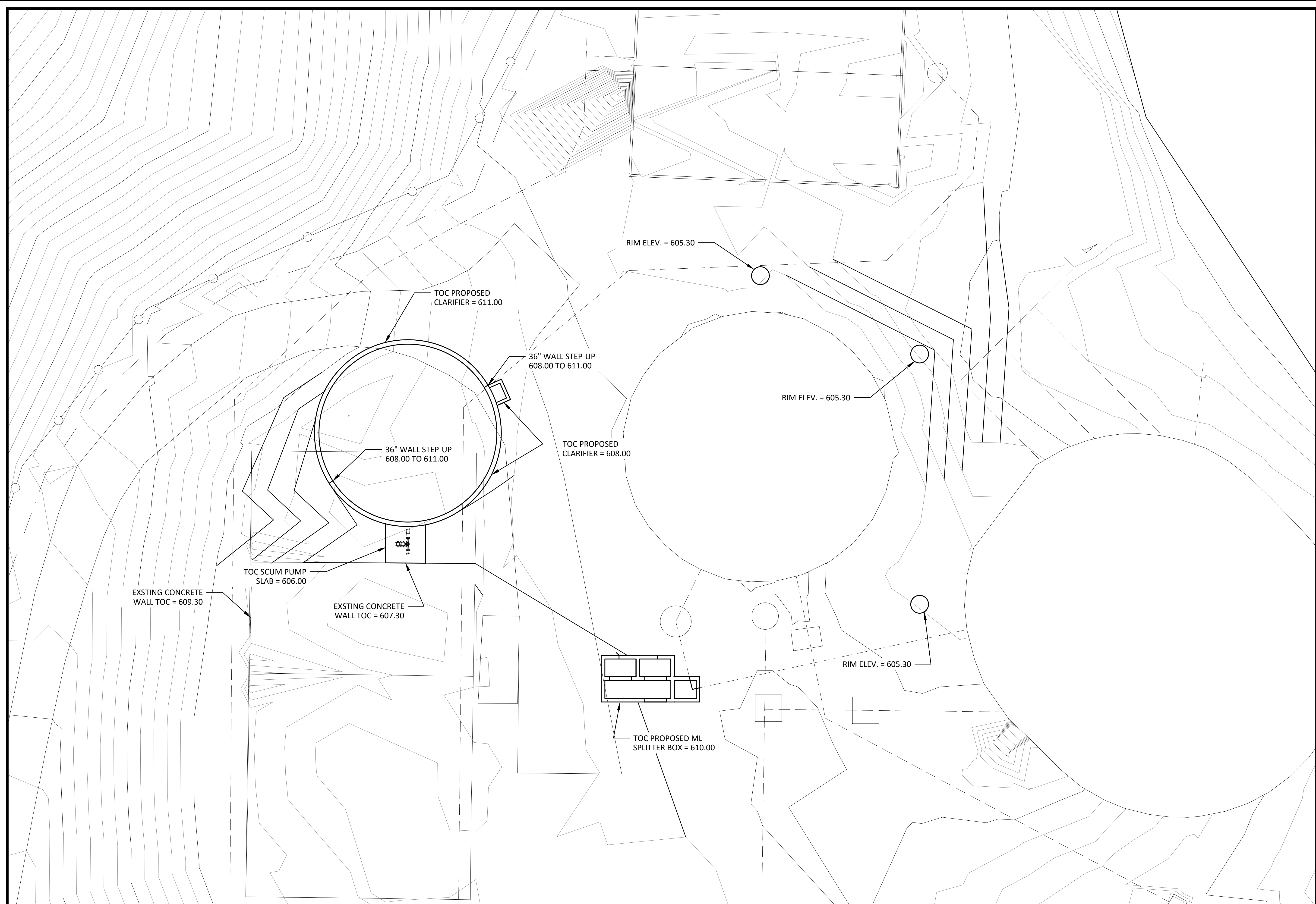
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YARD PIPING PLAN	SCALE: 1:10	DATE: MAY 2021	PROJECT: 20-018
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SHEET	OWNER	PROJECT	LOCATION

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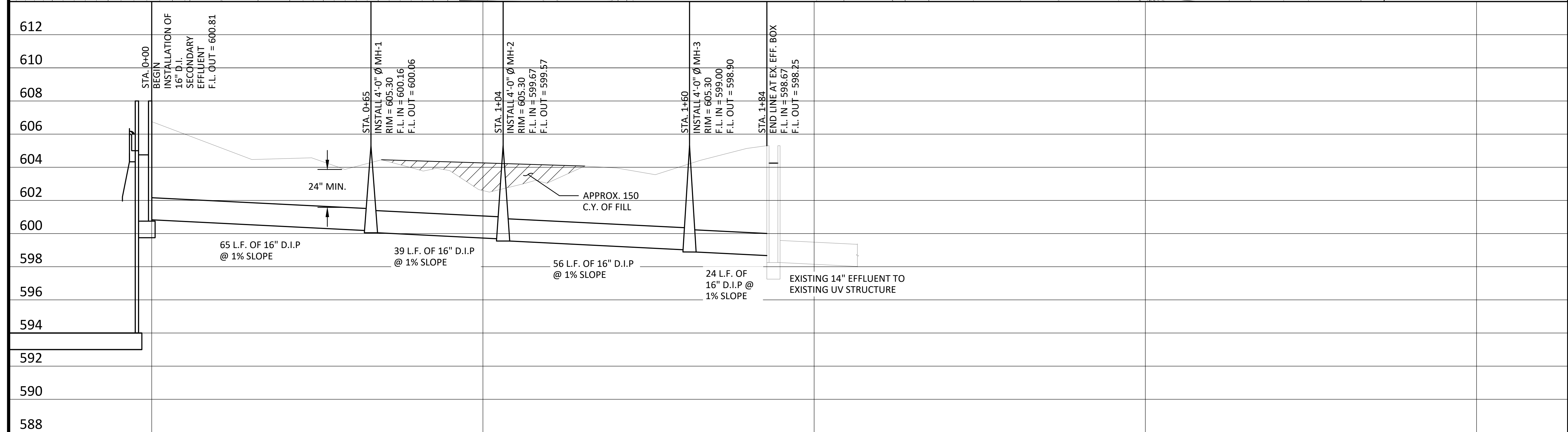
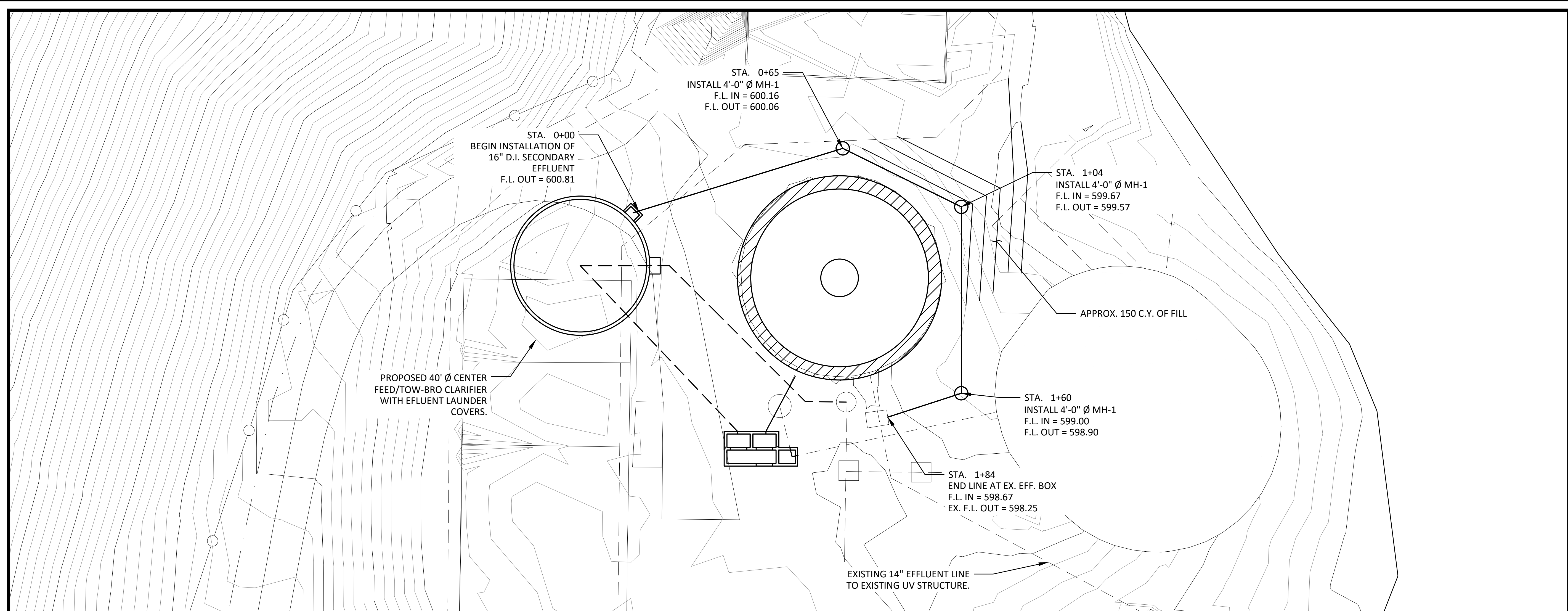
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<b>FINISHED GRADING PLAN</b>	<b>SCALE: 1:10</b>	<b>DATE: MAY 2021</b>	<b>PROJECT: 20-018</b>
<b>SHEET</b>	<b>CITY OF MOUNTAIN VIEW</b>	<b>WWTP IMPROVEMENTS</b>	<b>MOUNTAIN VIEW, AR</b>
<b>OWNER</b>			
<b>PROJECT</b>			
<b>LOCATION</b>			

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0+00

1+00

2+00

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CLARIFIER EFFLUENT P&P	SCALE: 1:16	DATE: MAY 2021	PROJECT: 20-018
	CITY OF MOUNTAIN VIEW	WWTIP IMPROVEMENTS	MOUNTAIN VIEW, AR
	SHEET	OWNER	PROJECT

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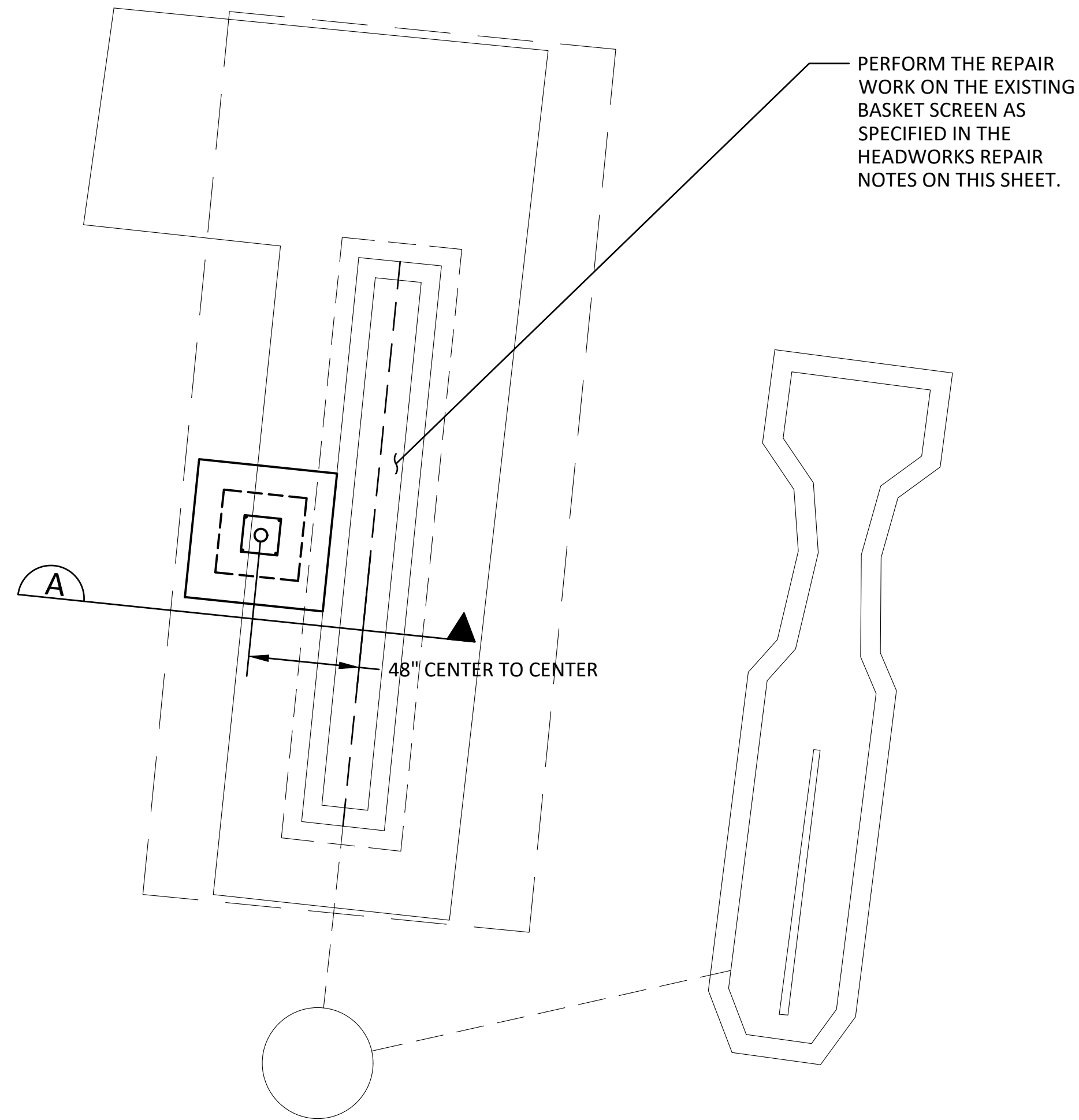
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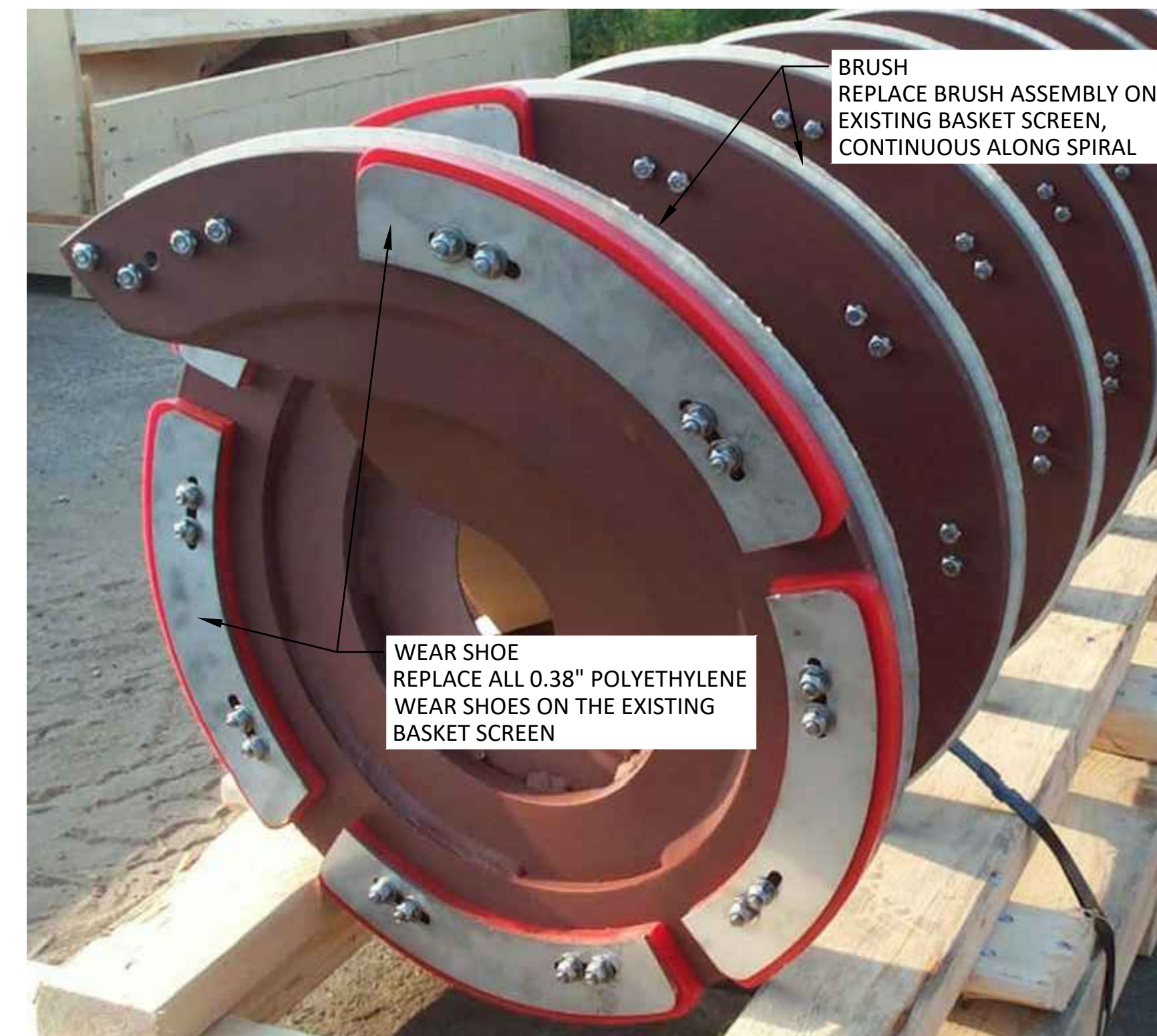
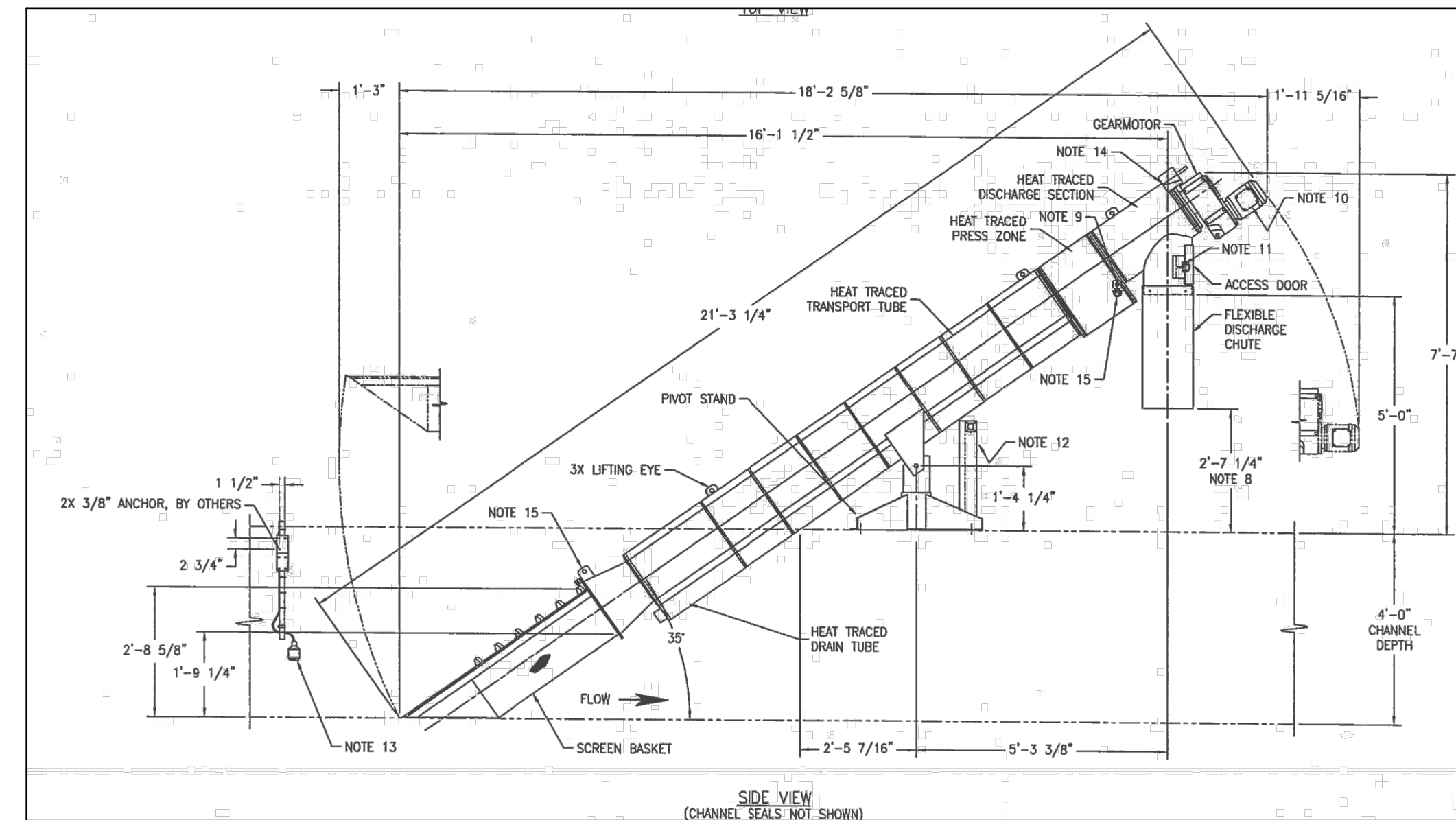


**HEADWORKS REPAIR NOTES**

- 1) REPLACE CHANNEL SEALS
- 2) REPLACE WEAR SHOES (5 TOTAL)
- 3) REPLACE BRUSH ASSEMBLY



PERFORM THE REPAIR WORK ON THE EXISTING BASKET SCREEN AS SPECIFIED IN THE HEADWORKS REPAIR NOTES ON THIS SHEET.



SAW CUT EXISTING CONCRETE SLAB & INSTALL CONSTRUCTION JOINT

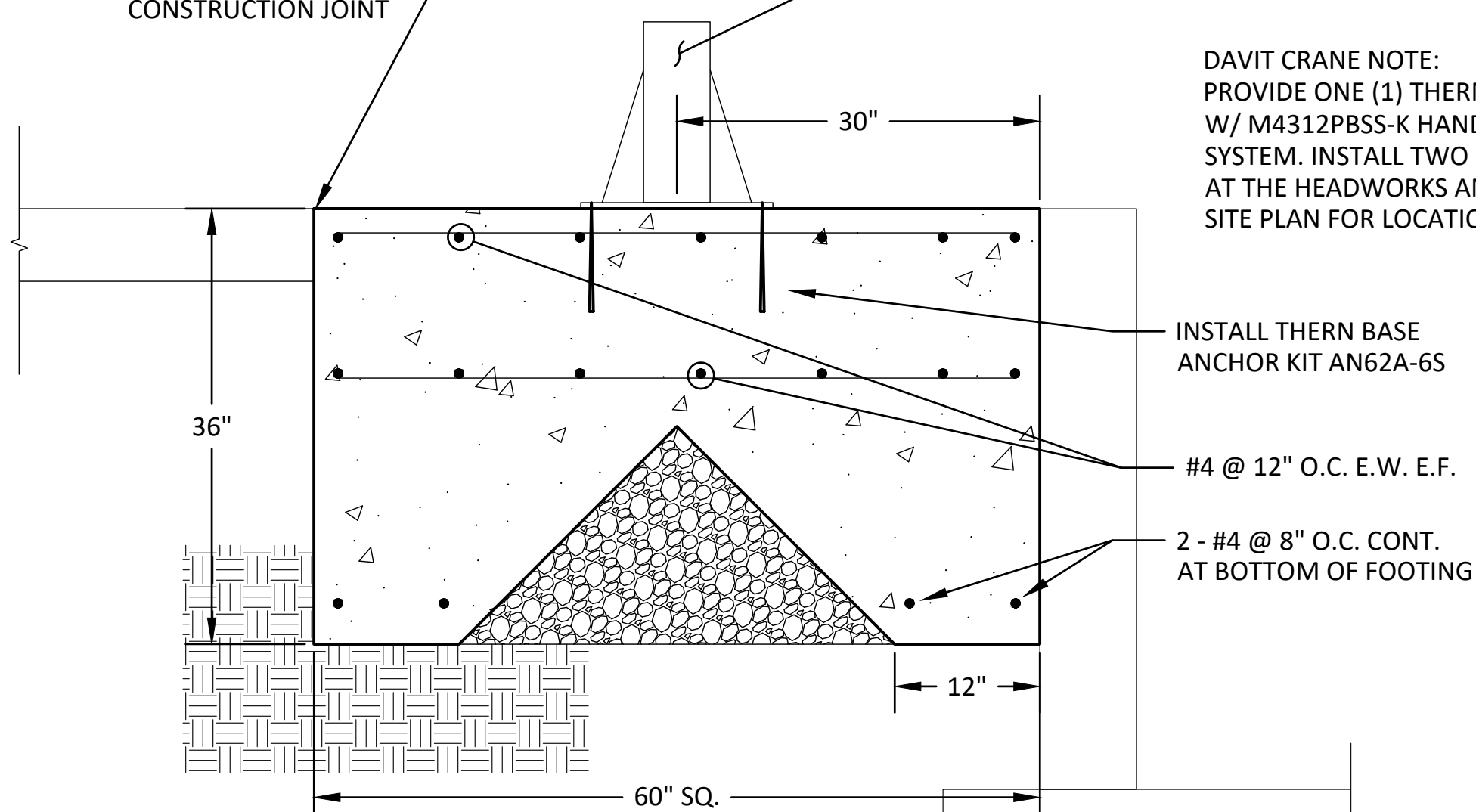
INSTALL THERN COMMANDER 2000 PEDESTAL BASE 5PT20S W/ 5PT20BRG-SS ROLLER BEARING

DAVIT CRANE NOTE:  
PROVIDE ONE (1) THERN COMMANDER 2000 5PT20S DAVIT CRANE W/ M4312PBSS-K HAND WINCH TO BE SHARED BETWEEN HEADWORKS AND UV SYSTEM. INSTALL TWO BASE ASSEMBLIES AS SHOWN AT LEFT. ONE (1) ASSEMBLY AT THE HEADWORKS AND ONE (1) ASSEMBLY AT THE UV STRUCTURE. REFER TO SITE PLAN FOR LOCATION OF EACH.

INSTALL THERN BASE ANCHOR KIT AN62A-6S

#4 @ 12" O.C. E.W. E.F.

2 - #4 @ 8" O.C. CONT. AT BOTTOM OF FOOTING



**SECTION A**  
SCALE: 1" = 1'-0"

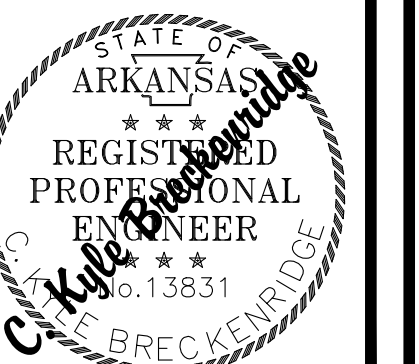
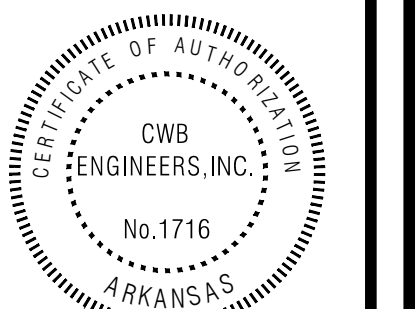
**HEADWORKS IMPROVEMENTS**

SHEET	OWNER	CITY OF MOUNTAIN VIEW
	PROJECT	WWTP IMPROVEMENTS
SCALE: 1:30	DATE: MAY 2021	PROJECT: 20-018
LOCATION	MOUNTAIN VIEW, AR	

Arkansas One Call



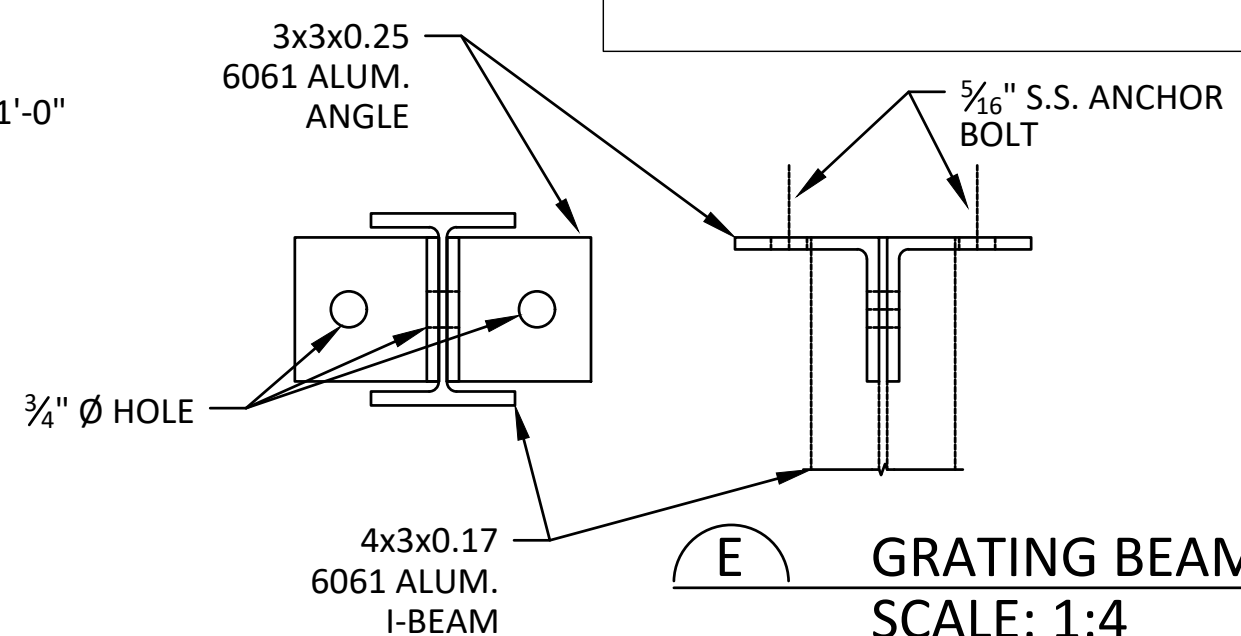
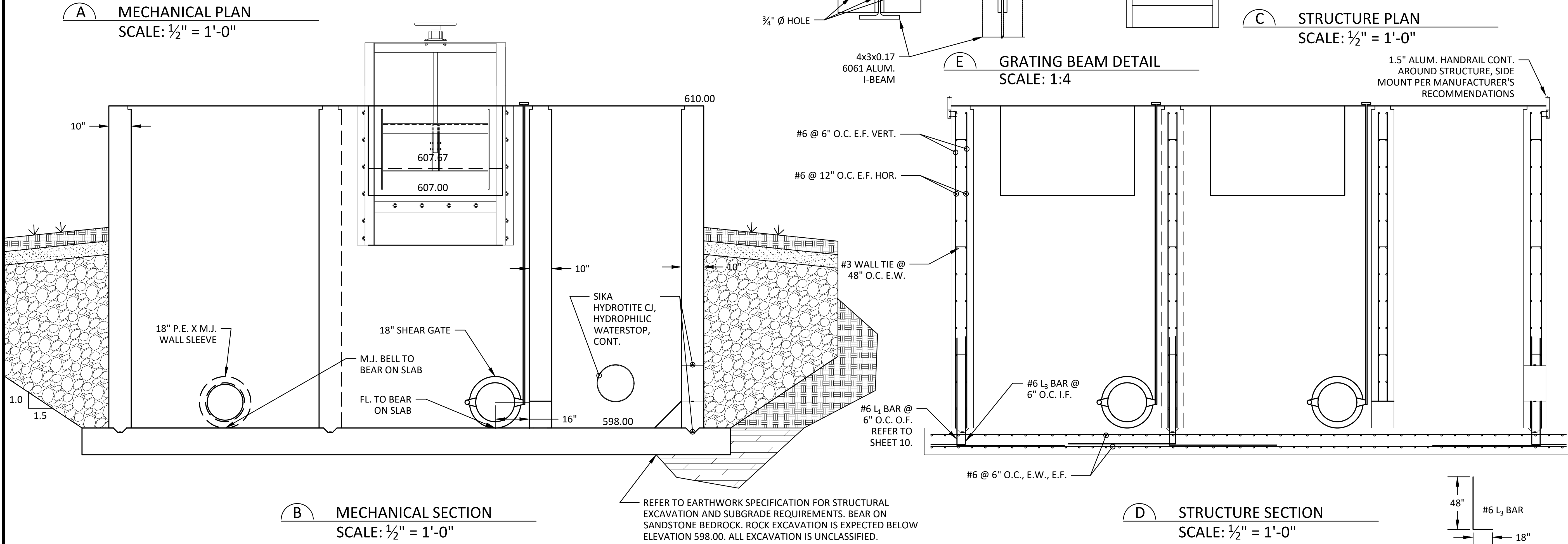
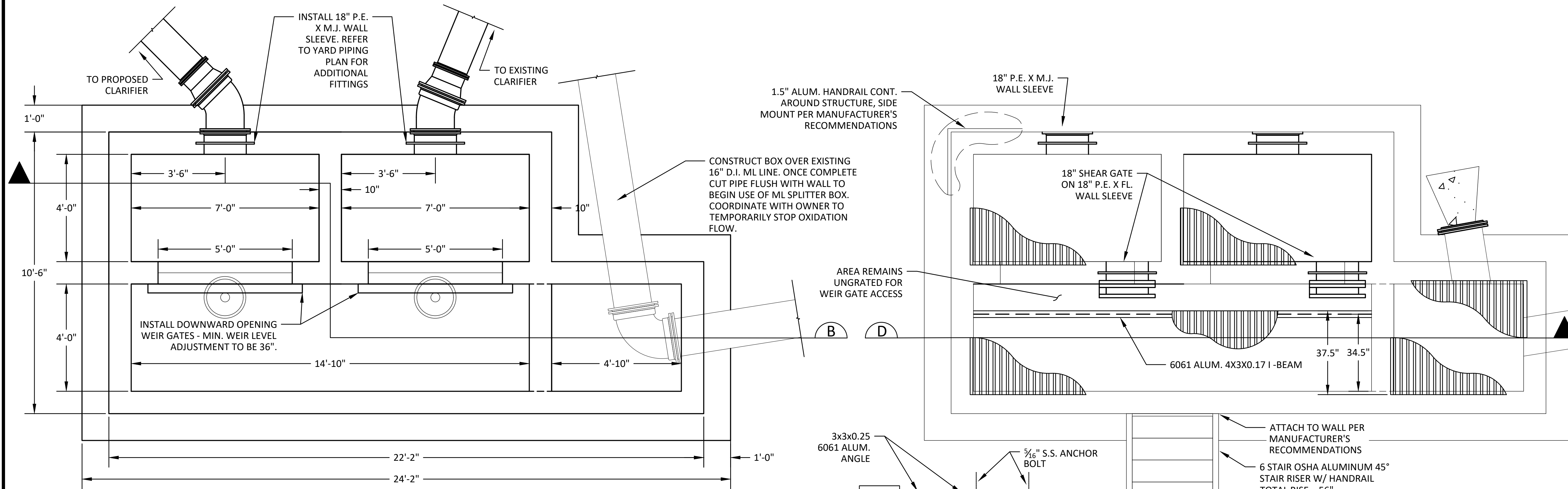
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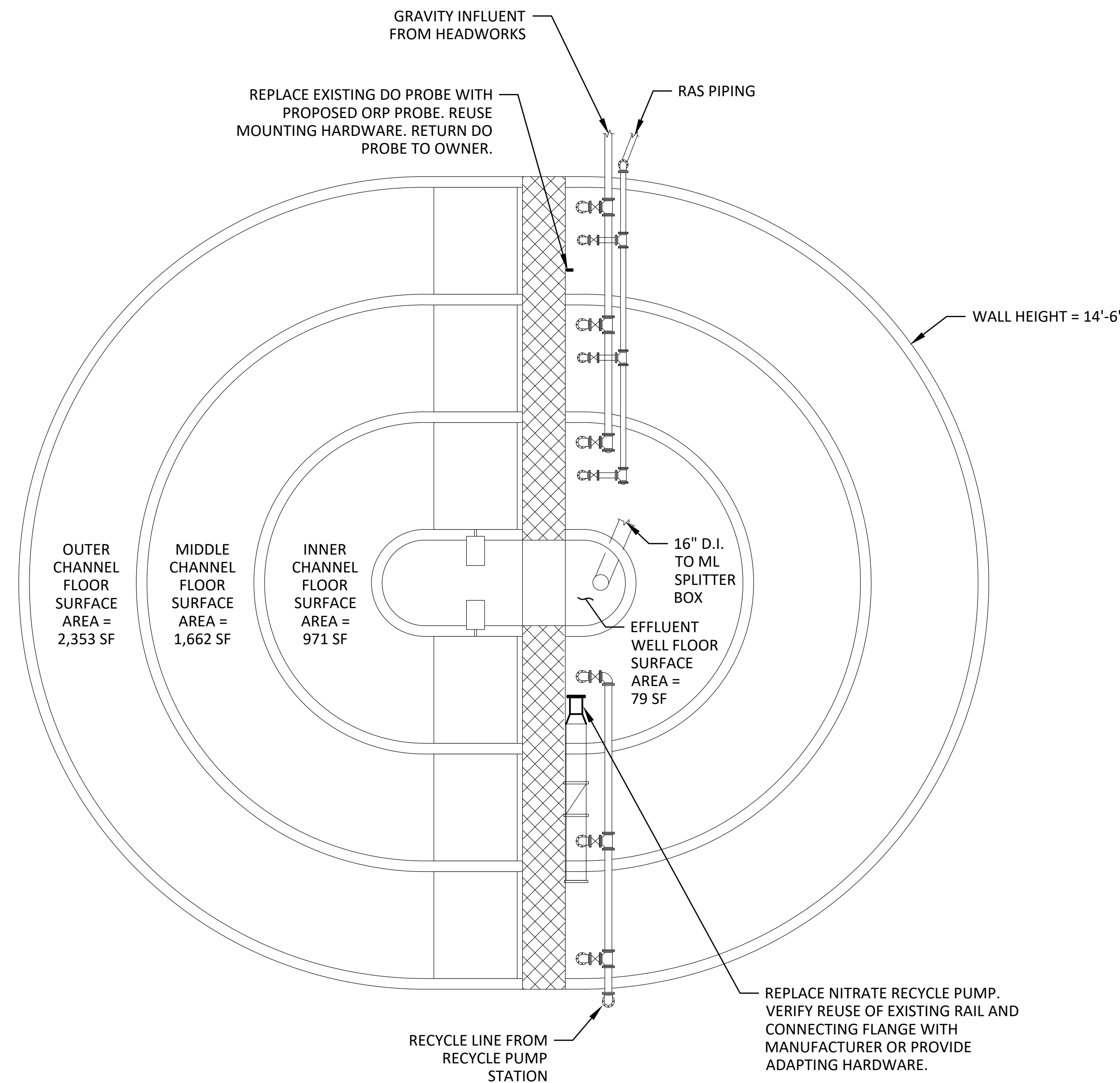
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MIXED LIQUOR SPLITTER BOX PLAN & SECTION	SCALE: 1/2" = 1'-0"	DATE: MAY 2021	PROJECT: 20-018
CITY OF MOUNTAIN VIEW	WWTIP IMPROVEMENTS	MOUNTAIN VIEW, AR	
SHEET	OWNER	PROJECT	LOCATION

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No. 13631  
C. KYLE BRECKENRIDGE



REPLACE EXISTING DO PROBE WITH PROPOSED ORP PROBE. REUSE MOUNTING HARDWARE. RETURN DO PROBE TO OWNER.

OUTER CHANNEL FLOOR SURFACE AREA = 2,353 SF  
 MIDDLE CHANNEL FLOOR SURFACE AREA = 1,662 SF  
 INNER CHANNEL FLOOR SURFACE AREA = 971 SF

**A** OXIDATION DITCH REHABILITATION  
 SCALE: 1/8" = 1'-0"

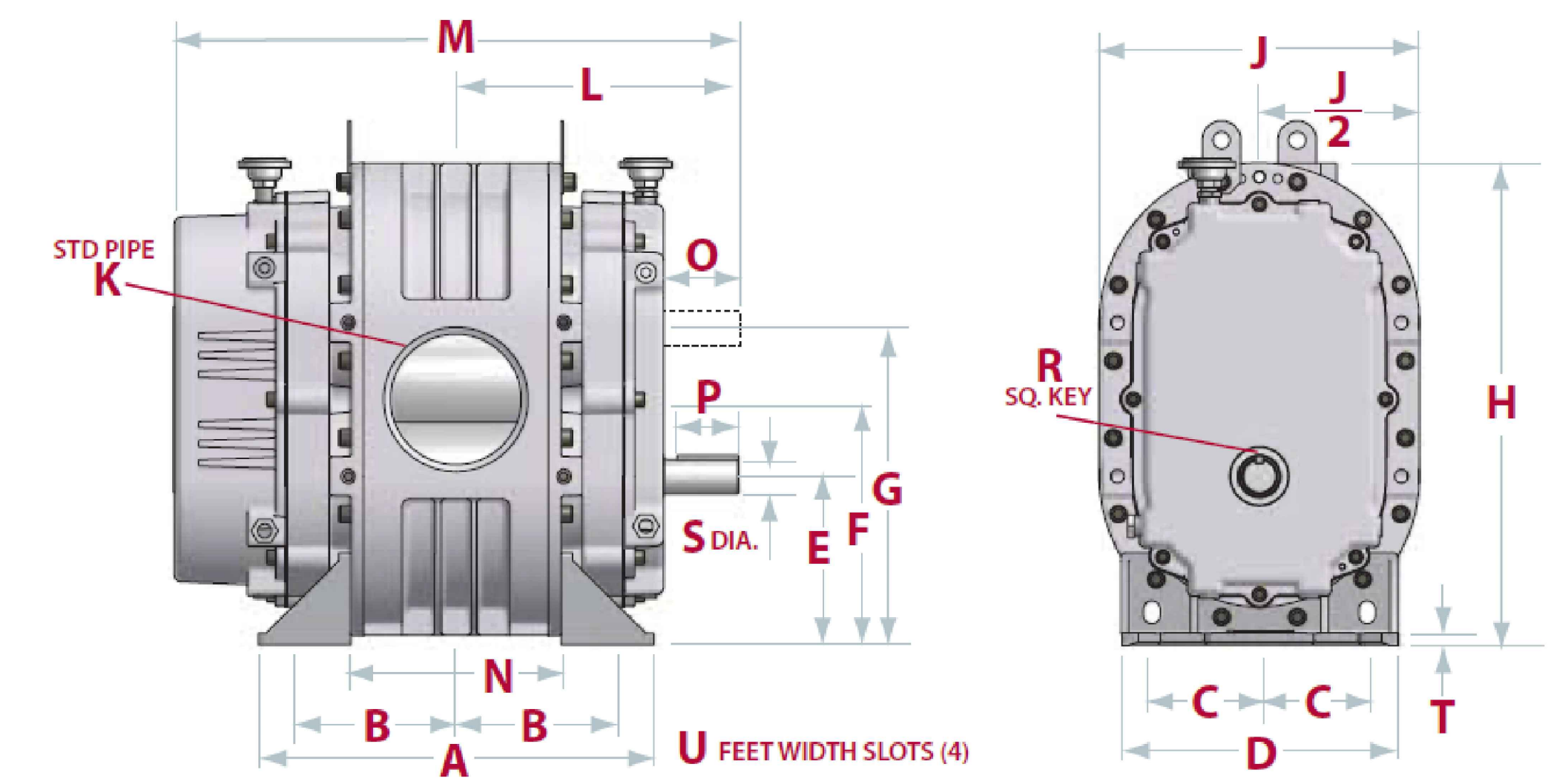
**PHASING SCHEDULE FOR OXIDATION DITCH CLEANING**

THE FOLLOWING WORK ITEMS MUST BE DONE IN LOW FLOW PERIODS AND ONLY AFTER THE HEADWORKS IMPROVEMENTS HAVE BEEN ACCOMPLISHED, AND BEFORE THE PROPOSED CLARIFIER OR REHABILITATED EXISTING CLARIFIER ARE PUT INTO SERVICE.

- COORDINATE WITH OWNER TO REMOVE MIDDLE AND INNER CHANNELS FROM SERVICE WHILE LEAVING OUTER CHANNEL IN SERVICE FOR TREATMENT. BYPASS PUMP EFFLUENT FROM OUTER CHANNEL TO EFFLUENT WELL WITH FULL THROTTLE TRASH PUMP CAPACITY OF AT LEAST 1,600 GPM. CONTINUE BYPASS PUMPING UNTIL MIDDLE AND INNER CHANNELS ARE RETURNED TO SERVICE.
- DEWATER MIDDLE AND INNER CHANNELS BY PUMPING TO THE EFFLUENT WELL OR EXISTING CLARIFIER CENTER WELL USING A TRASH PUMP.
- REMOVE ALL SLUDGE AND TRASH IN CHANNELS THAT REMAINS AFTER DEWATERING. DISPOSE OF MATERIAL AT A SUITABLE LANDFILL SOLIDIFICATION PIT. REMOVAL, HAULING, AND DISPOSAL WILL BE PAID BY THE CUBIC FOOT OF MATERIAL REMOVED.
- COORDINATE WITH OWNER TO RETURN MIDDLE AND INNER CHANNELS TO SERVICE IN THE TREATMENT STREAM AND TO REMOVE OUTER CHANNEL FOR CLEANING.
- REPEAT PROCESS TO REMOVE TRASH AND SLUDGE FROM OUTER CHANNEL AND THEN RETURN TO SERVICE.
- COORDINATE WITH OWNER TO REMOVE EFFLUENT WELL FROM SERVICE AND BEGIN BYPASS PUMPING FROM INNER CHANNEL TO FINAL CLARIFIER CENTER WELL.
- REMOVE ALL TRASH AND SLUDGE WITHIN EFFLUENT WELL AND THEN RETURN TO SERVICE.

**Dimensional Data – Vertical Configurations**

SIZE	WT.	CONN.	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	R	S	T	U
REPLACE 1 OF 2 EXISTING SUTORBILT LEGEND SERIES 4HP-GACHBPA BLOWER WITH SUTORBILT LEGEND DSL 4HV. REUSE EXISTING BASE MOUNT, MOTOR, AND BELT ASSEMBLY. RETURN LOCKED BLOWER TO OWNER.																					
4H	98	S	7.25	3	3	8.25	4.5	6.5	8.5	12.69	8.38	1.5	6.88	13.75	4	2.38	1.81	.19	.875	.38	.5 x .75



**B** EQ BASIN BLOWER REPLACEMENT  
 SCALE: N.T.S.

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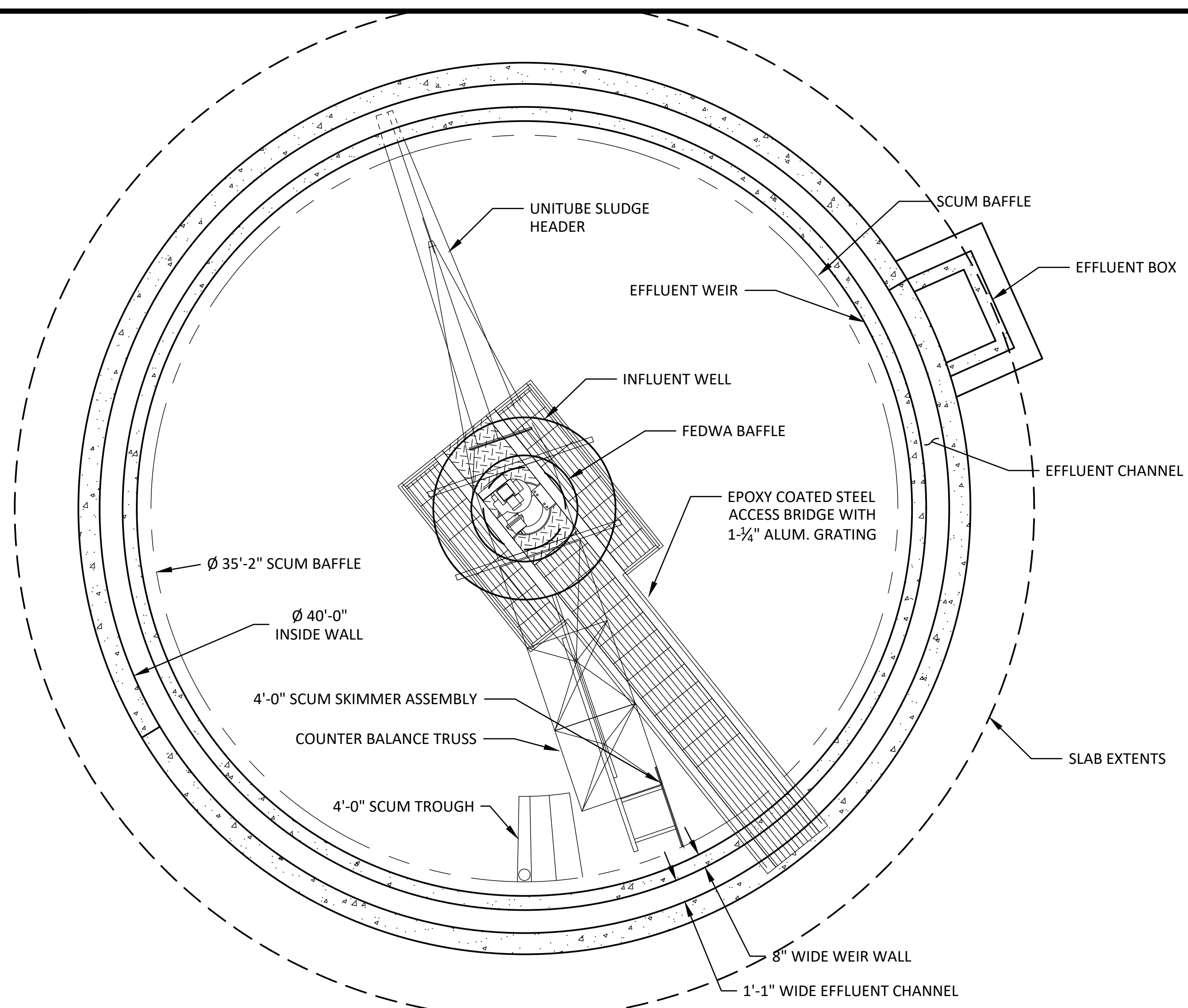
OXIDATION DITCH REHABILITATION	SCALE: 1/8" = 1'-0"	DATE: MAY 2021	PROJECT: 20-018
	CITY OF MOUNTAIN VIEW	WWTP IMPROVEMENTS	MOUNTAIN VIEW, AR
SHEET	OWNER	PROJECT	LOCATION

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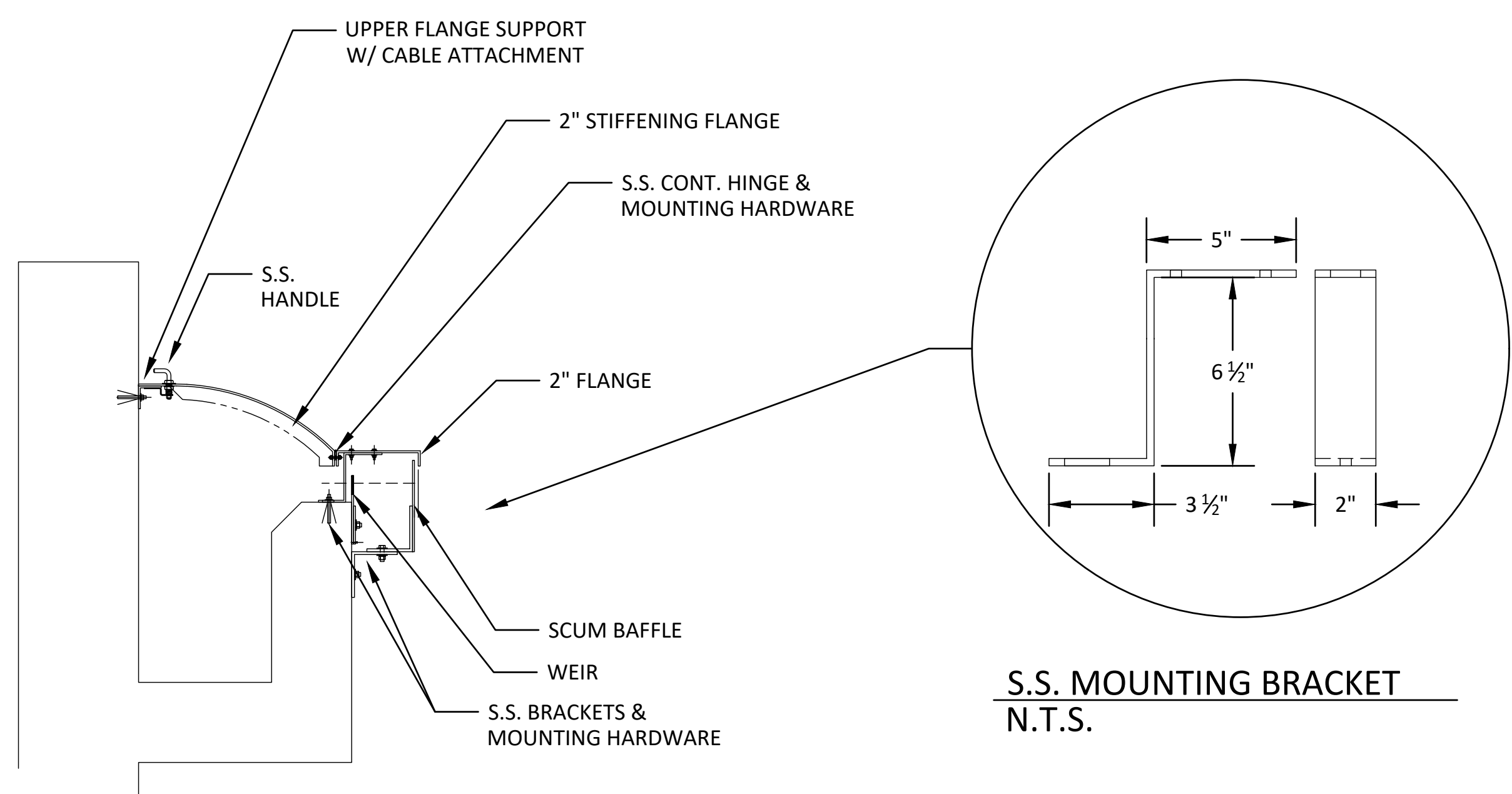
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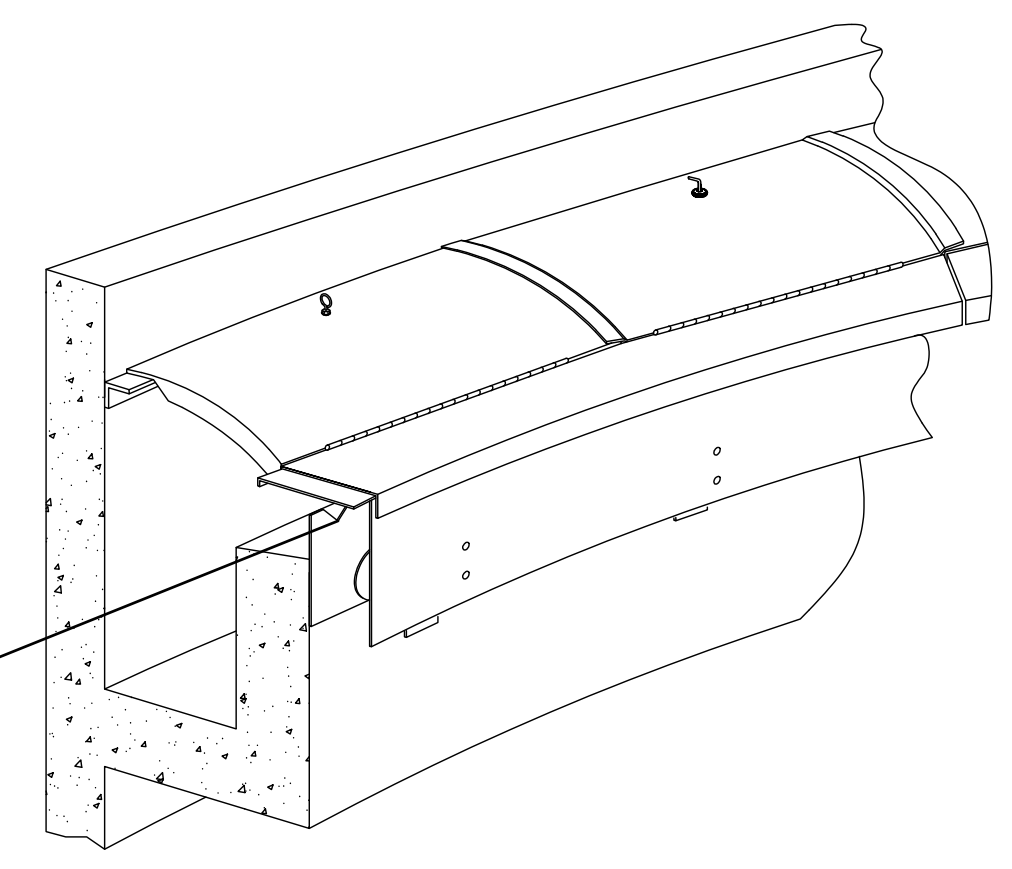


**A** PLAN  
SCALE: 1/4" = 1'-0"

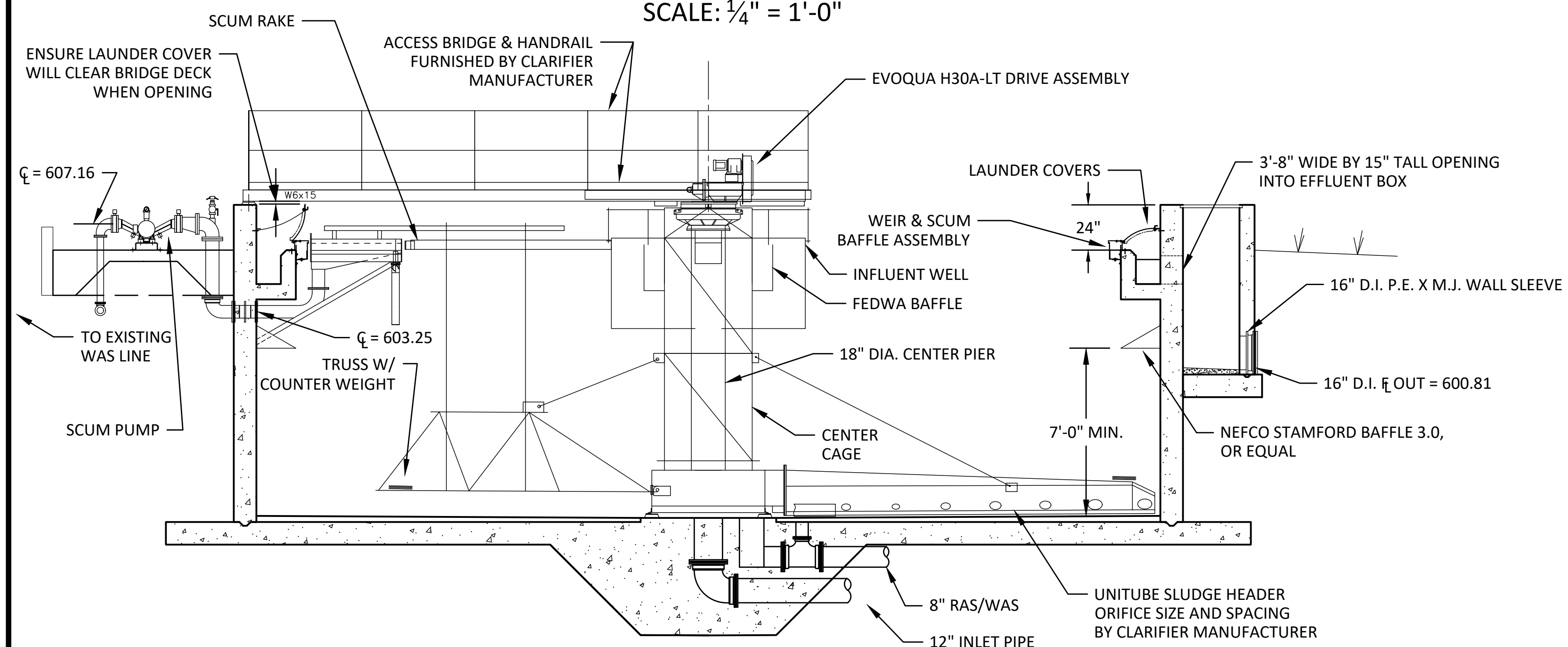


**C** LAUNDRER COVER SECTION  
SCALE: 1" = 1'-0"

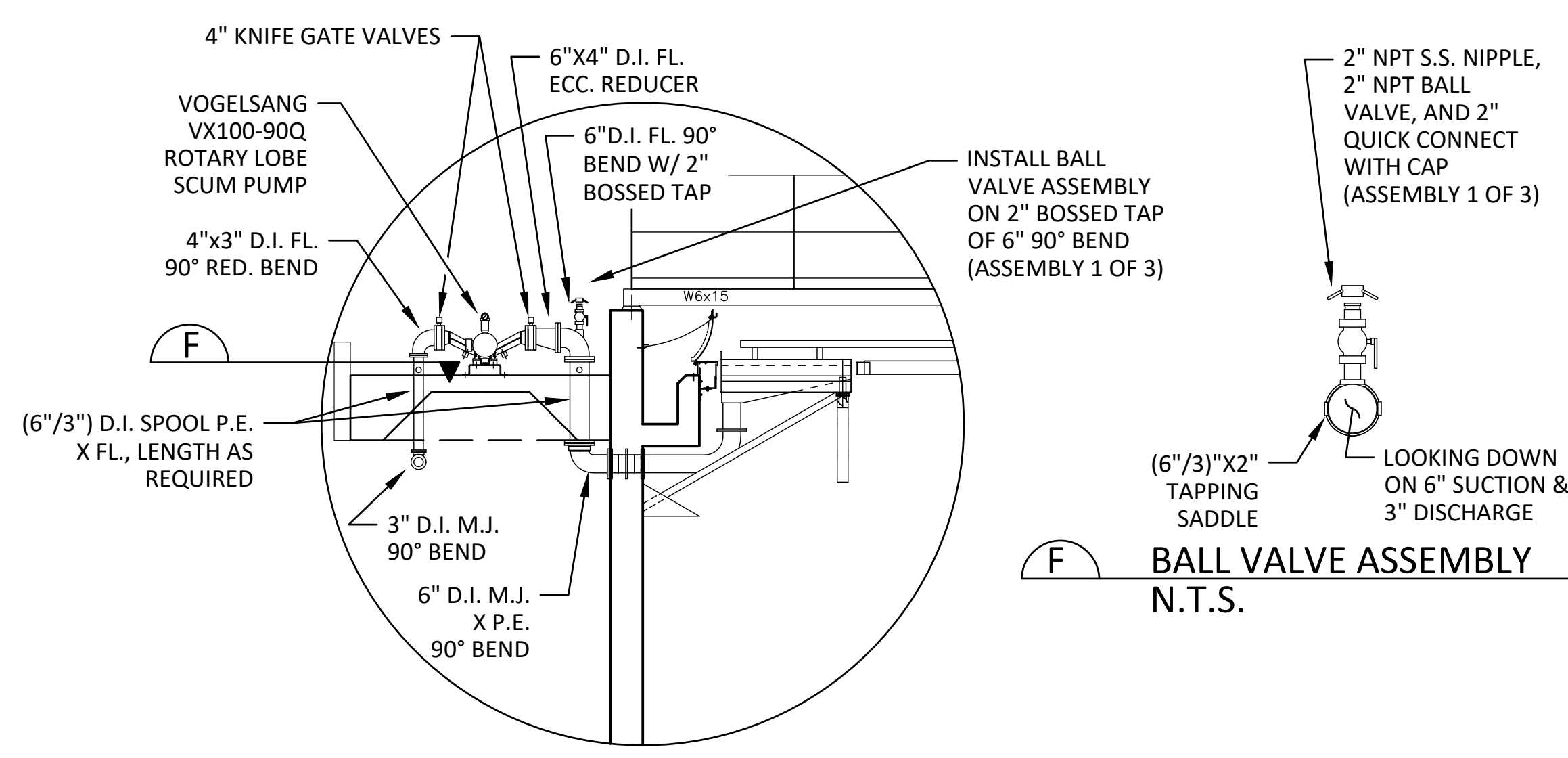
S.S. MOUNTING BRACKET  
N.T.S.



**D** LAUNDRER COVER ISOMETRIC  
N.T.S.



**B** SECTION  
SCALE: 1/4" = 1'-0"



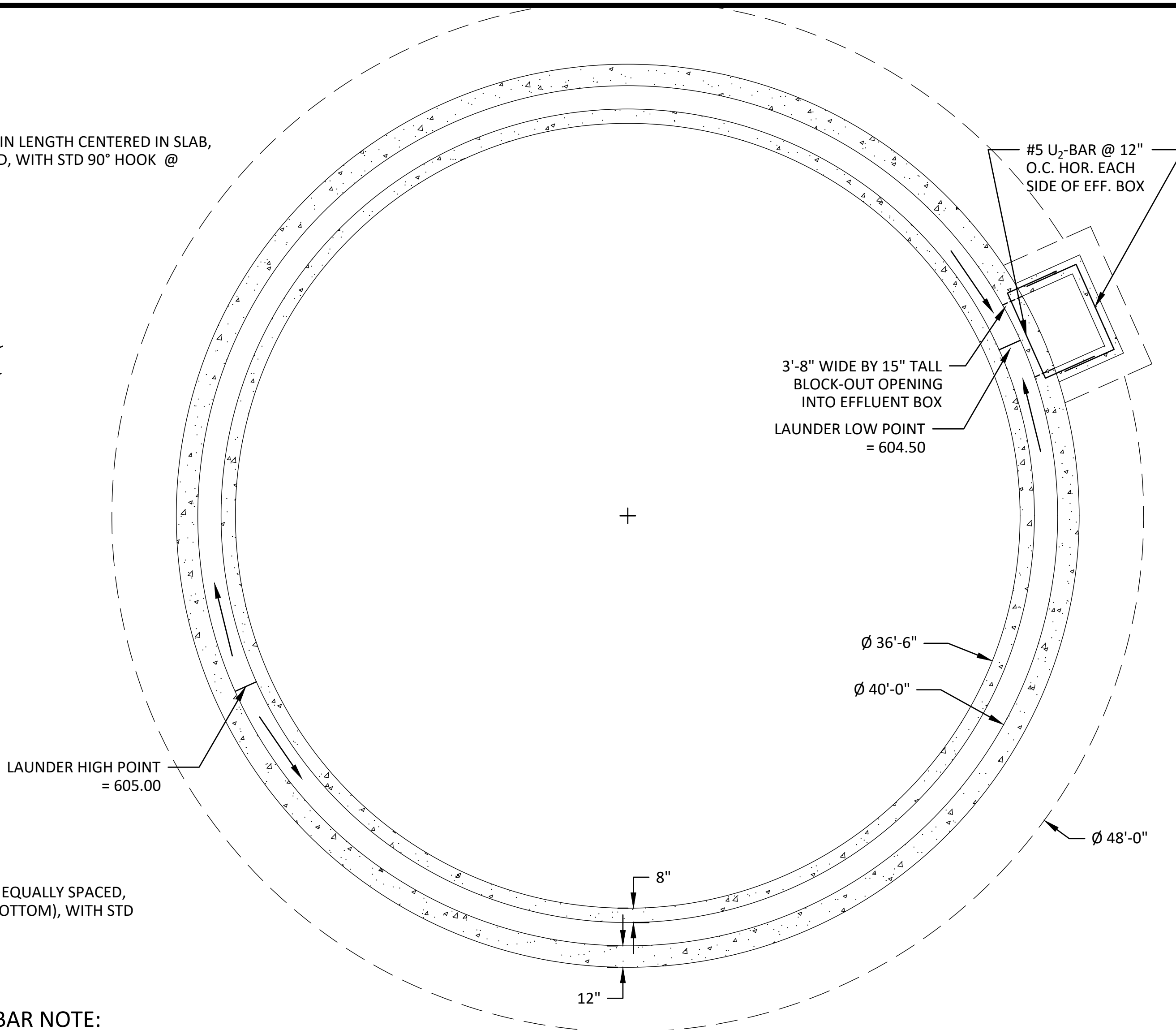
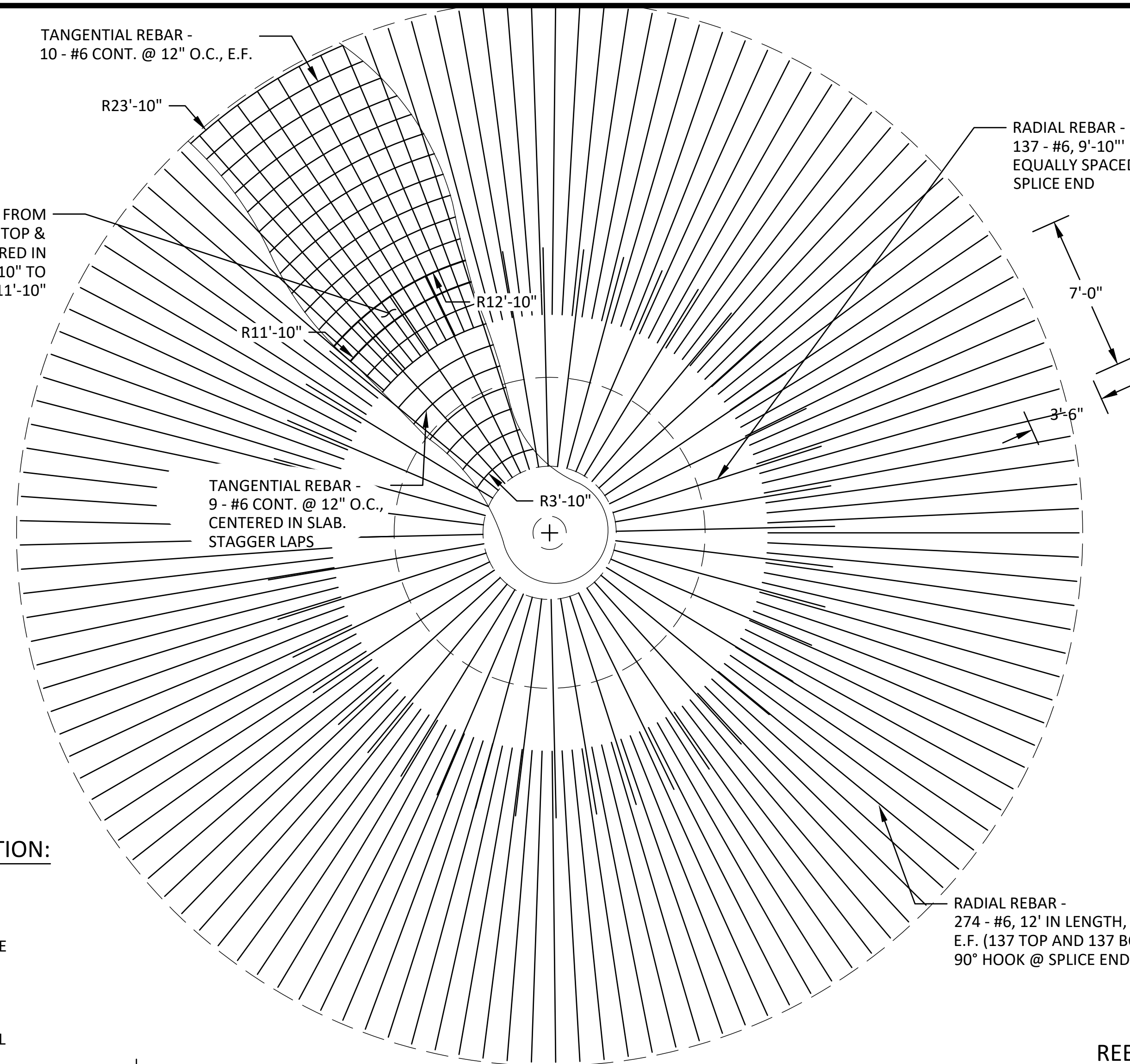
**E** SCUM PUMP DETAIL  
N.T.S.

**F** BALL VALVE ASSEMBLY  
N.T.S.

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CLARIFIER PLAN	SCALE: 1/4" = 1'-0"	DATE: MAY 2021	PROJECT: 20-018
CITY OF MOUNTAIN VIEW	WWT IMPROVEMENTS	MOUNTAIN VIEW, AR	
SHEET	OWNER	PROJECT	LOCATION

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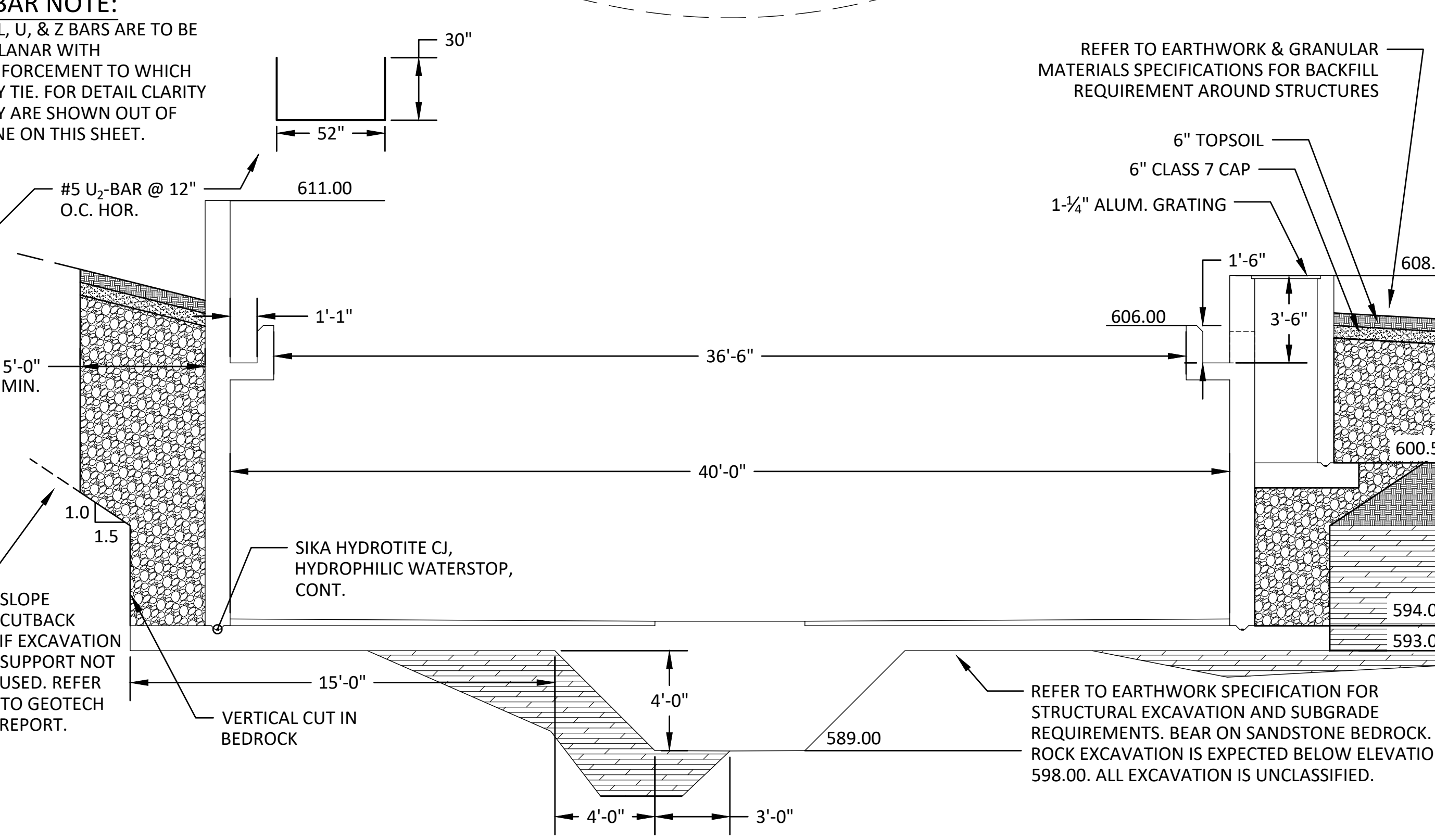
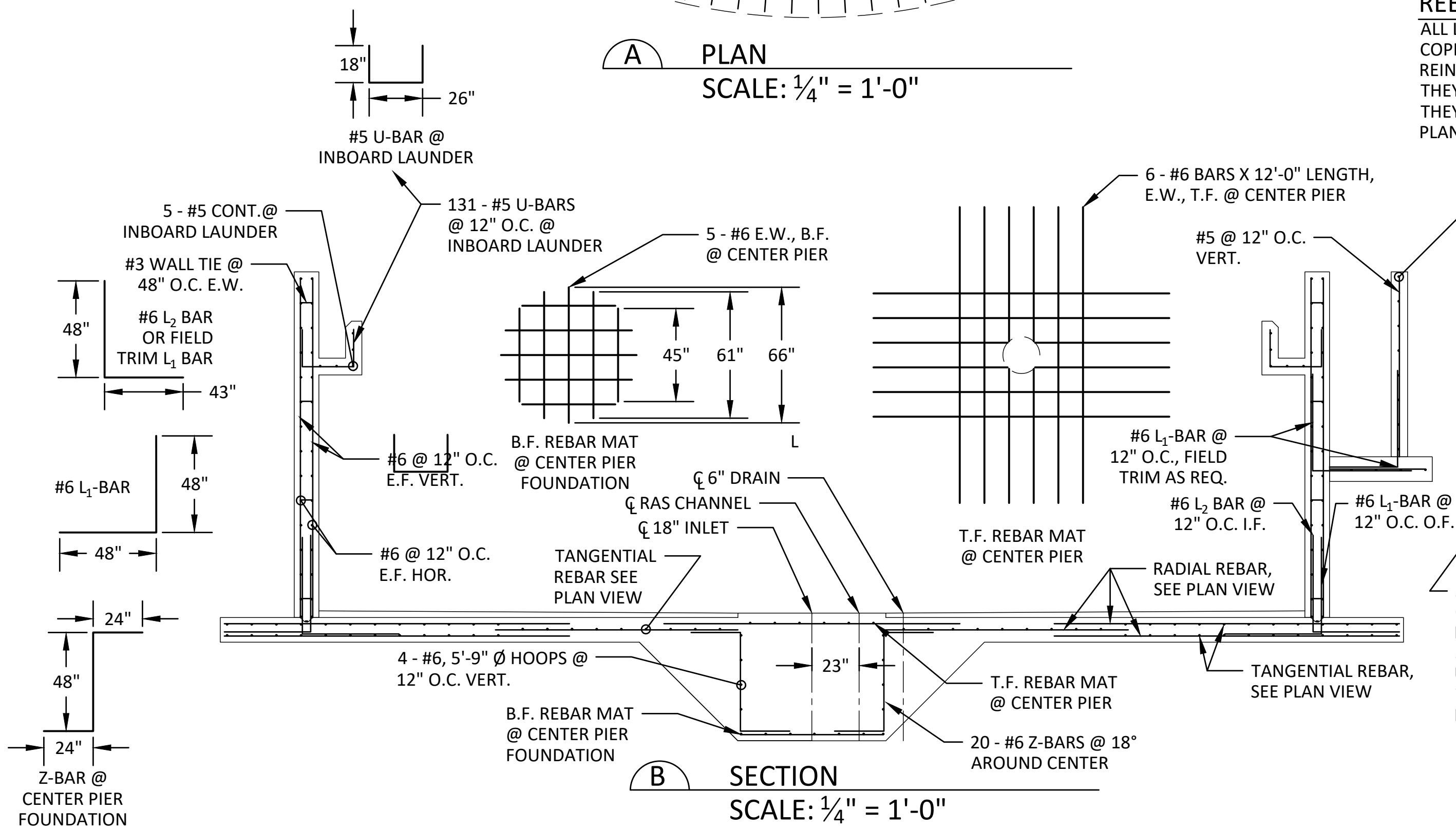


**REBAR NOTATION:**

E.W. = EACH WAY  
 E.F. = EACH FACE  
 O.C. = ON CENTER  
 B.F. = BOTTOM FACE  
 T.F. = TOP FACE  
 I.F. = INNER FACE  
 O.F. = OUTER FACE  
 VERT. = VERTICAL  
 HOR. = HORIZONTAL

**REBAR NOTE:**

ALL L, U, & Z BARS ARE TO BE COPLANAR WITH REINFORCEMENT TO WHICH THEY TIE. FOR DETAIL CLARITY THEY ARE SHOWN OUT OF PLANE ON THIS SHEET.



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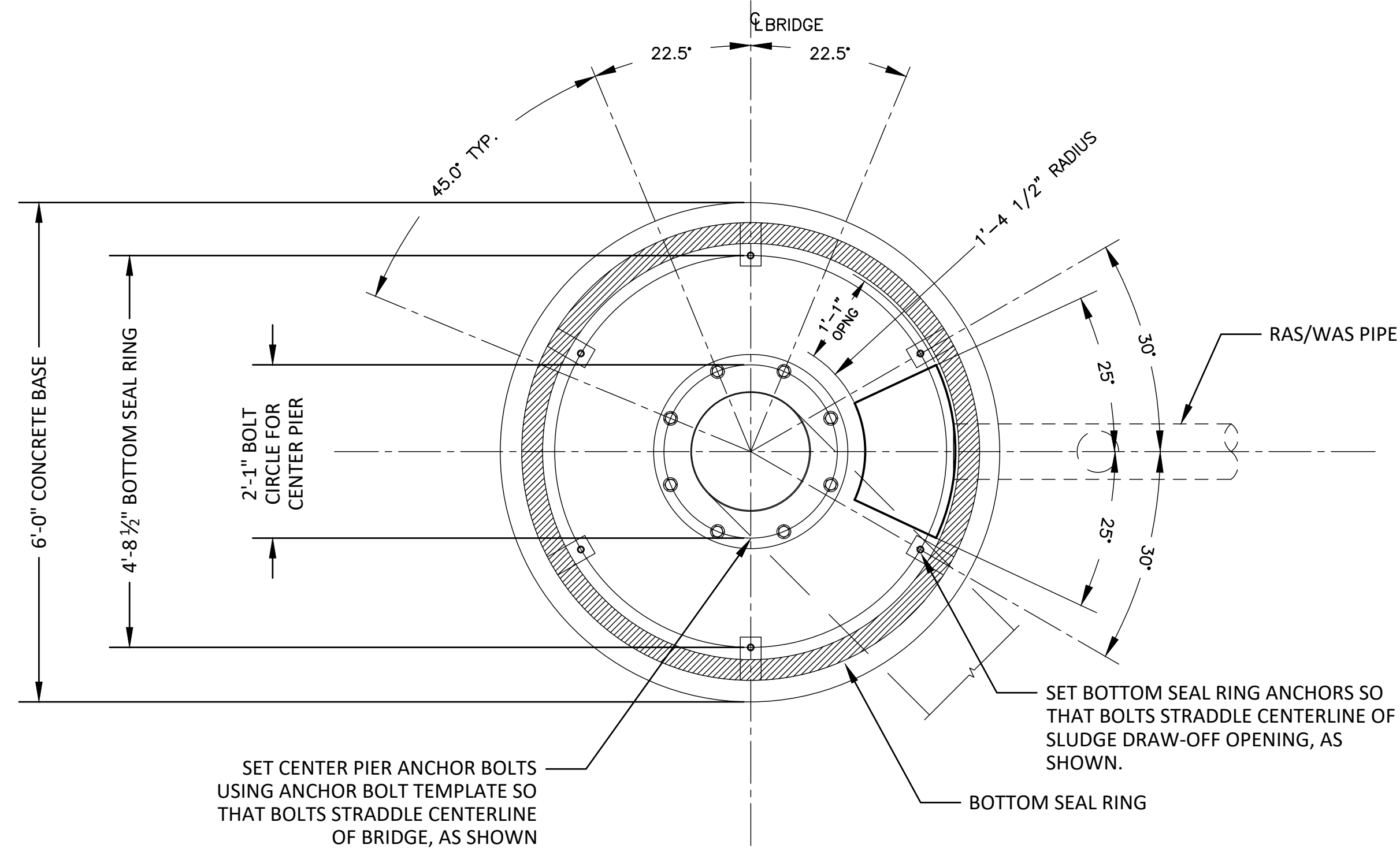
CLARIFIER STRUCTURAL PLAN	SCALE: 1/4" = 1'-0"	DATE: MAY 2021	PROJECT: 20-018
	CITY OF MOUNTAIN VIEW	WWTP IMPROVEMENTS	MOUNTAIN VIEW, AR
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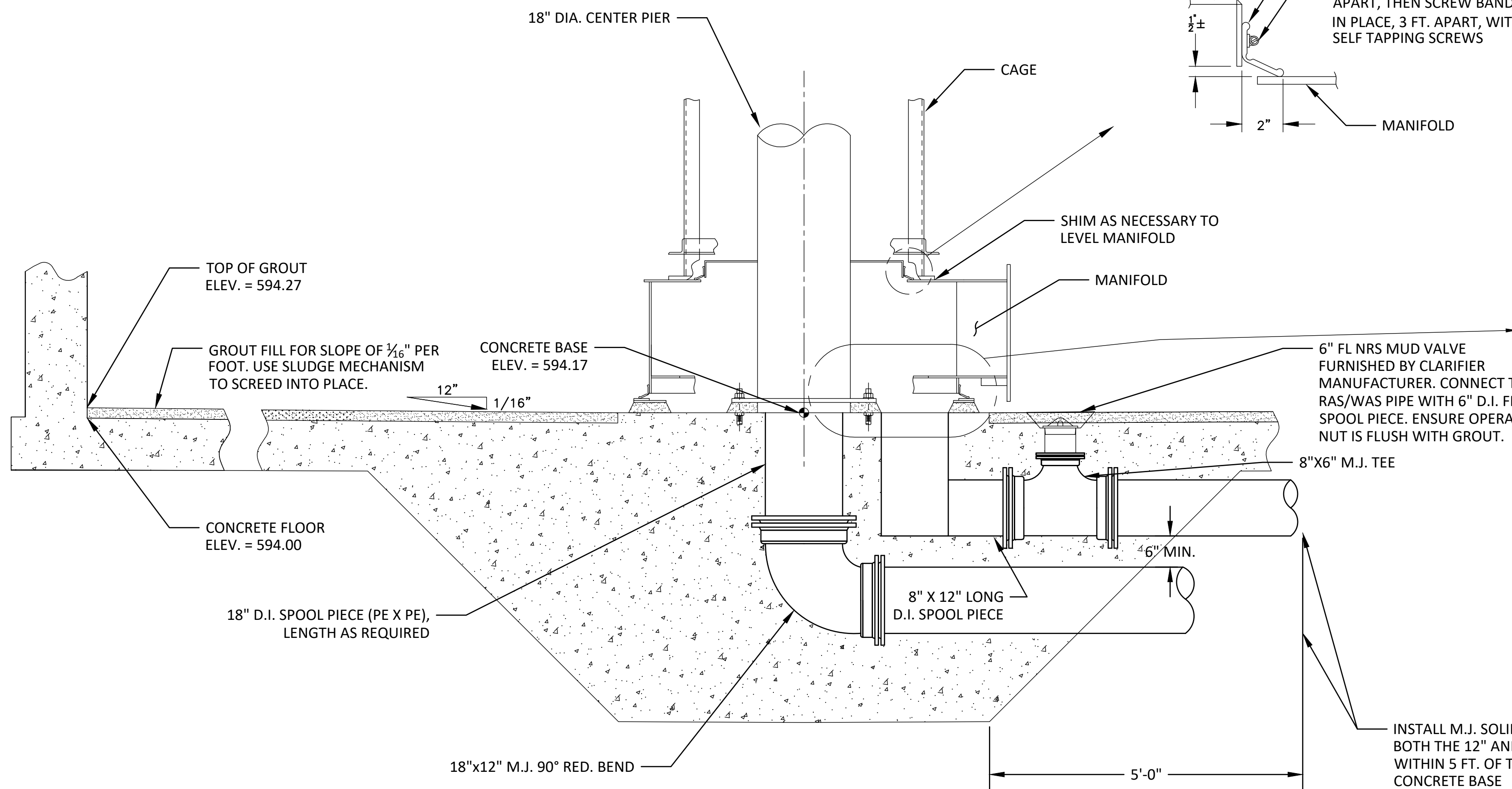
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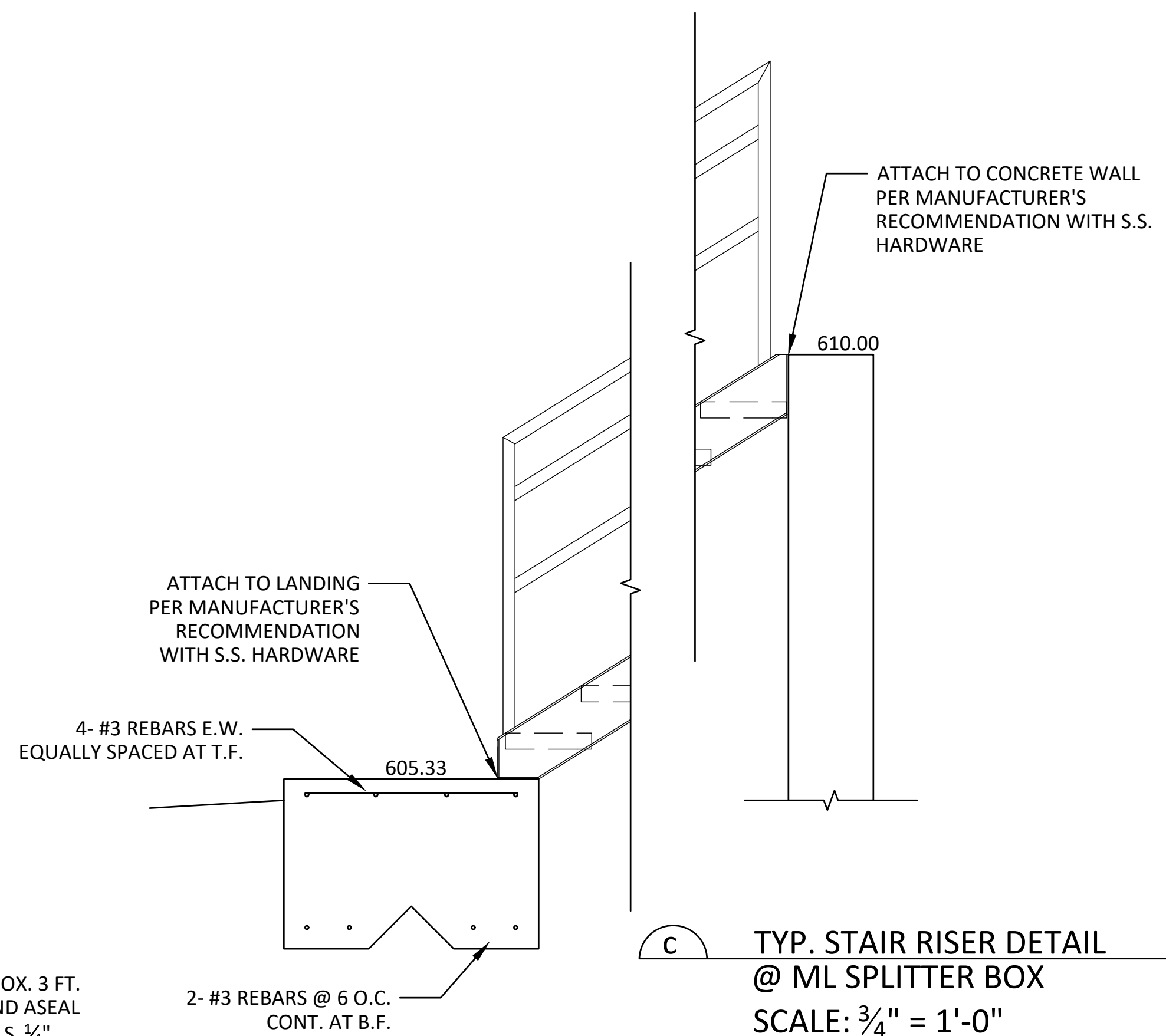




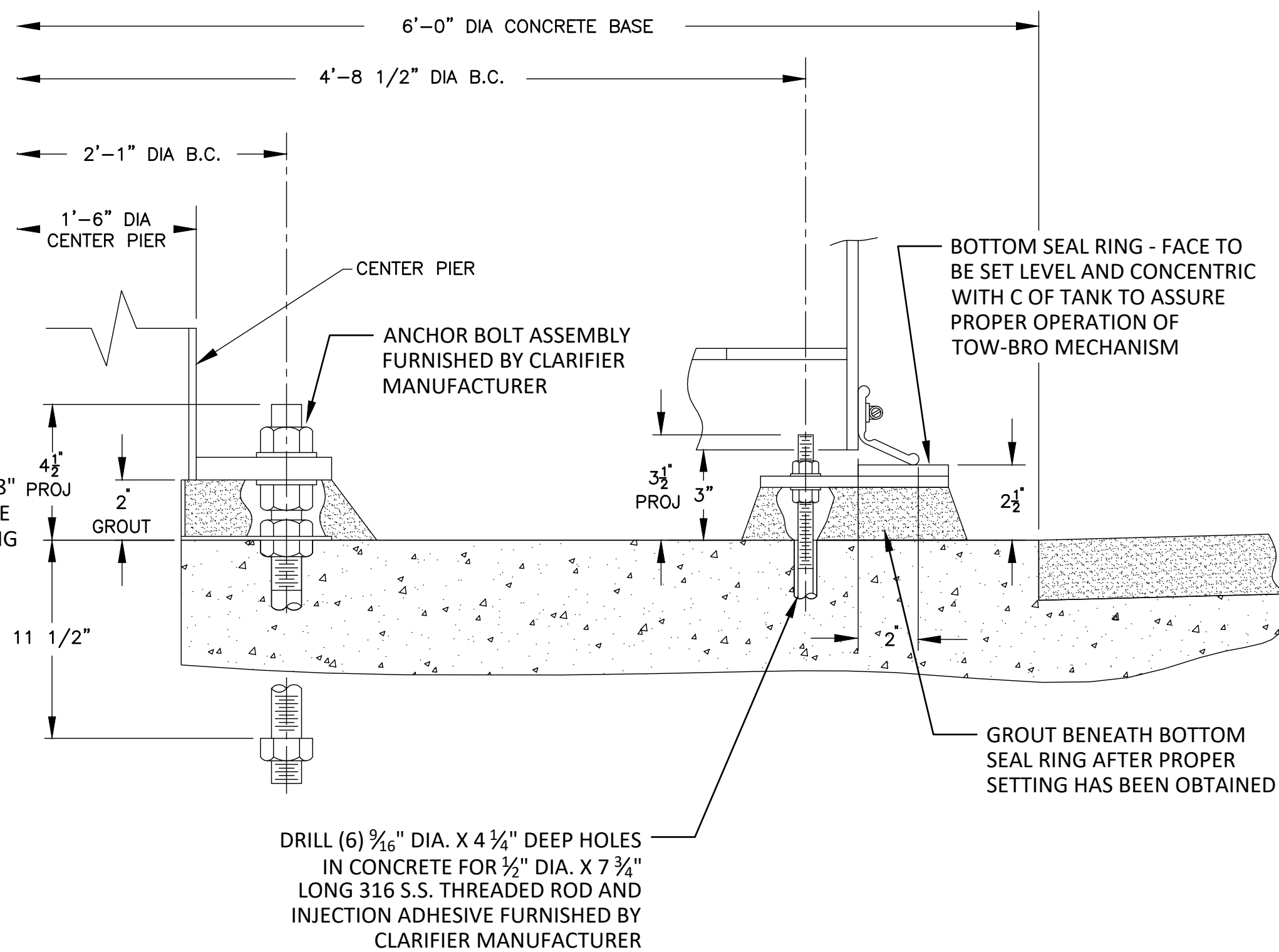
**A** ANCHOR BOLT PLAN  
SCALE: 3/4" = 1'-0"



**B** CENTER PIER BASE DETAIL  
SCALE: 3/4" = 1'-0"



**C** TYP. STAIR RISER DETAIL  
@ ML SPLITTER BOX  
SCALE: 3/4" = 1'-0"



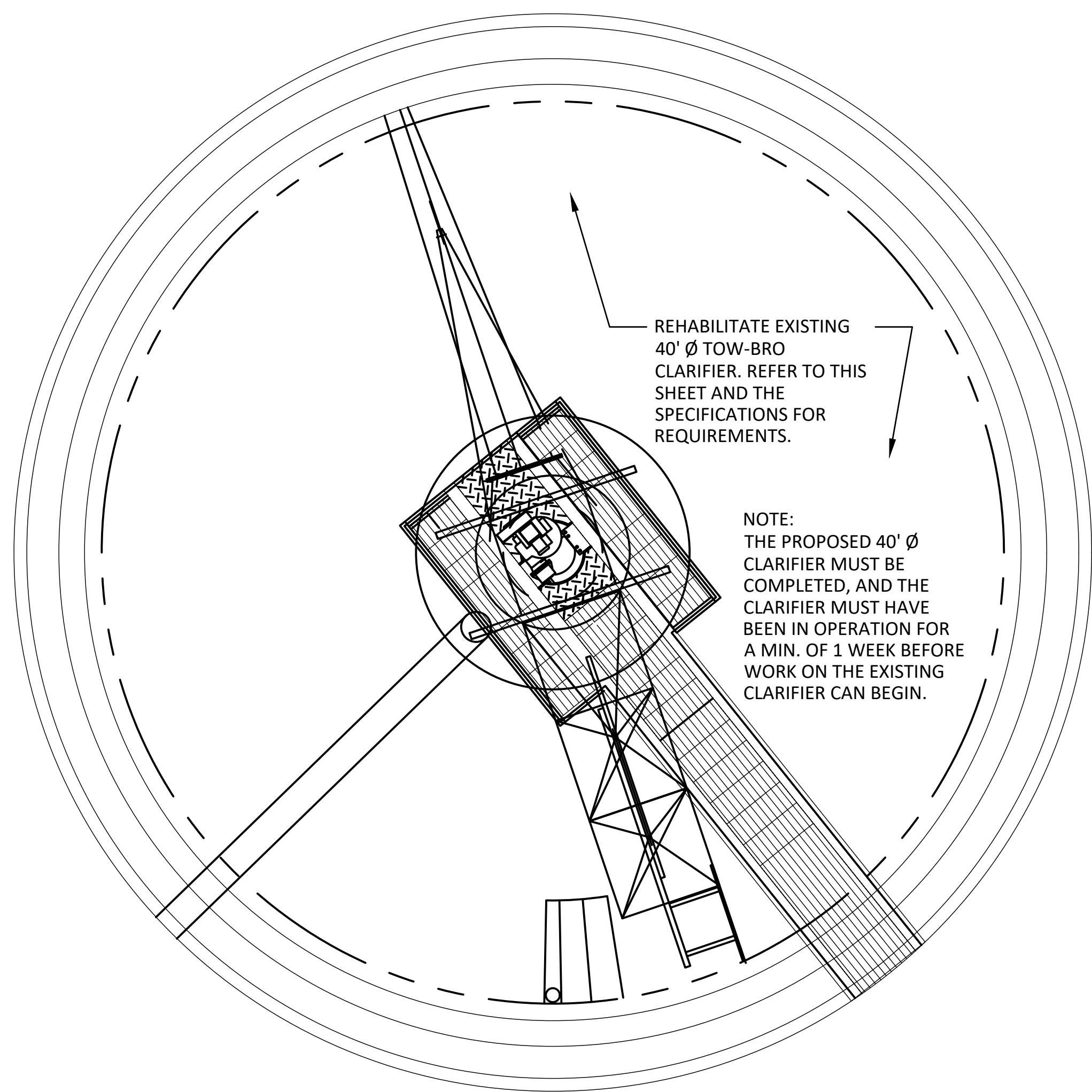
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cell: (501) 766-9832  
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CLARIFIER DETAILS	SCALE: 3/4" = 1'-0"	DATE: MAY 2021	PROJECT: 20-018
	CITY OF MOUNTAIN VIEW	WWTP IMPROVEMENTS	MOUNTAIN VIEW, AR
SHEET	OWNER	PROJECT	LOCATION

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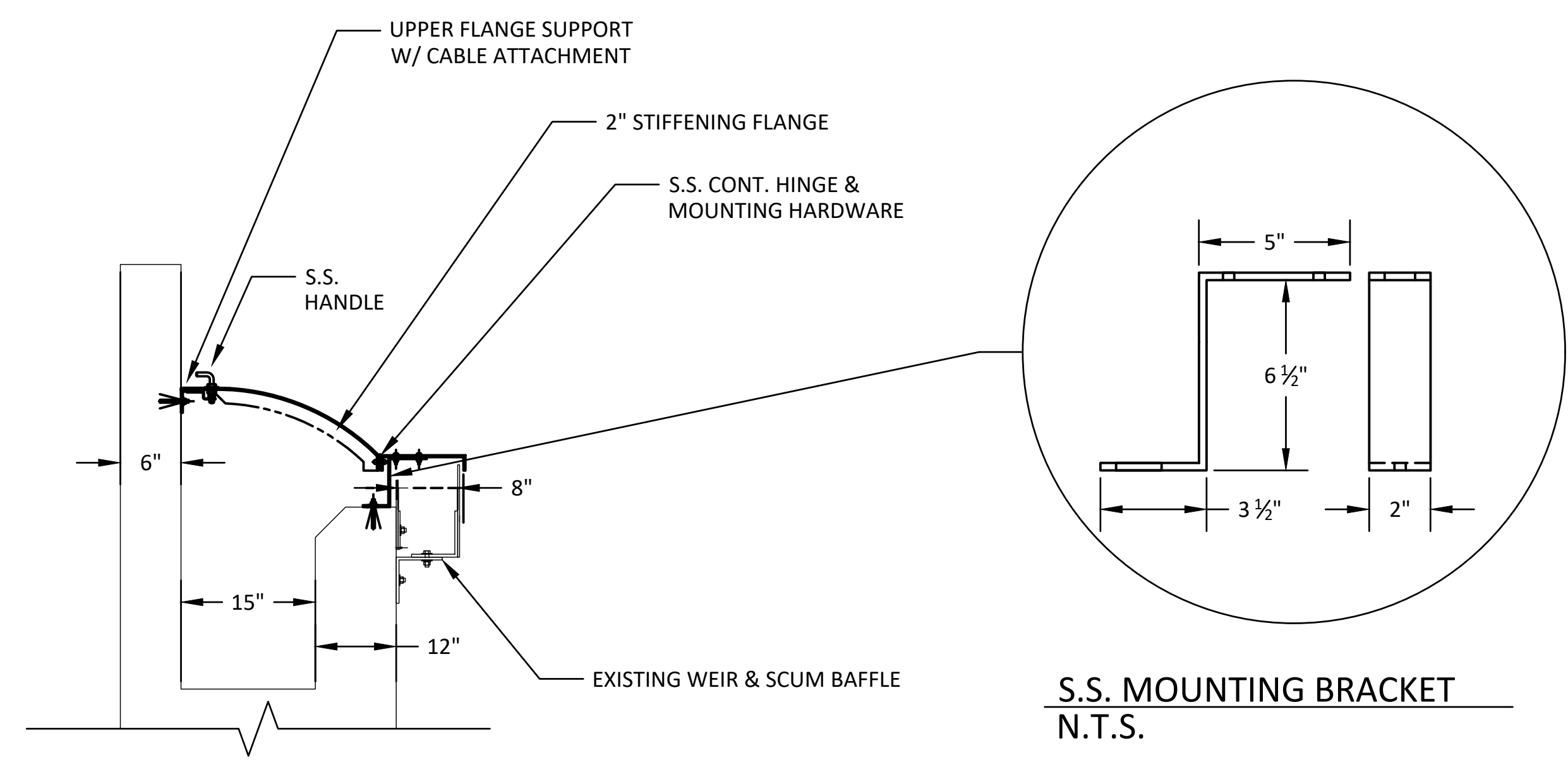
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REGISTERED PROFESSIONAL ENGINEER  
C. KYLE BRECKENRIDGE  
No. 13631  
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REHABILITATE EXISTING 40' Ø TOW-BRO CLARIFIER. REFER TO THIS SHEET AND THE SPECIFICATIONS FOR REQUIREMENTS.

NOTE: THE PROPOSED 40' Ø CLARIFIER MUST BE COMPLETED, AND THE CLARIFIER MUST HAVE BEEN IN OPERATION FOR A MIN. OF 1 WEEK BEFORE WORK ON THE EXISTING CLARIFIER CAN BEGIN.

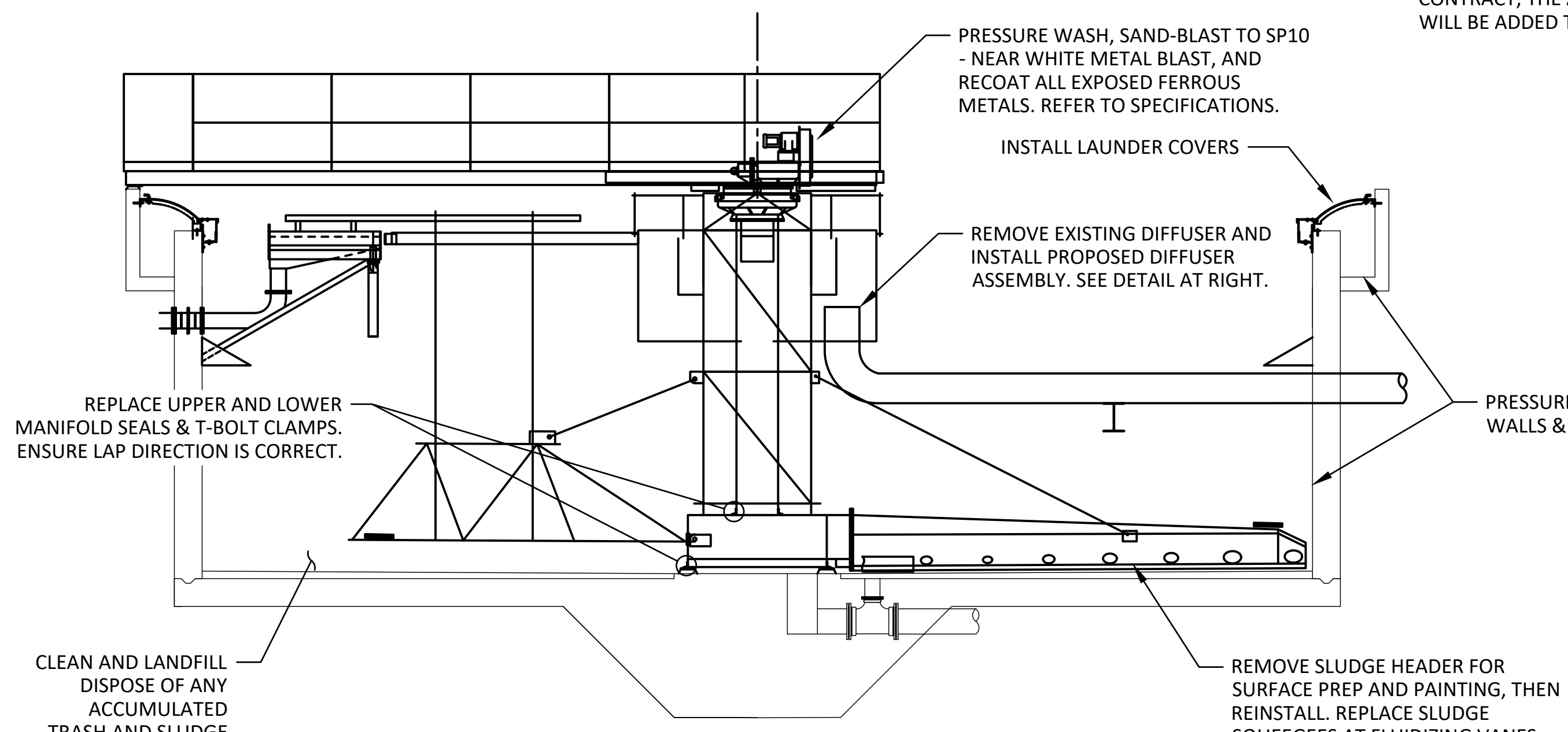
**A** PLAN  
SCALE: 1/4" = 1'-0"



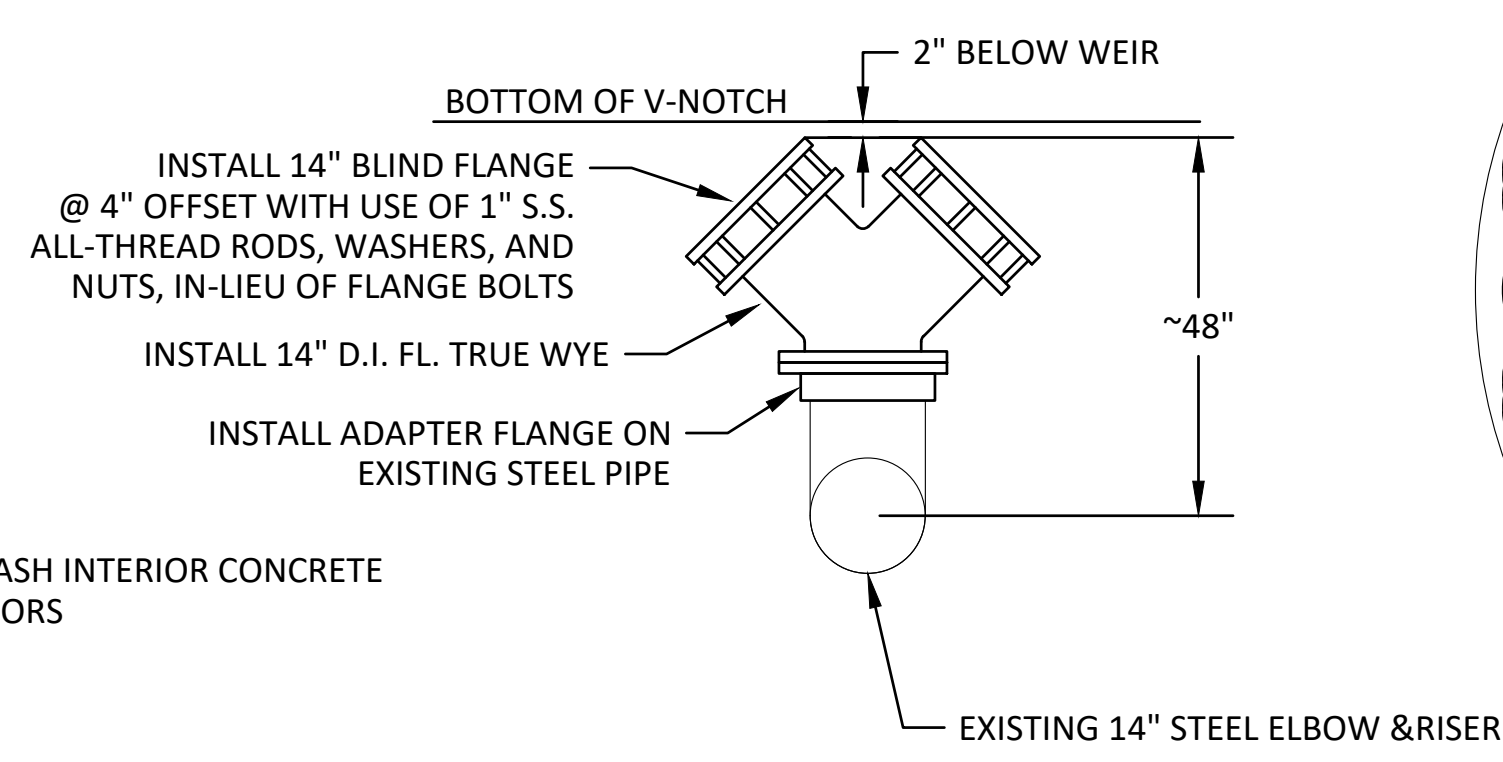
**C** LAUNDRY COVER SECTION  
N.T.S.

S.S. MOUNTING BRACKET  
N.T.S.

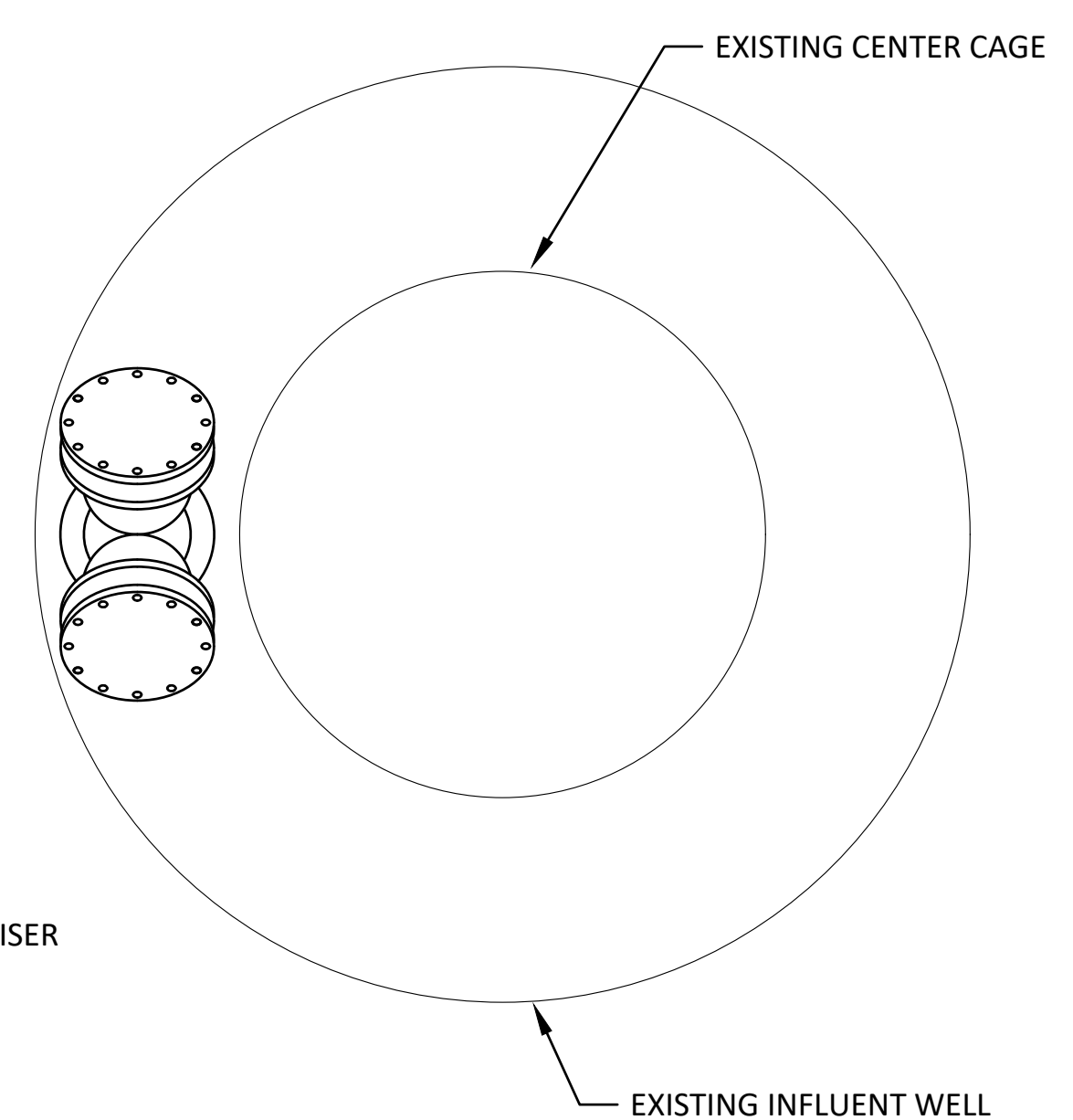
NOTE: CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING AN EVOQUA CLARIFIER SERVICE TECHNICIAN TO BE ONSITE FOR CLARIFIER INSPECTION FOR A MIN. OF 8 HOURS IN ONE TRIP. THE CONTRACTOR SHALL COORDINATE THE SERVICE TECH VISIT SO THAT THE CLARIFIER HAS BEEN DRAINED, CLEANED, AND PRESSURE WASHED BEFORE THE SERVICE TECH ARRIVES. THE SERVICE TECHNICIAN SHALL COMPILE A LIST OF ITEMS NEEDING REPAIR OR SERVICE THAT ARE NOT INCLUDED IN THE SCOPE OF THIS CONTRACT. THE OWNER WILL BE RESPONSIBLE FOR PERFORMING THE ADDITIONAL WORK AND MUST BE GIVEN A MIN. OF TWO MONTHS TO PERFORM THE WORK. IF MORE THAN TWO MONTHS IS REQUIRED, AND RESULTS IN DELAYING THE WORK OF THIS CONTRACT, THE ADDITIONAL TIME (ABOVE TWO MONTHS) WILL BE ADDED TO THE CONTRACT TIME OF THIS CONTRACT.



**B** SECTION  
SCALE: 1/4" = 1'-0"



**B** DIFFUSER DETAIL  
SCALE: 1/2" = 1'-0"



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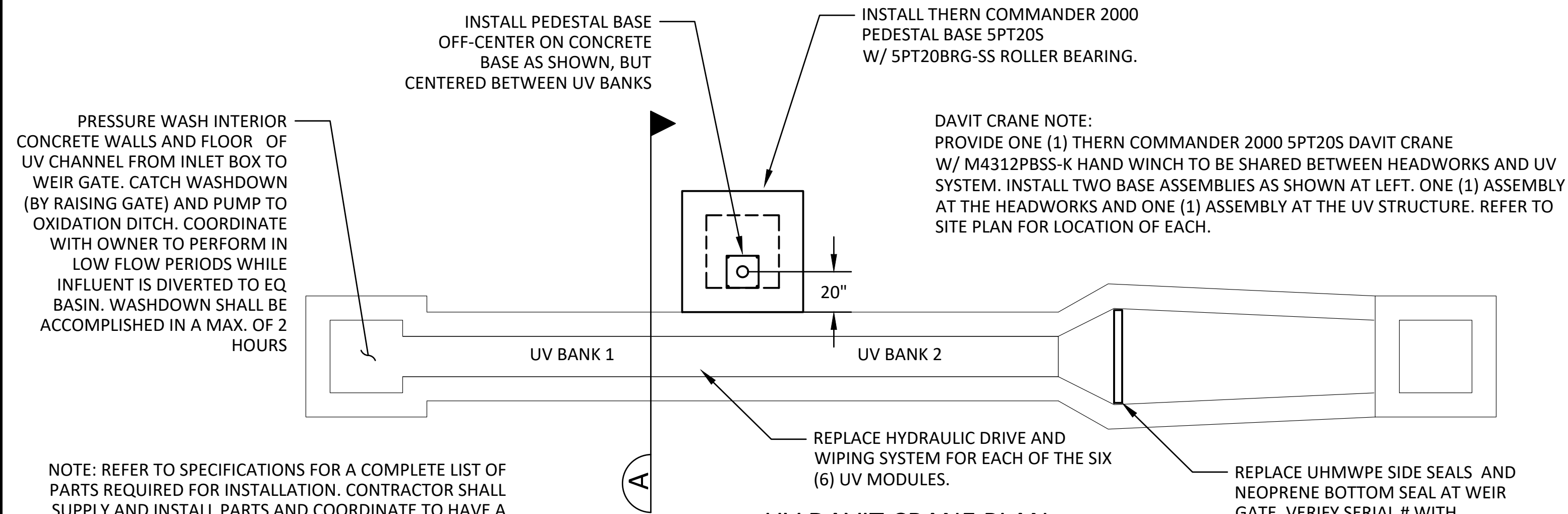
EXISTING CLARIFIER REHABILITATION PLAN	SCALE: 1/4" = 1'-0"	DATE: MAY 2021	PROJECT: 20-018
CITY OF MOUNTAIN VIEW	WWTP IMPROVEMENTS	MOUNTAIN VIEW, AR	
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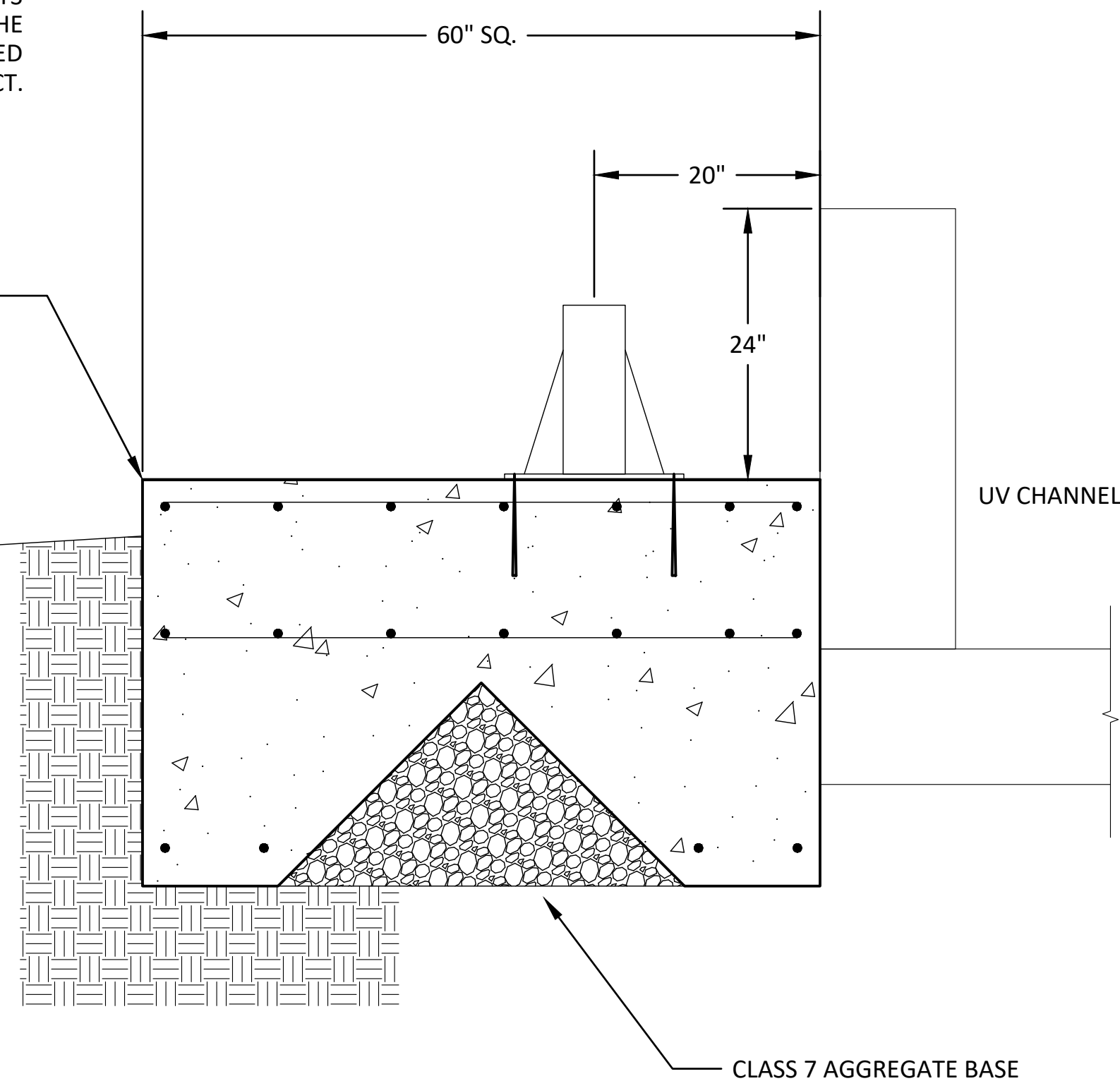




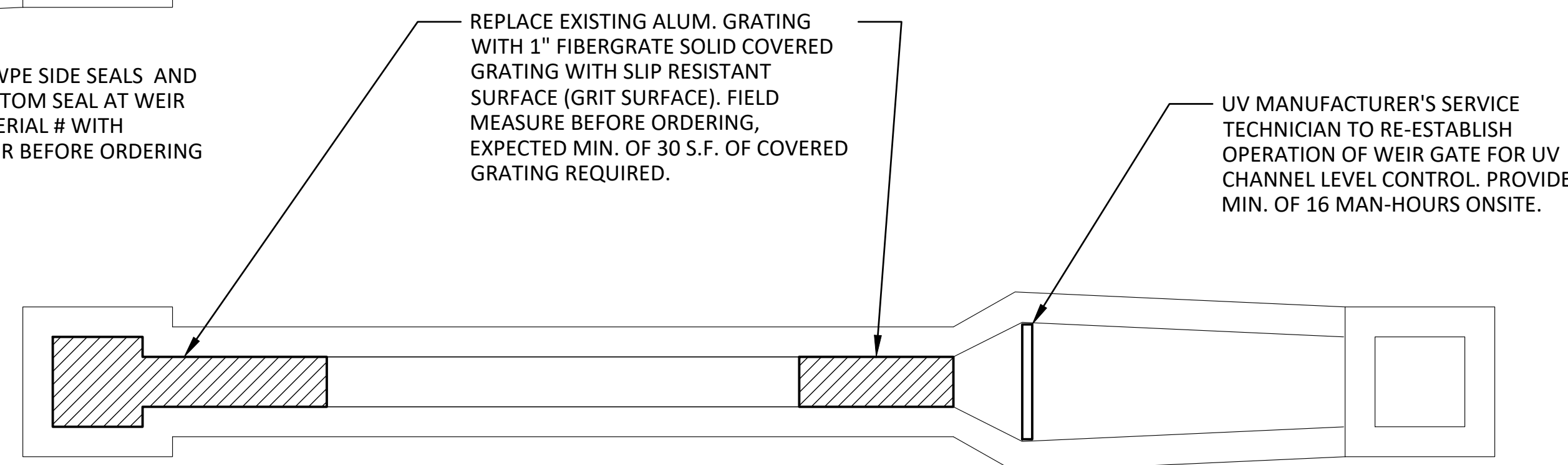
**UV DAVIT CRANE PLAN**  
SCALE: 1/4" = 1'-0"

NOTE: REFER TO SPECIFICATIONS FOR A COMPLETE LIST OF PARTS REQUIRED FOR INSTALLATION. CONTRACTOR SHALL SUPPLY AND INSTALL PARTS AND COORDINATE TO HAVE A TROJAN SERVICE TECHNICIAN ONSITE FOR A MIN. OF 8 HOURS IN ONE TRIP TO INSTRUCT ON HOW TO PERFORM THE INSTALLATION. THE SERVICE TECHNICIAN SHALL ALSO COMPILE A LIST OF ADDITIONAL ITEMS NEEDING REPAIR OR SERVICE THAT ARE NOT INCLUDED IN THE SCOPE OF THIS CONTRACT. THE OWNER WILL BE RESPONSIBLE FOR PERFORMING THE ADDITIONAL WORK AND MUST BE GIVEN A MIN. OF TWO MONTHS TO PERFORM THE WORK. IF MORE THAN TWO MONTHS IS REQUIRED, AND RESULTS IN DELAYING THE WORK OF THIS CONTRACT, THE ADDITIONAL TIME (ABOVE TWO MONTHS) WILL BE ADDED TO THE CONTRACT TIME OF THIS CONTRACT.

REFER TO DETAIL ON SHEET X FOR STRUCTURAL DETAILS OF CONCRETE BASE



**SECTION A**  
SCALE: 1" = 1'-0"



**SOLID GRATING PLAN**  
SCALE: 1/4" = 1'-0"



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UV IMPROVEMENTS	SCALE: AS-SHOWN	DATE: MAY 2021	PROJECT: 20-018
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**GENERAL STRUCTURAL NOTES:**

ALL STRUCTURAL DRAWING SHALL BE COORDINATED WITH MECHANICAL, PROCESS, AND ELECTRICAL PLANS.

**CAST-IN-PLACE CONCRETE NOTES:**

REINFORCED CONCRETE SHALL CONFORM TO ACI 318 AND ACI 350

MIN. CONCRETE COMP. STRENGTH AT 28 DAYS:

- CLASS A - 4,500 PSI
- CLASS B - 3,000 PSI

REINFORCING STEEL SHALL BE BILLET STEEL CONFORMING TO THE LATEST EDITION OF ASTM A615, GRADE 60.

REINFORCING STEEL SHALL HAVE THE FOLLOWING MIN. CLEAR CONCRETE COVER

1. CAST AGAINST EARTH - 3 INCHES
2. FORMED FOR WASTEWATER EXPOSURE - 3 INCHES
3. ALL OTHER - 2 INCHES

CONSTRUCTION JOINTS SHALL NOT BE PLACED AT LOCATIONS OTHER THAN AS SHOWN ON THE DRAWINGS WITHOUT APPROVAL OF THE ENGINEER.

ALL EXPOSED CORNERS OF CONCRETE SHALL HAVE A 3/4" CHAMFER.

**CONCRETE JOINT NOTES:**

JOINTS SHALL HAVE SEALANT APPLIED TO BOTH SIDES OF JOINT, EXCEPT FOR THE SOIL SIDE OF A BASE SLAB JOINT.

CONTROL JOINTS AND CONSTRUCTION JOINTS WILL REQUIRE SEALANT.

PROVIDE CONTINUOUS WATERSTOPS AT JOINTS OF ALL EXTERIOR BELOW GRADE WALLS AND SLABS.

**STEEL NOTES:**

STRUCTURAL SHAPES, PLATES, AND BARS SHALL CONFORM TO ASTM A36, UNLESS OTHERWISE NOTED.

MIN. THICKNESS OF CLIP ANGLES OR CONNECTOR PLATES SHALL BE 1/4".

BOLTED CONNECTIONS SHALL BE MADE USING TYPE 316 S.S. BOLTS OF 3/4" Ø, UNLESS OTHERWISE NOTED.

ALL HARDWARE FOR ACCESS PLATFORMS AND STAIRS SHALL BE TYPE 316 S.S.

**ALUM. GRATING AND COVER PLATE NOTES:**

GRATING SHALL BE ALUM. ALLOY 6063-T6, UNLESS NOTED OTHERWISE. GRATING SUPPORTS SHALL BE GALVANIZED STEEL WITH ONE COAT OF COAL TAR EPOXY BETWEEN GRATING AND SUPPORTS TO PROVIDE DIELECTRIC SEPARATION.

FASTENERS, ANCHORS, BOLTS, NUTS, WASHERS, AND HARDWARE FOR ALUM. GRATING SHALL BE TYPE 316 S.S.

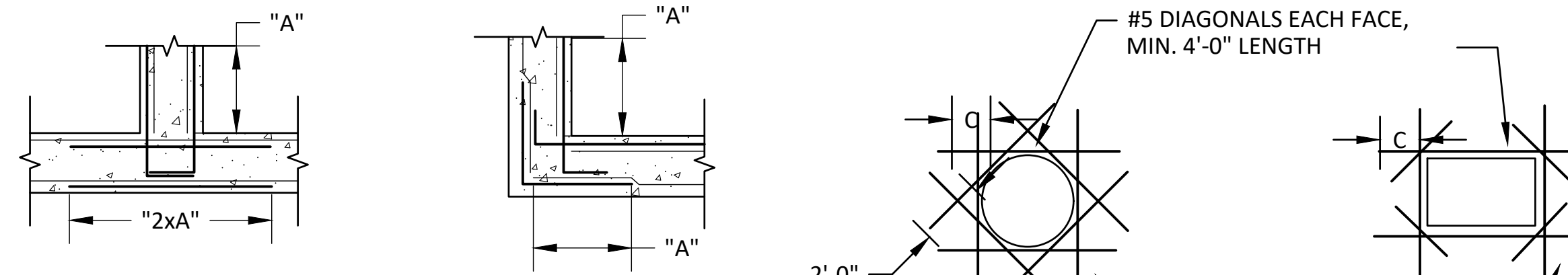
ALL GRATING SHALL BE SECURELY FASTENED TO SUPPORTS WITH S.S. GRATING CLIPS AND ANCHORS.

GRATING PANEL LAYOUT SHALL PROVIDE FOR THE REMOVAL OF GRATING AROUND PIPE AND OTHER GRATING PENETRATIONS.

ALL COVER PLATES SHALL BE SECURELY FASTENED TO SUPPORTS WITH 1/4" S.S. FLAT HEAD MACHINE SCREWS AT 2'-0" O.C.

FIELD VERIFY GRATING SUPPORT LOCATIONS BEFORE FABRICATING GRATING.

BAND ALL GRATING AT EDGES AND AT OPENINGS WITH CONT. BAR EQUAL TO BEARING BARS.



**NOTES:**

A = 1/4 CLEAR HORIZ. SPAN BUT NOT < TENSION LAP SPLICE, NOR > 10 FT.

B = TENSION LAP SPLICE

1. SPLICE BARS TO MATCH SIZE AND SPACING OF LARGEST BAR BEING SPLICED. LAP WITH TYPICAL WALL REINFORCEMENT.
2. EXTEND BAR HOOKED ENDS TO FAR FACE OF WALL.

— DENOTES TYPICAL REINFORCEMENT

- - - DENOTES ADDITIONAL REINFORCEMENT

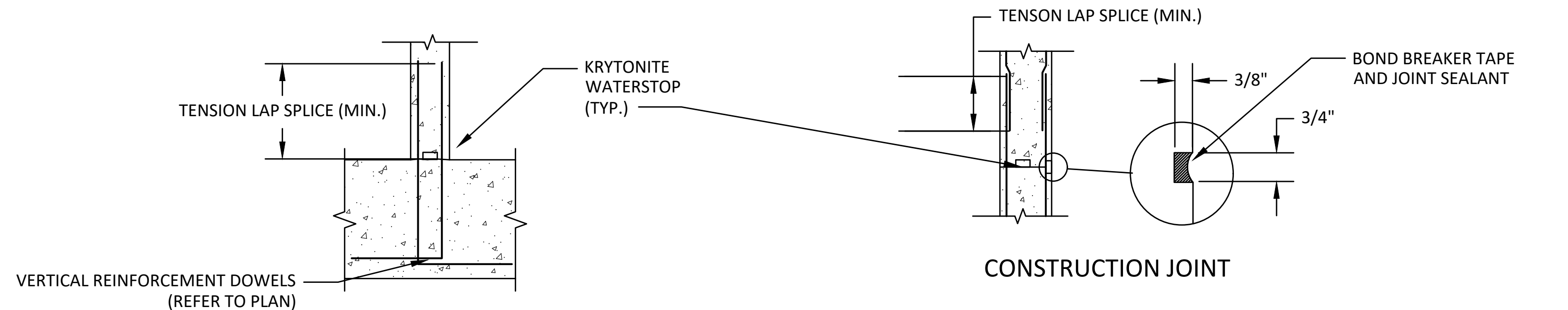
**NOTES:**

C = TENSION DEVELOPMENT LENGTH, PROVIDE STANDARD HOOK IF TENSION DEVELOPMENT LENGTH IS NOT POSSIBLE.

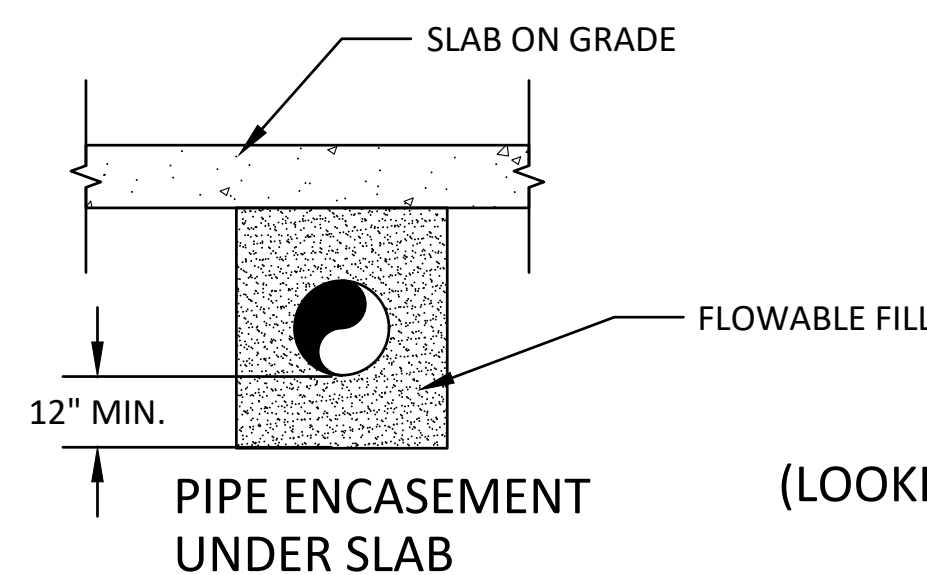
1. REINFORCING STEEL IS TO BE CARRIED ACROSS ALL CONSTRUCTION JOINTS.
2. DETAIL IS TYPICAL FOR ALL OPENING > 8" IN CONCRETE WALLS AND SLABS.
3. EXTRA BARS ARE NOT REQUIRED AT OPENING EDGES PARALLEL TO AND WITHIN 6" OF WALL OR BEAM.

**CORNER REINFORCEMENT DETAILS**

**EXTRA REINFORCEMENT AT OPENINGS**



**WALL CONSTRUCTION JOINT AT SLAB**



**WALL CONTROL JOINT (LOOKING DOWN ON WALL SECTION)**

**NOTES:**

TABLE IS BASED ON ACI 318, f'c = 4,000 PSI

MIN. BAR SPACING = 6" O.C.

A TOP BAR IS A HORIZONTAL BAR WHERE MORE THAN 12" OF FRESH CONCRETE IS CAST DIRECTLY BELOW THE BAR

LAP SPLICES AND DEVELOPMENT LENGTHS SHALL BE INCREASED FOR LOWER CONCRETE COMPRESSIVE STRENGTH AS FOLLOWS:

f'c	MULTIPLIER
3,000 PSI	1.16
3,500 PSI	1.07

**BASIC TENSION DEVELOPMENT LENGTHS IN WALLS AND SLABS (IN.)**

BAR SIZE	TOP BARS	OTHER BARS
3	16	12
4	20	15
5	24	18
6	29	22
7	33	25
8	39	30
9	50	38
10	63	48
11	78	50

**TENSION LAP SPLICE LENGTHS IN WALLS AND SLABS (IN.)**

BAR SIZE	TOP BARS	OTHER BARS
3	21	16
4	26	20
5	31	24
6	38	29
7	43	33
8	51	39
9	65	50
10	82	63
11	102	78

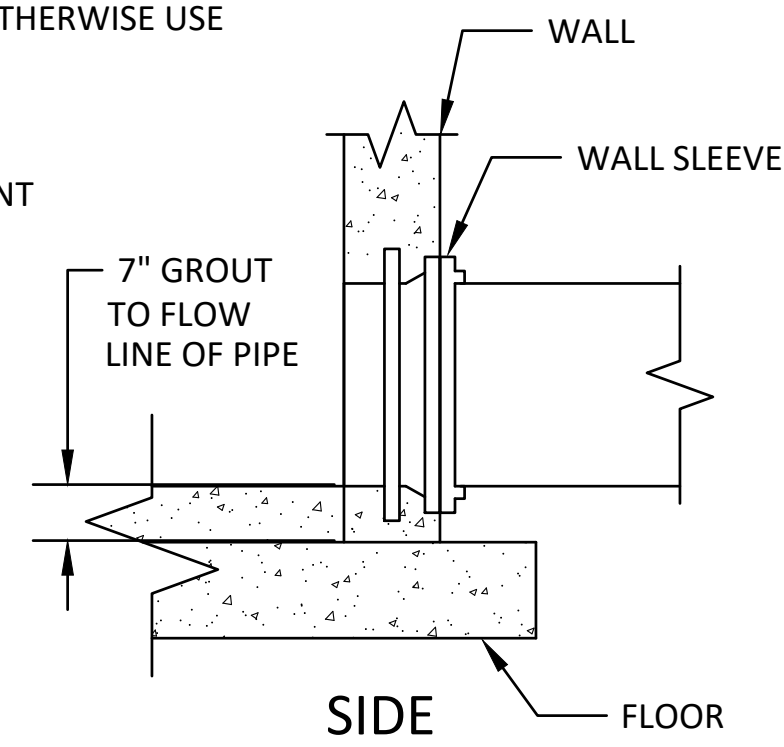
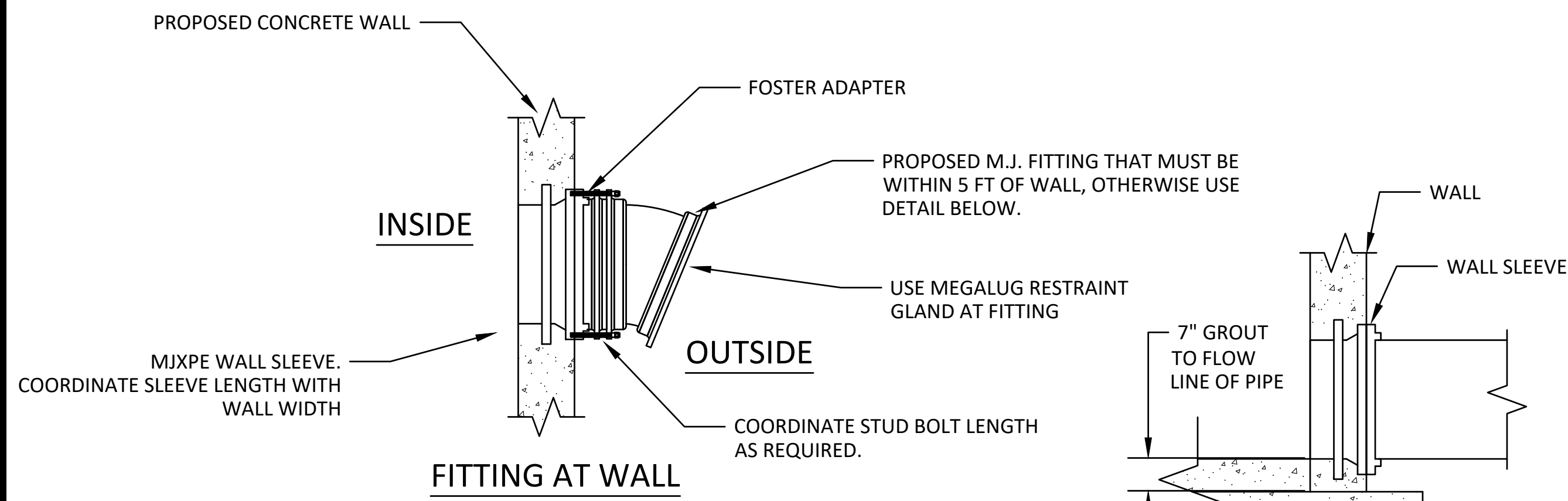
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GENERAL DETAILS 1	SCALE: NTS	DATE: MAY 2021	PROJECT: 20-018
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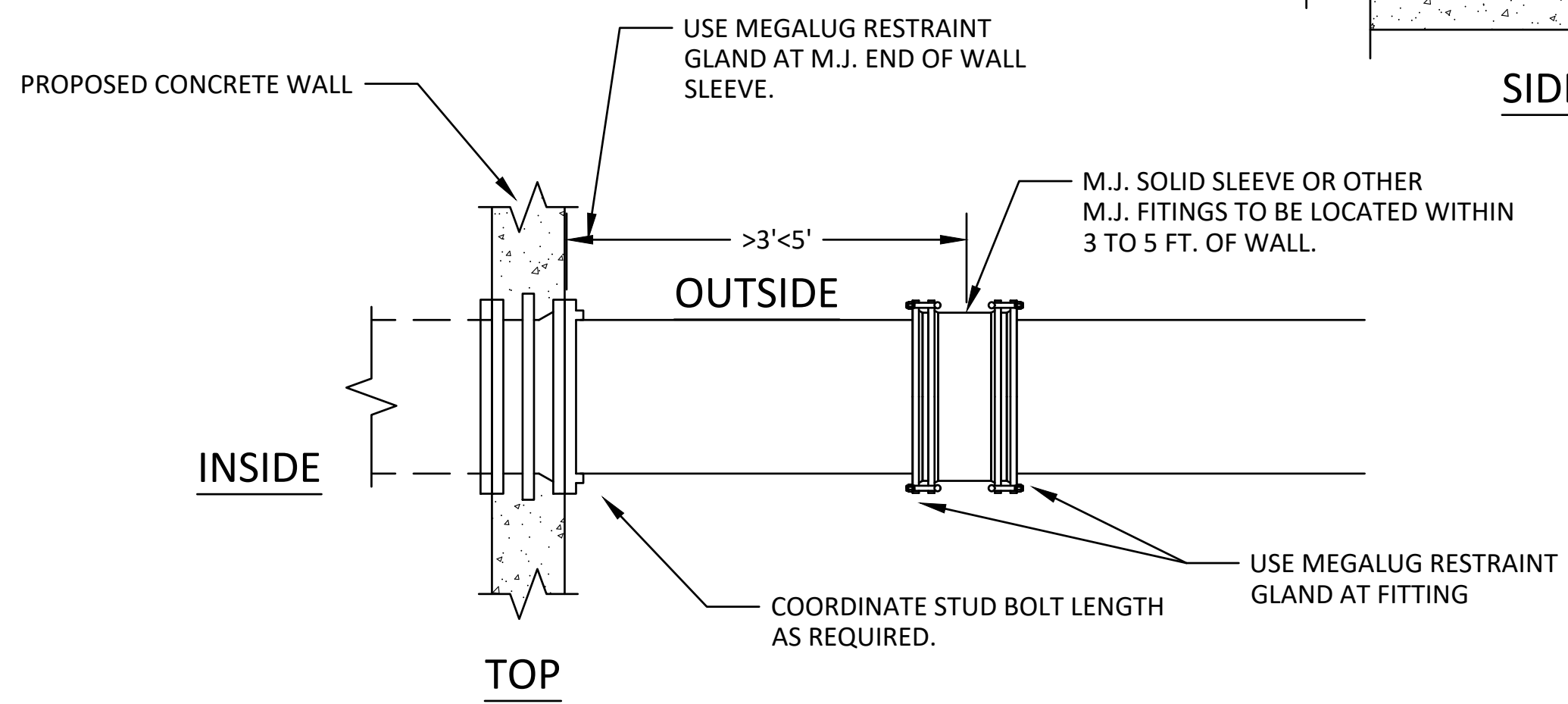
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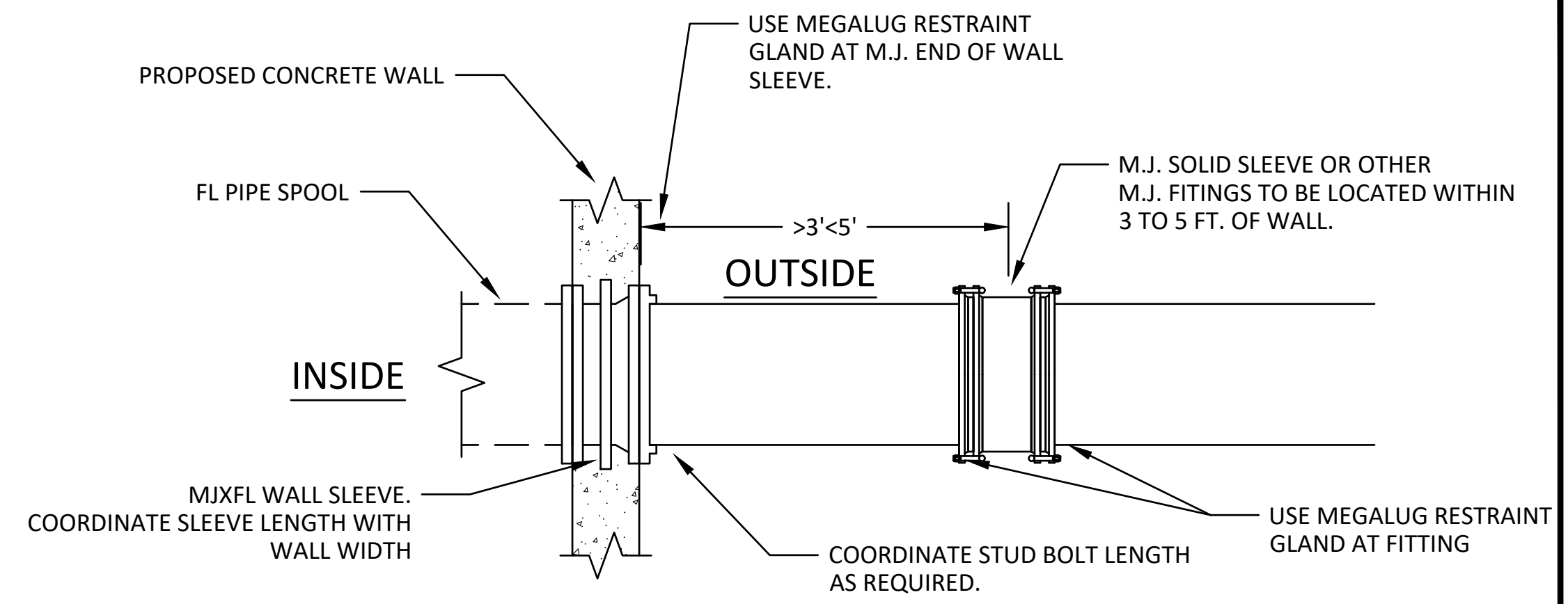
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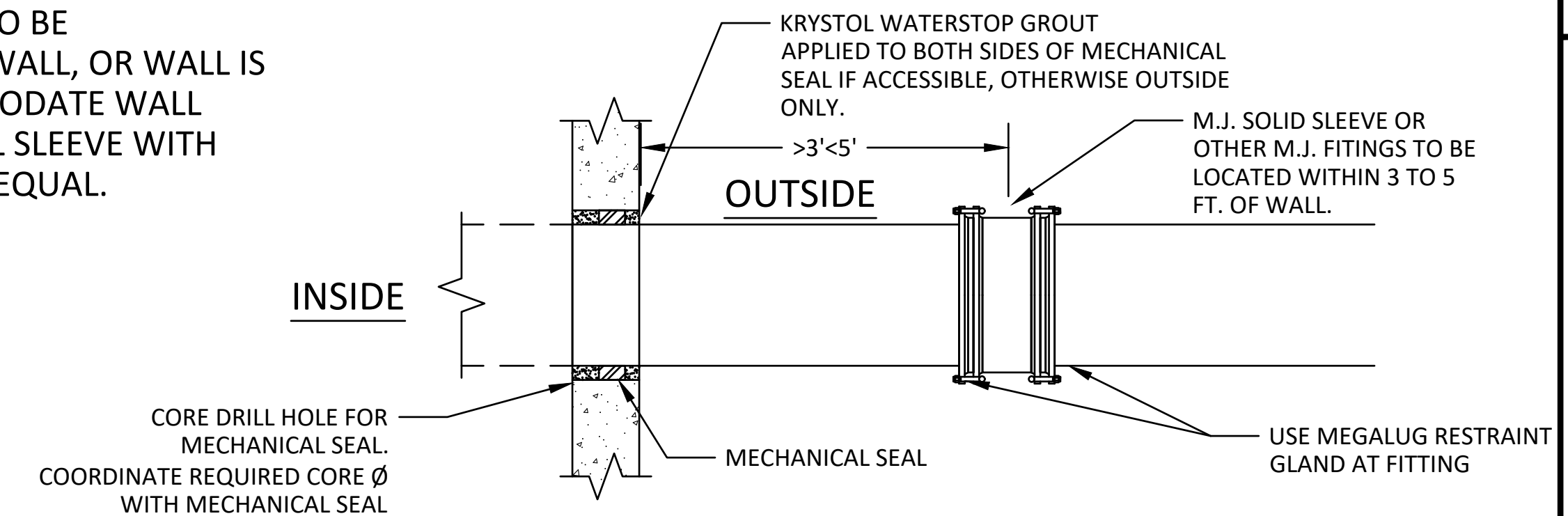
**WALL SLEEVE NOTE:**  
 IN AREAS WHERE PIPE IS TO BE CONTINUOUS THROUGH WALL, OR WALL IS TOO NARROW TO ACCOMODATE WALL SLEEVE, SUBSTITUTE WALL SLEEVE WITH SIGMA OMNI-SLEEVE, OR EQUAL.



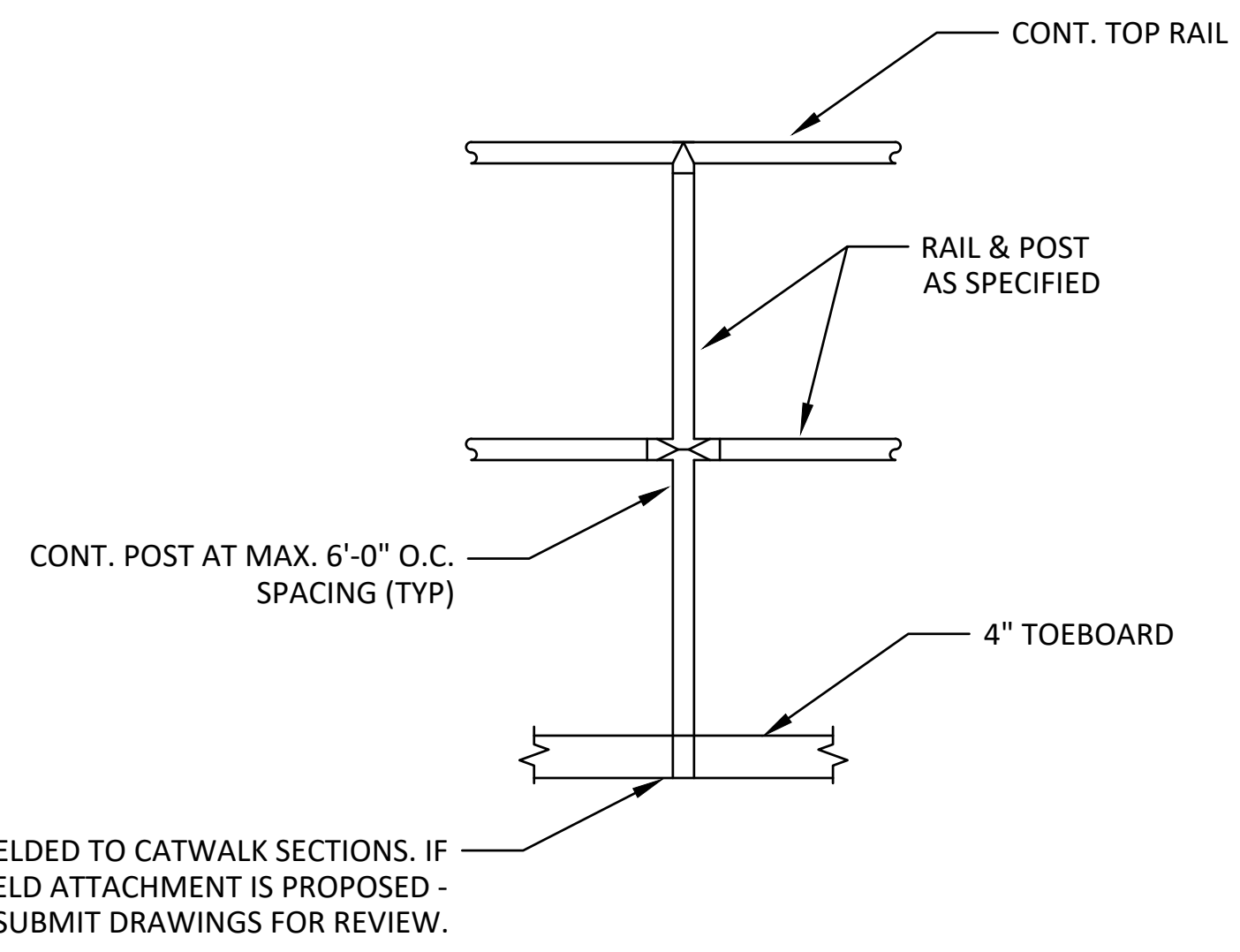
**A** NEW WALL PENETRATION DETAIL  
 SOLID PIPE THROUGH WALL



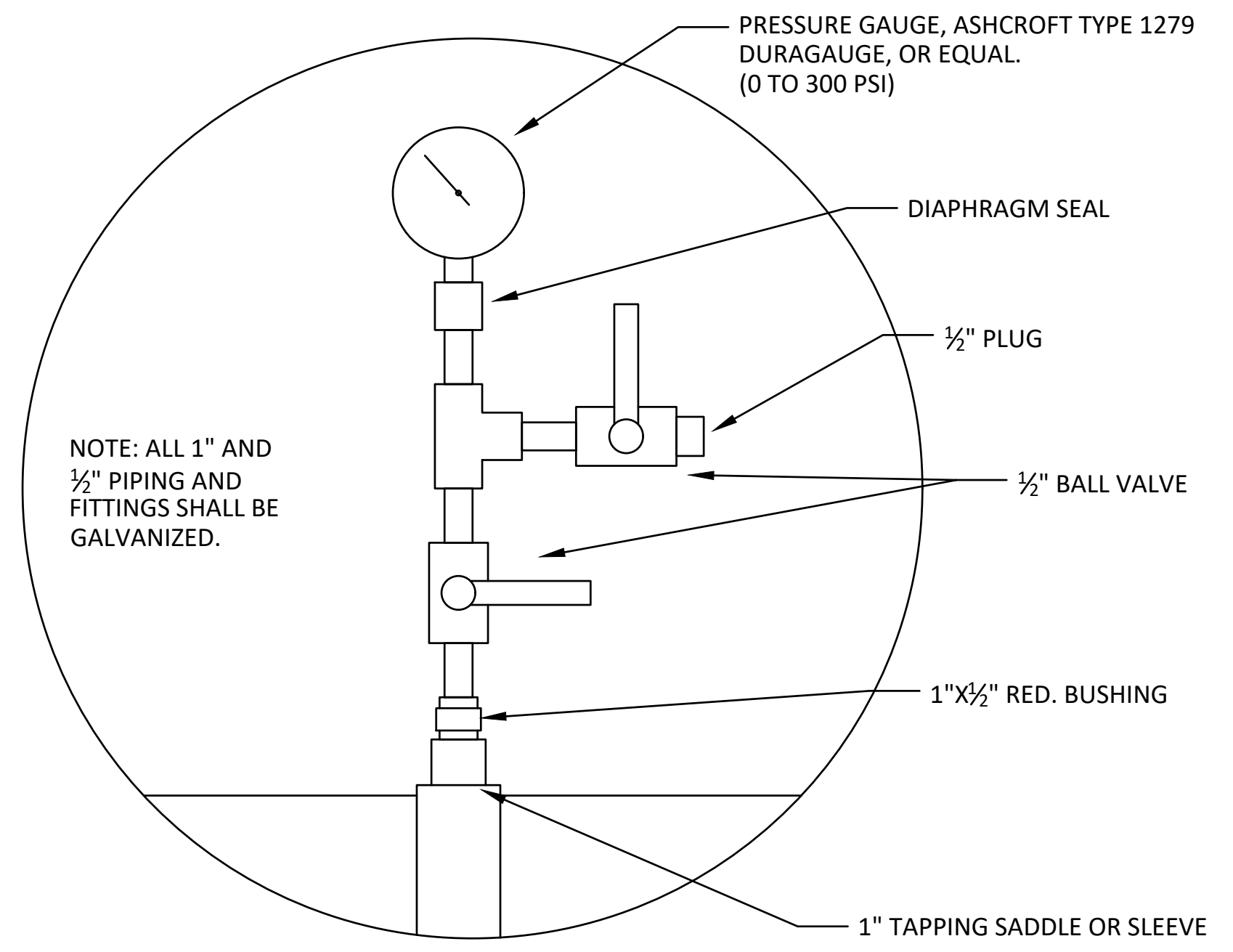
**B** NEW WALL PENETRATION DETAIL  
 JOINT AT WALL



**C** EXISTING WALL  
 PENETRATION DETAIL



**E** ALUM. HANDRAIL DETAIL



**D** PRESSURE GAUGE DETAIL  
 AT EACH PUMP DISCHARGE

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GENERAL DETAILS 2	SCALE: NTS	DATE: MAY 2021	PROJECT: 20-018
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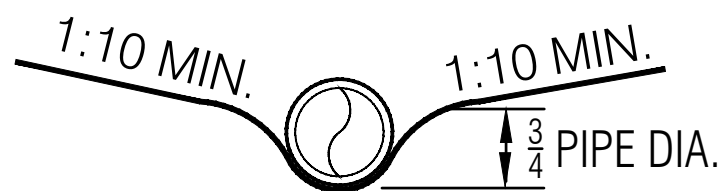
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NOTE:  
BENCHES AND INVERTS SHALL BE  
CONSTRUCTED TO RETAIN FLOW  
CHARACTERISTICS AND CHANNEL  
SHALL BE CONSTRUCTED TO  
PREVENT SEDIMENT DEPOSITION IN  
INVERT.

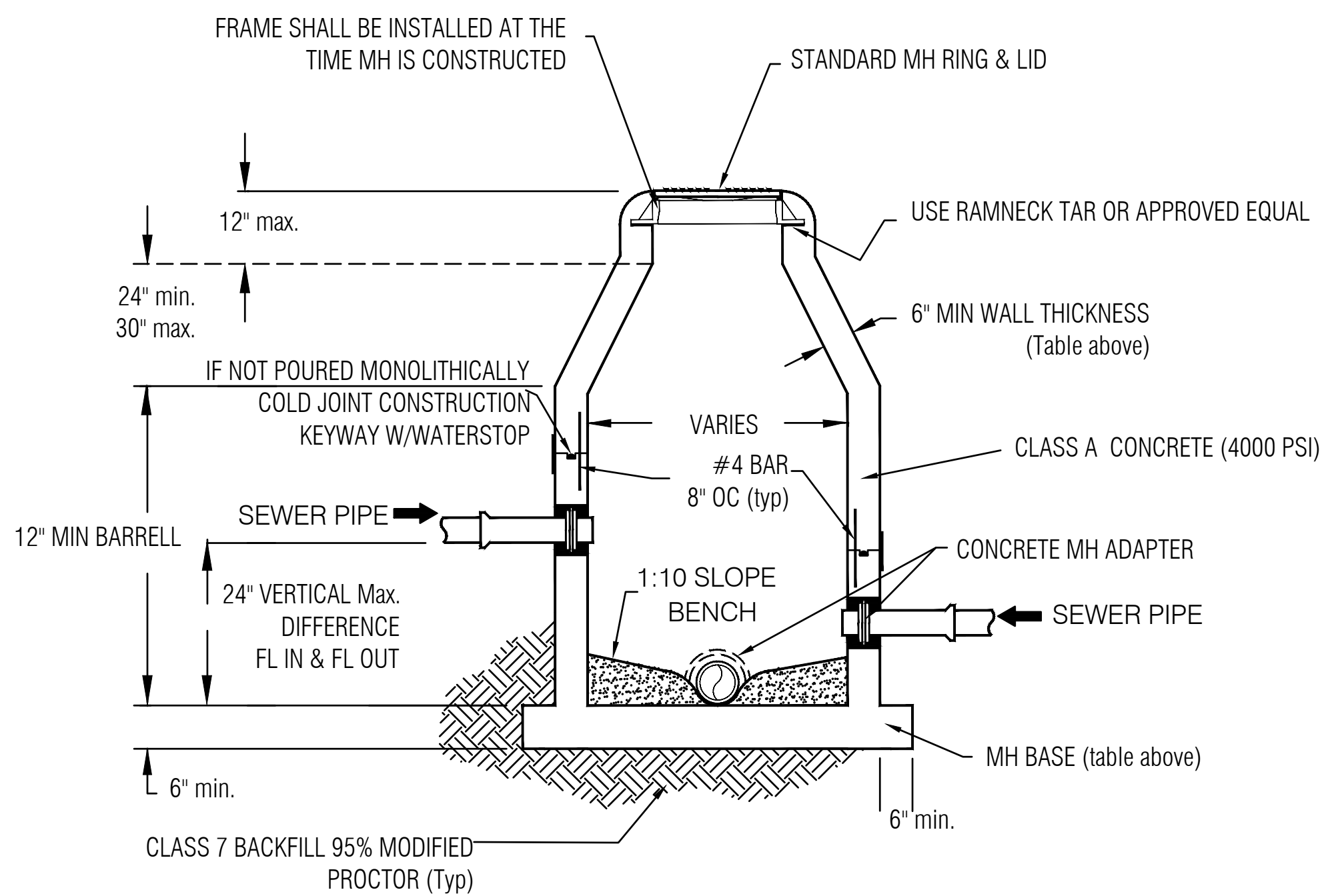
**MANHOLE INFORMATION TABLE**

Inside Diameter of Manhole	Minimum Wall Thickness	Base Thickness	Minimum Lid & Ring Size
4' DIA	5"	6"	24" (< or Equal to 24" Pipes)
5' DIA	6"	8"	24" (< 24" Pipes) or 30" (> 24" Pipes)
6' DIA	7"	8"	36" (> 36" Pipes)

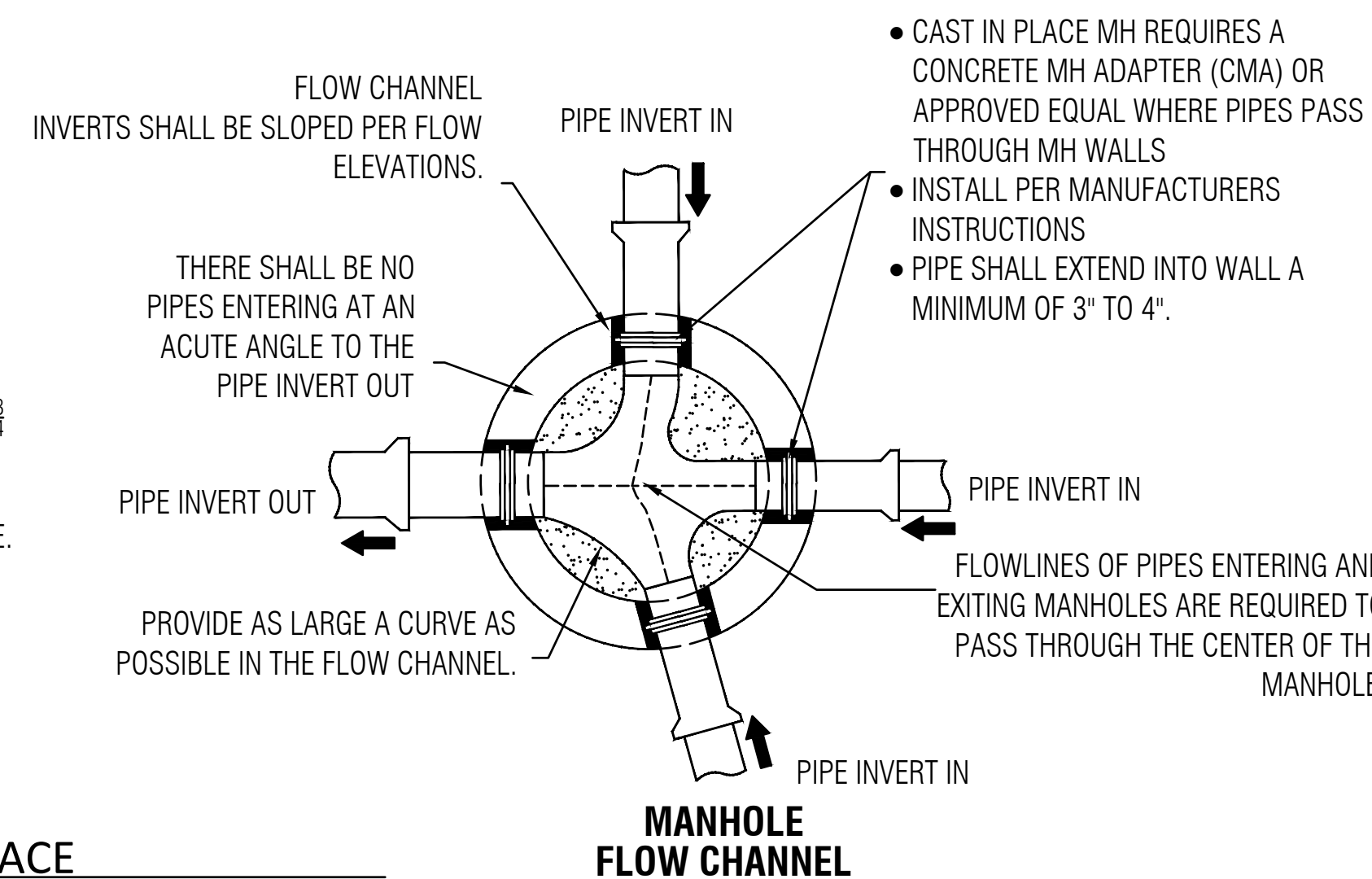


**TYPICAL INVERT SECTION**

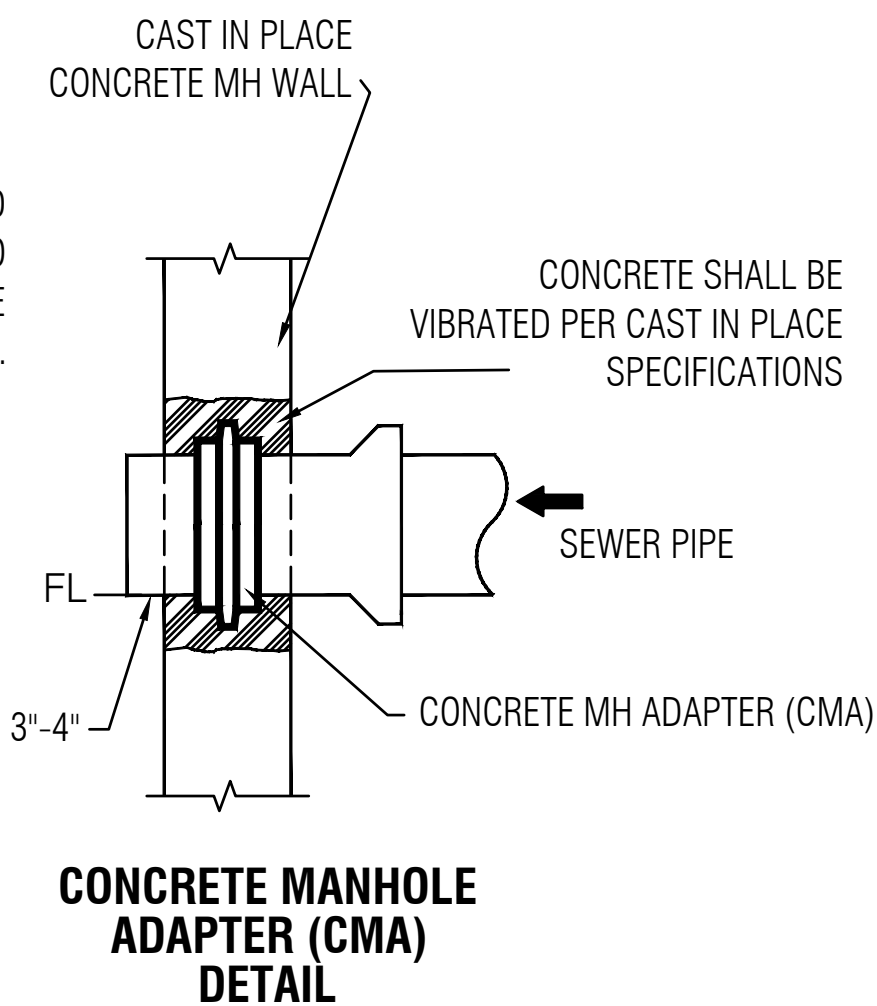
- NOTES:
1. INVERT DEPTH SHALL BE A MINIMUM OF  $\frac{3}{4}$  PIPE DIAMETER (OUTLET PIPE).
  2. NO BELL SHALL BE CAST INTO MH WALL. THERE MUST BE A MIN. 3' OF STRAIGHT PIPE.
  3. CONCRETE MUST BE 4000 PSI



**CAST-IN-PLACE MANHOLE DETAILS**

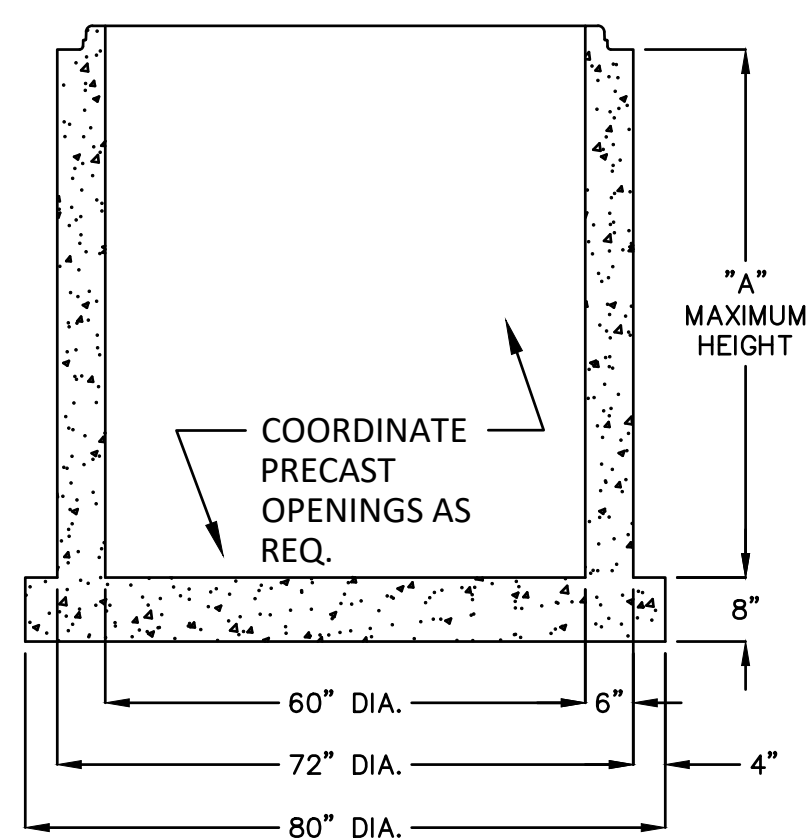


- CAST IN PLACE MH REQUIRES A CONCRETE MH ADAPTER (CMA) OR APPROVED EQUAL WHERE PIPES PASS THROUGH MH WALLS
- INSTALL PER MANUFACTURERS INSTRUCTIONS
- PIPE SHALL EXTEND INTO WALL A MINIMUM OF 3" TO 4".

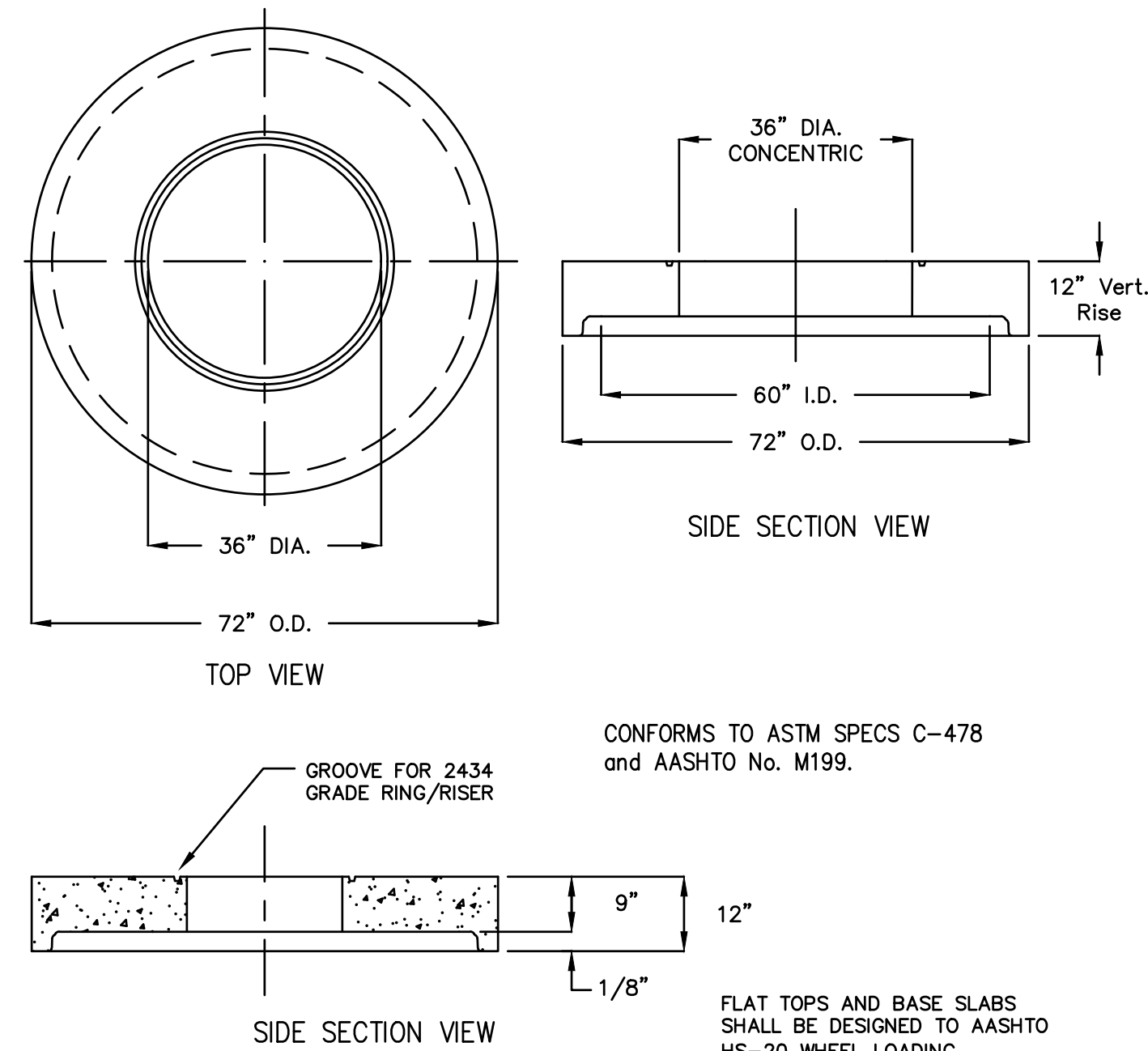


**CONCRETE MANHOLE ADAPTER (CMA) DETAIL**

CONCRETE MANHOLE COMPONENTS CONFORM TO ASTM C 478 AND AASHTO M199.  
BASE SLABS ARE TO BE DESIGNED FOR AASHTO HS-20 WHEEL LOADING.



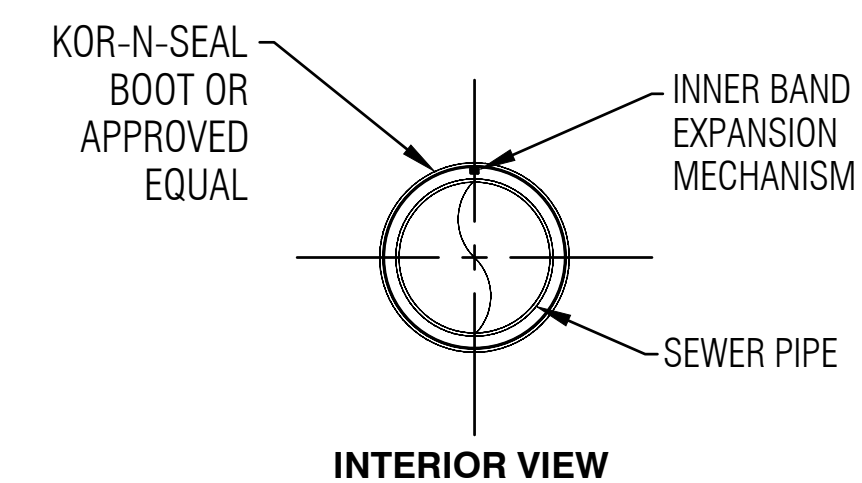
"A" MAXIMUM HEIGHT	APPROX. WEIGHT
24"	6100 LBS.
36"	7390 LBS.
48"	8690 LBS.
60"	9980 LBS.
72"	11,280 LBS.



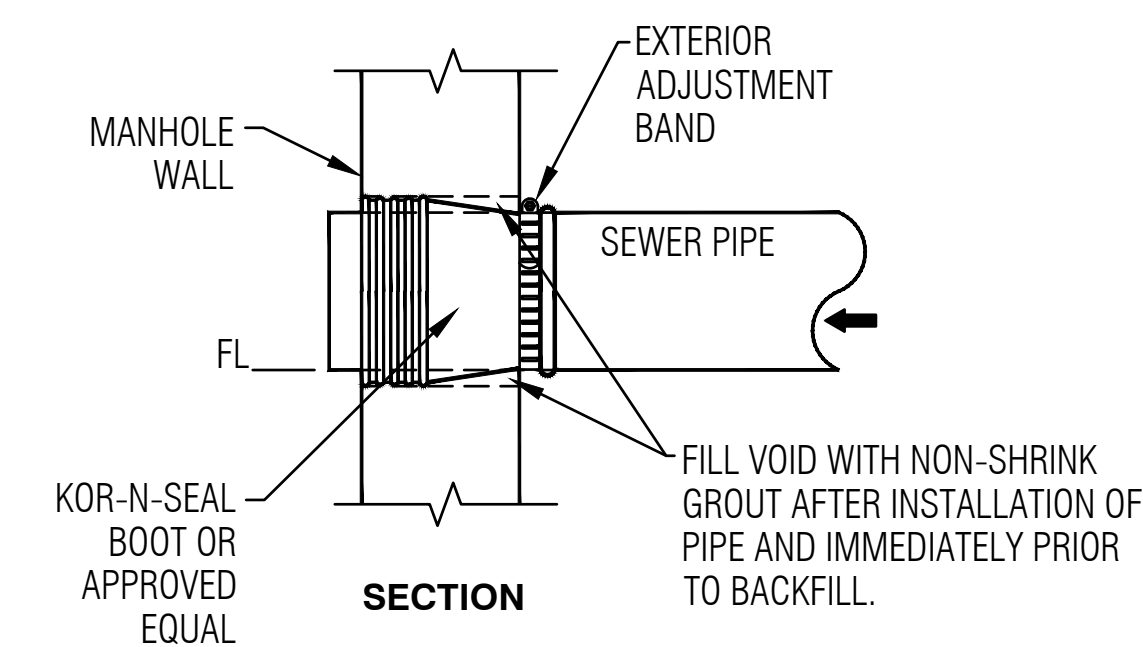
CONFORMS TO ASTM SPECS C-478 and AASHTO No. M199.

FLAT TOPS AND BASE SLABS SHALL BE DESIGNED TO AASHTO HS-20 WHEEL LOADING.

- NOTES:
1. WHEN SETTING MH RING & PRECAST MH SECTION TO SECTION, USE TYLOX SUPERSEAL, OR EQUAL.
  2. GATORWRAP BY SSI SHALL BE APPLIED TO ALL EXTERIOR JOINTS.



**INTERIOR VIEW**



**SECTION**

**PRE-CAST MANHOLE DETAILS VAULTS ONLY**

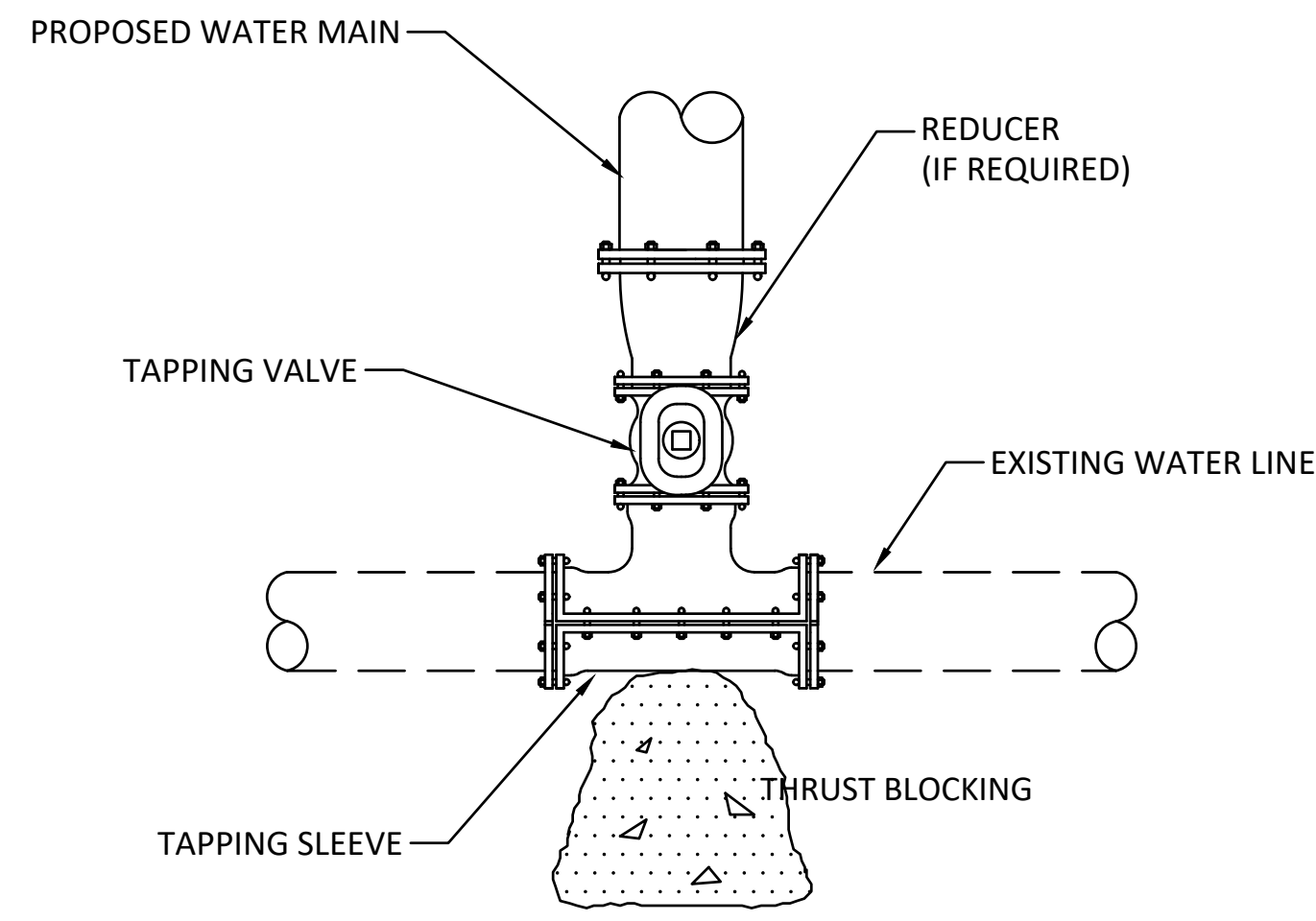
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GENERAL DETAILS 3	SCALE: NTS	DATE: MAY 2021	PROJECT: 20-018
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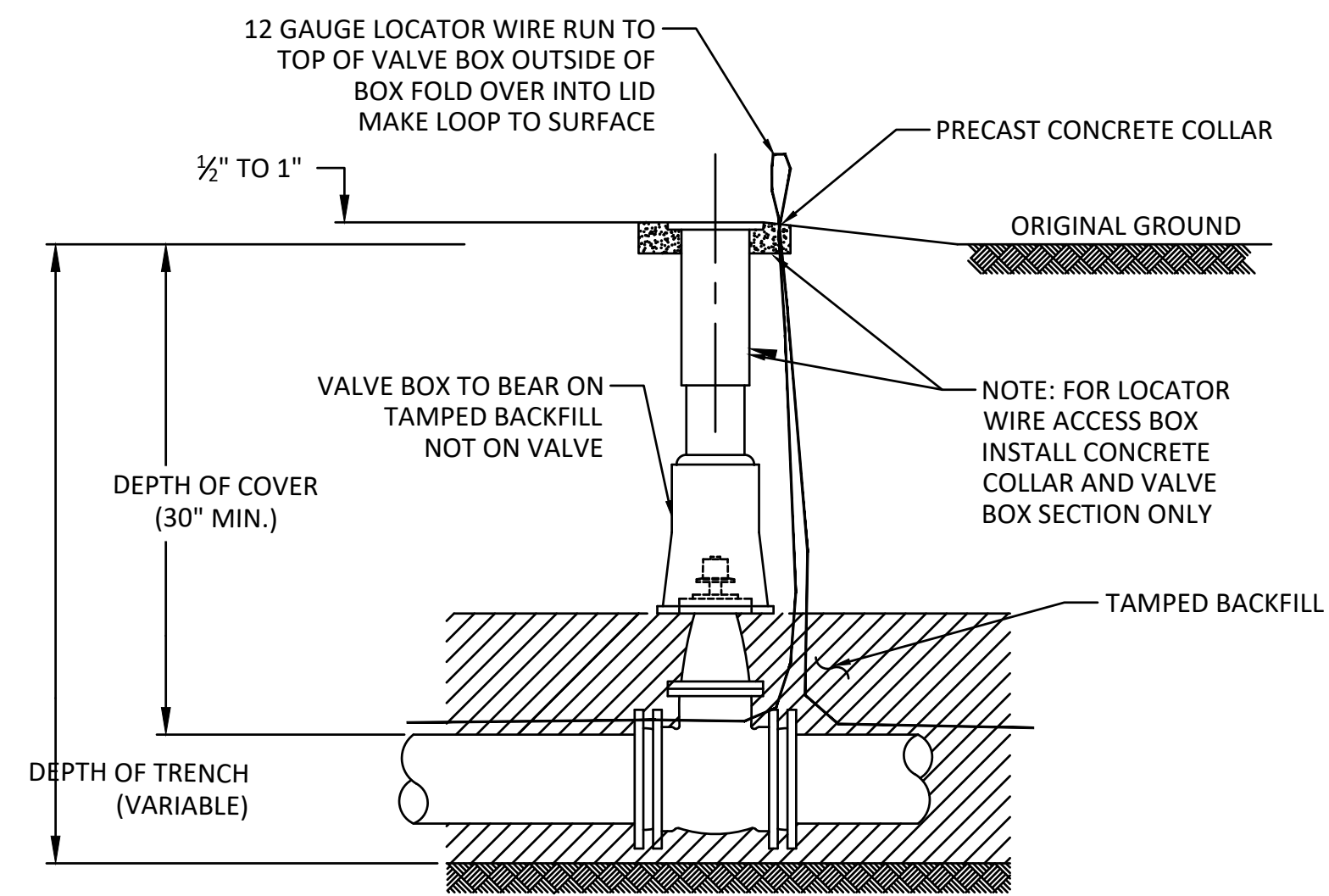
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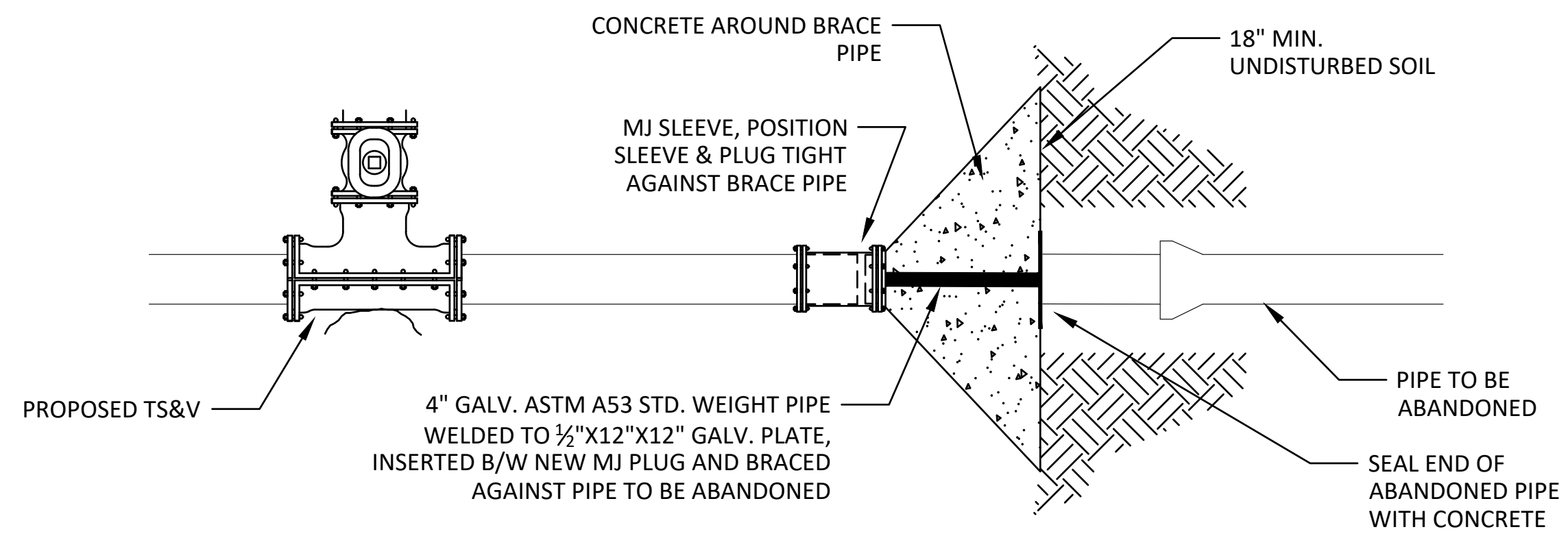
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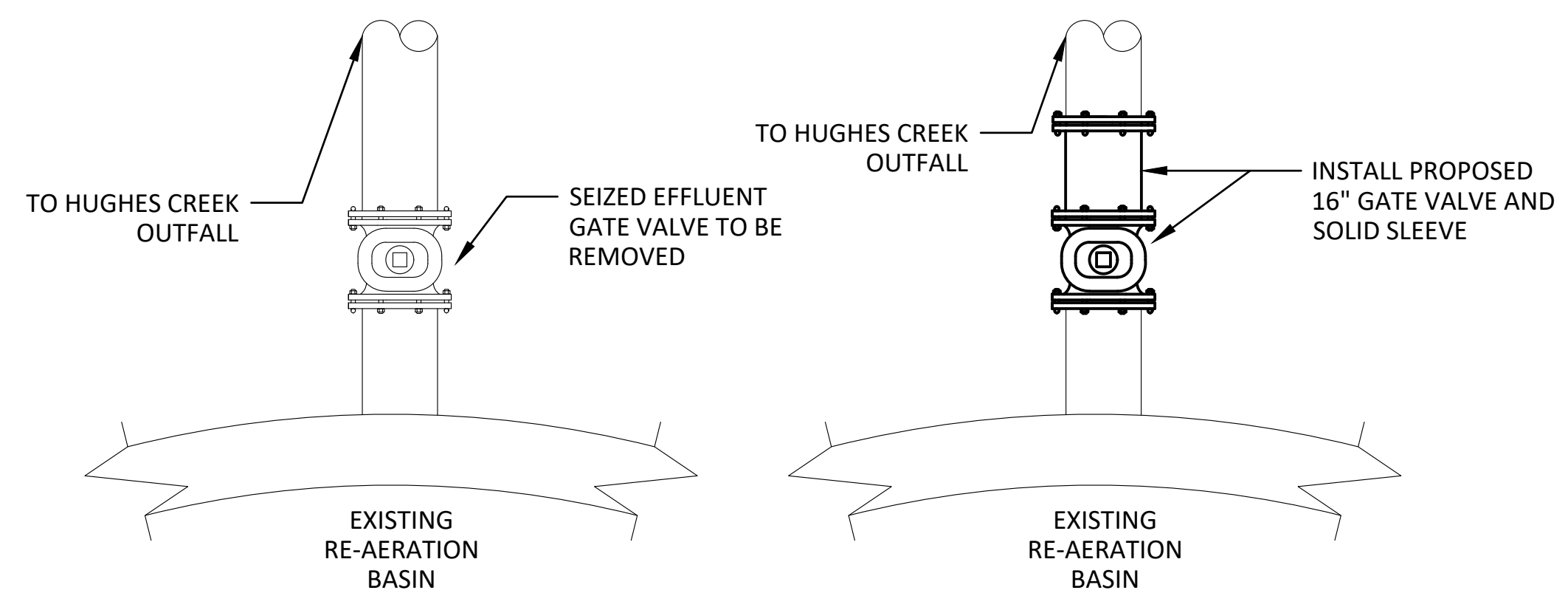
**A** TS&V DETAIL



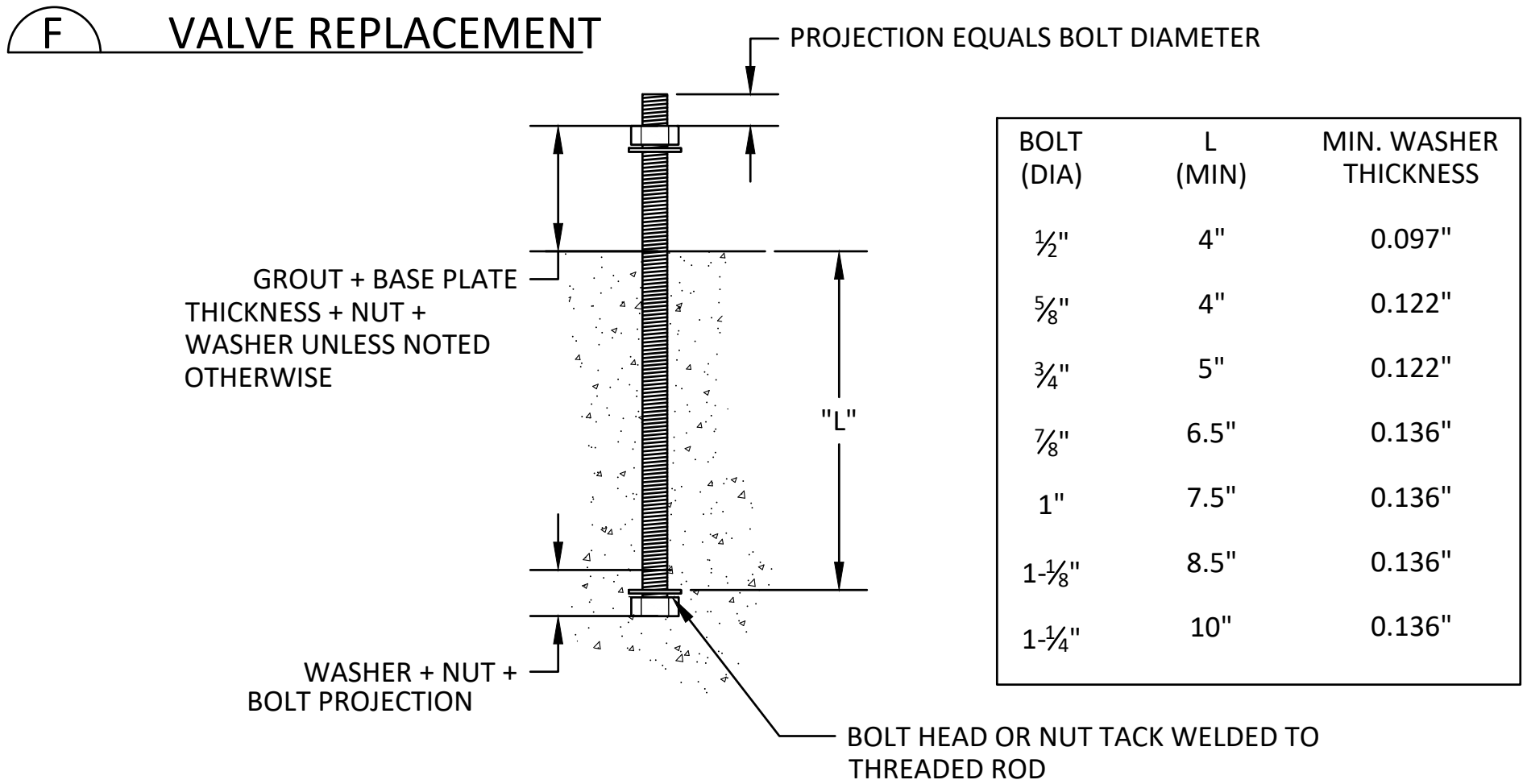
**B** GATE VALVE DETAIL



**C** CUT & PLUG DETAIL



**D** THRUST BLOCK DETAIL



**E** PIPE TRENCH DETAILS

GENERAL DATA FOR BLOCKING STANDARD FITTING

S.F. BEARING AREA REQUIRED AT PLUGS, TEES & BENDS FOR EACH 100 PSI OF TEST PRESSURE

PIPE SIZE	PLUG	TEE	90° BEND	45° BEND	22.5° BEND	11.25° BEND
4" or less	0.63	0.63	0.89	0.48	0.25	0.12
6"	1.40	1.40	2.00	1.08	0.55	0.28
8"	2.50	2.50	3.55	1.92	0.98	0.49
10"	3.93	3.93	5.55	3.00	1.53	0.77
12"	5.65	5.65	8.00	4.33	2.21	1.11
14"	7.70	7.70	10.88	5.89	3.00	1.51
16"	10.05	10.05	14.21	7.69	3.85	1.97
18"	12.70	12.70	17.99	9.74	4.96	2.49
20"	15.71	15.71	22.22	12.02	6.13	3.08
24"	22.67	22.67	32.00	17.31	8.83	4.43
27"	28.63	28.63	40.48	21.91	11.17	5.61
30"	35.35	35.35	50.00	27.06	13.79	6.93
36"	50.90	50.90	72.98	38.95	19.89	9.98
42"	69.27	69.27	97.97	53.02	27.03	13.58
48"	90.48	90.48	127.96	69.25	35.30	17.74
54"	114.51	114.51	161.94	87.64	44.68	22.45

- NOTES:
1. ALL FITTINGS SHALL BE MECHANICAL JOINT WITH MEGA LUGS.
  2. DO NOT COVER BELLS OR FLANGES WITH CONCRETE.
  3. WRAP ALL FITTINGS WITH POLYETHYLENE.
  4. BACK ALL TEES ACCORDING TO SIZE OF BRANCH.
  5. BACKING FOR FUTURE LINE EXTENSIONS SHALL BE SUCH THAT LATER REMOVAL IS POSSIBLE.
  6. ALL BENDS WHERE FITTINGS ARE USED, BOTH HORIZONTAL AND VERTICAL, SHALL BE BACKED.
  7. REACTION BACKING TABLE IS BASED ON 100 p.s.i. AND SOIL BEARING PRESSURE OF 2,000 lb./sq. ft. ADDITIONAL BACKING MAY BE REQUIRED IN SOME AREAS AS DIRECTED BY ENGINEER.
  8. TYPICAL ALL BLOCKING: SHOULD NOT EXTEND PAST HUB FITTING.
  9. ALL CONCRETE SHALL HAVE 3000 p.s.i. MIN. COMP. STRENGTH.

**NOTE TO CONTRACTOR:**  
ANCHOR BOLT TYPE, SIZE, NUMBER, AND LOCATION FOR EQUIPMENT PADS ARE TO BE AS REQUIRED BY THE EQUIPMENT MANUFACTURER.

**CAST-IN-PLACE ANCHOR BOLT DETAIL:**

1. BOLT EDGE DISTANCE SHALL BE A MINIMUM OF 1.5xL.
2. MIN. CENTER TO CENTER SPACING OF BOLTS SHALL BE 3xL.
3. PROVIDE 1.5" NON-SHRINK GROUT UNDER BASEPLATE UNLESS NOTED OTHERWISE.
4. BOLTS SHALL CONFORM TO ASTM F1554, GRADE 36.
5. NUT SHALL CONFORM TO ASTM A563, GRADE A HEX.
6. WASHERS SHALL CONFORM TO ASTM F436.
7. CONTRACTOR SHALL COORDINATE BOLT PROJECTION WITH EQUIPMENT MANUFACTURERS.

**CWB Engineers, Inc.**  
-Designing a Better Arkansas-  
phone: (501) 362-3744  
cell: (501) 766-9832  
email: kbreckenridge@cwbenigneers.com

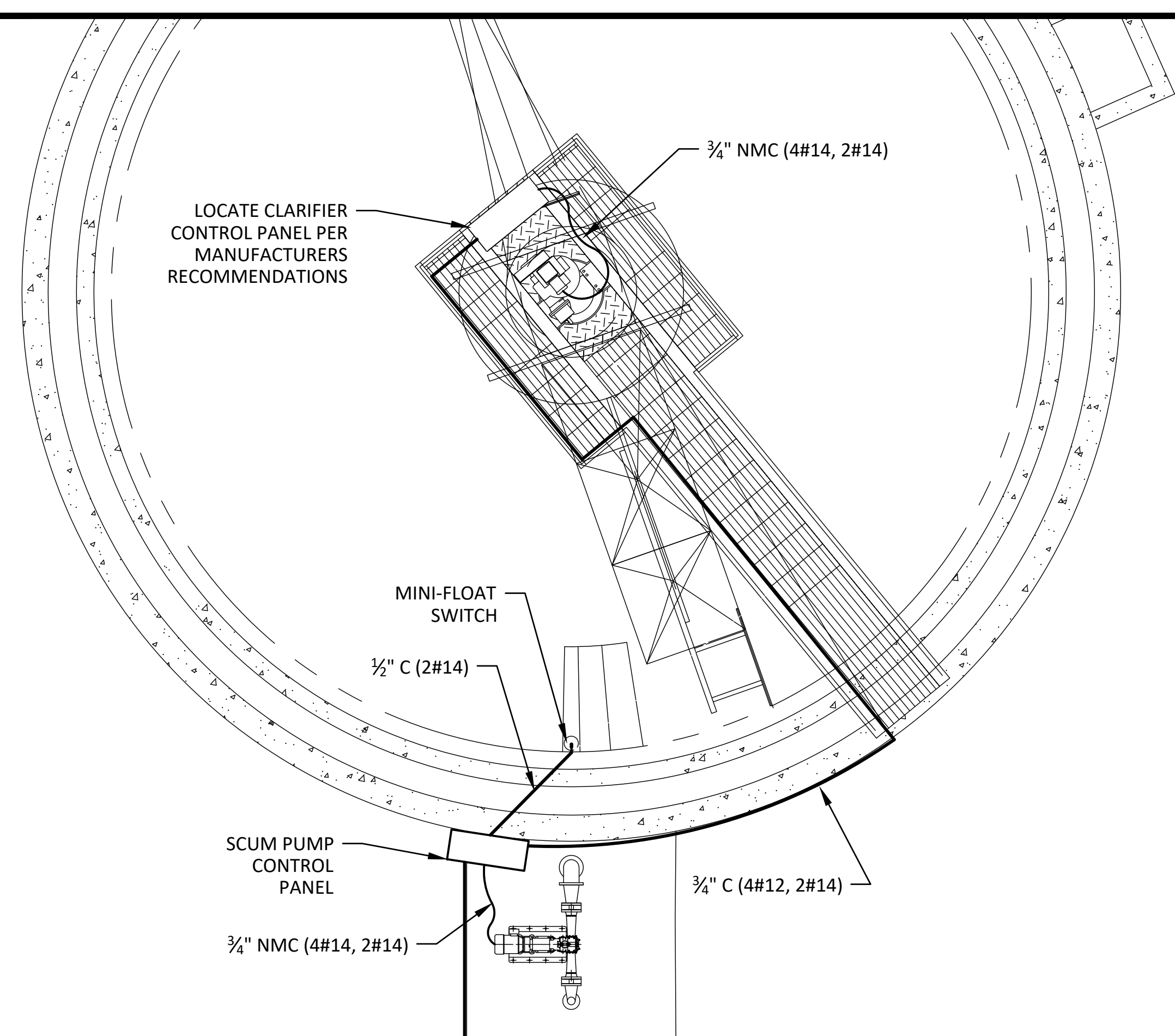
GENERAL DETAILS 4	SCALE: NTS	DATE: MAY 2021	PROJECT: 20-018
CITY OF MOUNTAIN VIEW	WWT IMPROVEMENTS	MOUNTAIN VIEW, AR	
SHEET	OWNER	PROJECT	LOCATION

Arkansas One Call  
**811**  
Know what's below.  
Call before you dig.

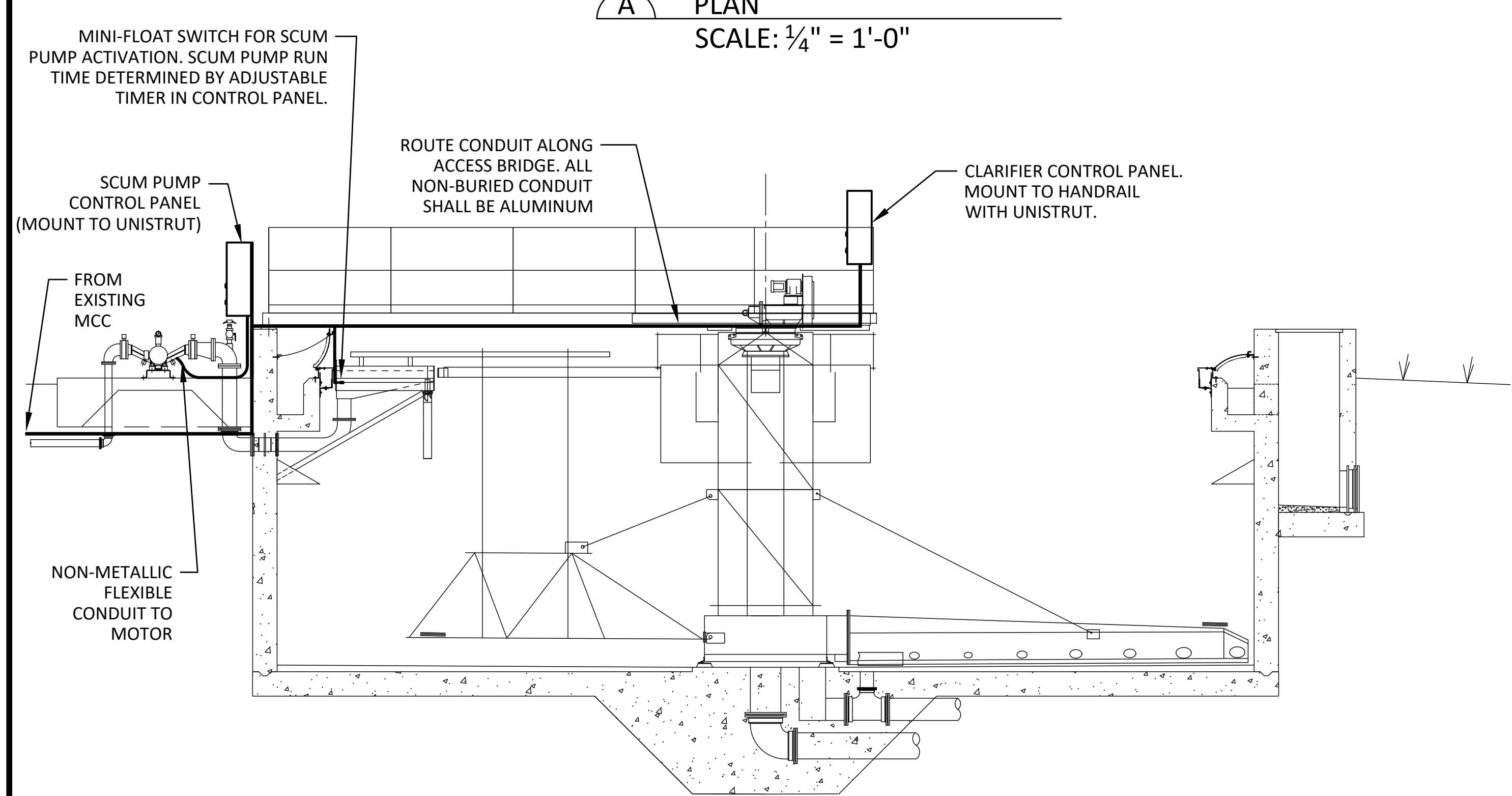
CERTIFICATE OF AUTHORIZATION  
CWB ENGINEERS, INC.  
No. 1716  
ARKANSAS

STATE OF ARKANSAS  
REGISTERED PROFESSIONAL ENGINEER  
C. Kyle Breckenridge  
No. 13631

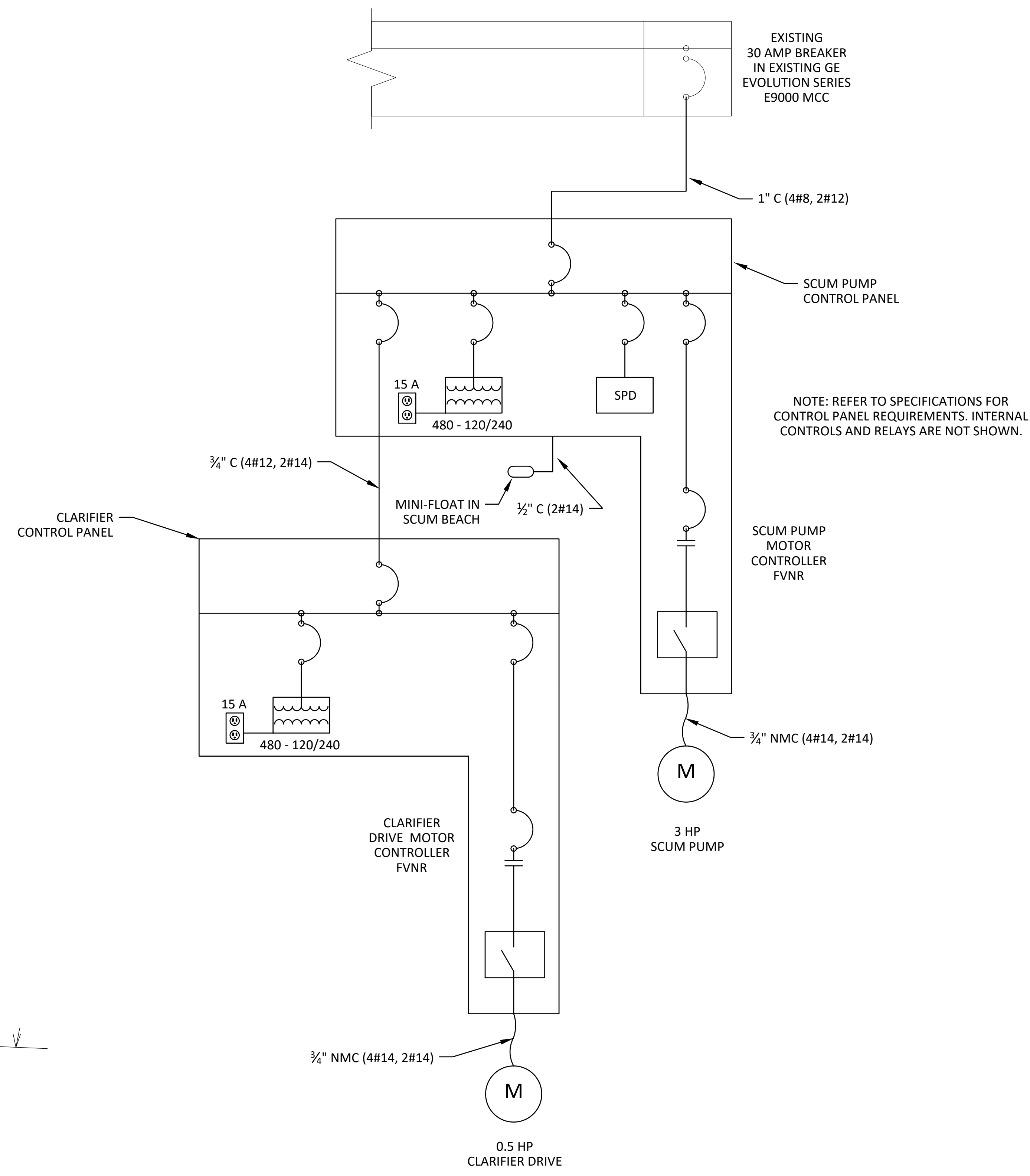




**A** PLAN  
SCALE: 1/4" = 1'-0"



**B** SECTION  
SCALE: 1/4" = 1'-0"



**C** ONE LINE DIAGRAM  
N.T.S.

EXISTING  
30 AMP BREAKER  
IN EXISTING GE  
EVOLUTION SERIES  
E9000 MCC

SCUM PUMP  
CONTROL PANEL

NOTE: REFER TO SPECIFICATIONS FOR  
CONTROL PANEL REQUIREMENTS. INTERNAL  
CONTROLS AND RELAYS ARE NOT SHOWN.

SCUM PUMP  
MOTOR  
CONTROLLER  
FVNR

3 HP  
SCUM PUMP

0.5 HP  
CLARIFIER DRIVE

**CWB**  
Engineers, Inc.  
-Designing a Better Arkansas-  
1915 Highway 25B  
Heber Springs  
AR 72543  
phone: (501) 362-3744  
cell: (501) 766-9832  
email: kbreckenridge@cwbenigneers.com

CLARIFIER ELECTRICAL PLAN	SCALE: 1/4" = 1'-0"	DATE: MAY 2021	PROJECT: 20-018
	CITY OF MOUNTAIN VIEW	WWTP IMPROVEMENTS	MOUNTAIN VIEW, AR
SHEET	OWNER	PROJECT	LOCATION

Arkansas One Call  
**811**  
Know what's below.  
Call before you dig.

CERTIFICATE OF AUTHORIZATION  
CWB  
ENGINEERS, INC.  
No. 1716  
ARKANSAS

STATE OF  
ARKANSAS  
REGISTERED  
PROFESSIONAL  
ENGINEER  
KYLE BRECKENRIDGE  
No. 13631  
5/12/21



## Mt. View WWTP Final Clarifier Design Calculations

---

### Existing Clarifier

Min. Flow            0.2 MGD  
Max. Flow            2.25 MGD

Design MLSS in Oxidation Ditch =        3,500.00 mg/L

Existing Clarifier Diameter =                55.00 ft  
Depth =    12.00 ft  
Volume =                                         213,254.45 gal  
Detention Time Min. =                        25.59 hours  
Detention Time Max. =                        2.27 hours

Min. SOR =                                        84.18 gpd/sf  
Max. SOR =                                        947.04 gpd/sf        10 SS requires < 1,000 gpd/sf for Extended Aeration

Min. SLR =                                        2.46 ppd/sf  
Max. SLR =                                        27.64 ppd/sf        10 SS requires < 35 ppd/sf for Extended Aeration

Min. WLR =                                       1,157.49 gpd/lf  
Max. WLR =                                       13,021.77 gpd/lf    10 SS requires < 20,000 for WWTP ADF < 1 MGD

### Proposed Clarifier

Min. Flow            0.2 MGD  
Max. Flow            1.25 MGD

Proposed Clarifier Diameter =                40.00 ft  
Depth =    12.00 ft  
Volume =                                         112,795.74 gal  
Detention Time Min. =                        13.54 hours  
Detention Time Max. =                        2.17 hours

Min. SOR =                                        159.15 gpd/sf  
Max. SOR =                                        994.72 gpd/sf        10 SS requires < 1,000 gpd/sf for Extended Aeration

Min. SLR =                                        4.65 ppd/sf  
Max. SLR =                                        29.04 ppd/sf        10 SS requires < 35 ppd/sf for Extended Aeration

Min. WLR =                                       1,591.55 gpd/lf  
Max. WLR =                                       9,947.18 gpd/lf    10 SS requires < 20,000 for WWTP ADF < 1 MGD

**Total Combined Max. Clarifier Capacity =        3.5 MGD**

Existing Effluent Box to Existing UV Channel

PIPE SIZE	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING VALVE	CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
0.5	0.22	9.2	1.48	0.08	-	0.49	0.81	0.43	0.43	0.54	1.62	2.7	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
0.75	0.2	8.5	1.38	0.08	-	0.45	0.75	0.4	0.4	0.5	1.5	2.5	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1	0.18	7.8	1.27	0.07	-	0.41	0.69	0.37	0.37	0.46	1.38	2.3	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.25	0.18	7.5	1.21	0.07	-	0.4	0.66	0.35	0.35	0.44	1.32	2.2	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.5	0.15	7.1	1.16	0.06	-	0.38	0.63	0.34	0.34	0.42	1.26	2.1	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2	0.15	6.5	1.05	0.06	0.86	0.34	0.57	0.3	0.3	0.38	1.14	1.9	2.3	2.3	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2.5	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
3	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
4	0.14	5.8	0.94	0.05	0.77	0.31	0.51	0.27	0.27	0.34	1.02	1.7	2	2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
6	0.12	5.1	0.83	0.05	0.68	0.27	0.45	0.24	0.24	0.3	0.9	1.5	1.8	1.8	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
8	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
10	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
12	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
14	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
16	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
18	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
20	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
24	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
30	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
36	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
42	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
48	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
QUANTITY	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING VALVE	CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
SUMMED K	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0.78	1	0	0	0	0	0	0

TOTAL K 2.4  
 DIAMETER: 14  
 C VALUE H 140  
 C VALUE L 100  
 LENGTH 110

Q GPM	Hh FEET	Hl FEET	V FPS	ML FEET	Total Loss
2431	1.115	0.598	5.067	0.957	2.072

UV WL = 602.5  
 Eff Box WL = 604.57  
 Top of Effluent Box = 605 0.52 ft. of freeboard @ 3.5 MGD flow

Existing Effluent Box to Proposed Final Clarifier

PIPE SIZE	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING VALVE	CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
0.5	0.22	9.2	1.48	0.08	-	0.49	0.81	0.43	0.43	0.54	1.62	2.7	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
0.75	0.2	8.5	1.38	0.08	-	0.45	0.75	0.4	0.4	0.5	1.5	2.5	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1	0.18	7.8	1.27	0.07	-	0.41	0.69	0.37	0.37	0.46	1.38	2.3	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.25	0.18	7.5	1.21	0.07	-	0.4	0.66	0.35	0.35	0.44	1.32	2.2	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.5	0.15	7.1	1.16	0.06	-	0.38	0.63	0.34	0.34	0.42	1.26	2.1	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2	0.15	6.5	1.05	0.06	0.86	0.34	0.57	0.3	0.3	0.38	1.14	1.9	2.3	2.3	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2.5	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
3	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
4	0.14	5.8	0.94	0.05	0.77	0.31	0.51	0.27	0.27	0.34	1.02	1.7	2	2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
6	0.12	5.1	0.83	0.05	0.68	0.27	0.45	0.24	0.24	0.3	0.9	1.5	1.8	1.8	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
8	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
10	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
12	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
14	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
16	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
18	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
20	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
24	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
30	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
36	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
42	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
48	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
QUANTITY	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING VALVE	CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
SUMMED K	0	0	0	0	0	0.23	0.39	0	0	0	0	0	0	0	3.12	4	0	0	0	0	0	0

TOTAL K 7.74  
 DIAMETER: 16  
 C VALUE H 140  
 C VALUE L 100  
 LENGTH 180

Q GPM	H <sub>L</sub> FEET	H <sub>L</sub> FEET	V FPS	ML FEET	Total Loss
1042	0.199	0.107	1.663	0.332	0.531

Eff Box WL = 604.57  
 WL after FC weir = 605.10

Oxidation Ditch to Proposed Final Clarifier

PIPE SIZE	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	PIPE REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
0.5	0.22	9.2	1.48	0.08	-	0.49	0.81	0.43	0.43	0.54	1.62	2.7	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
0.75	0.2	8.5	1.38	0.08	-	0.45	0.75	0.4	0.4	0.5	1.5	2.5	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1	0.18	7.8	1.27	0.07	-	0.41	0.69	0.37	0.37	0.46	1.38	2.3	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.25	0.18	7.5	1.21	0.07	-	0.4	0.66	0.35	0.35	0.44	1.32	2.2	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.5	0.15	7.1	1.16	0.06	-	0.38	0.63	0.34	0.34	0.42	1.26	2.1	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2	0.15	6.5	1.05	0.06	0.86	0.34	0.57	0.3	0.3	0.38	1.14	1.9	2.3	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2.5	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
3	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
4	0.14	5.8	0.94	0.05	0.77	0.31	0.51	0.27	0.27	0.34	1.02	1.7	2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
6	0.12	5.1	0.83	0.05	0.68	0.27	0.45	0.24	0.24	0.3	0.9	1.5	1.8	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
8	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
10	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
12	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
14	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
16	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
18	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
20	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
24	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
30	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
36	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
42	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
48	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
QUANTITY SUMMED K	0	0	0	0	0	0	0.39	0.21	0	0	0	0	0	0.78	1	0	0	0	0	0	0

TOTAL K 2.38

DIAMETER: 12  
 C VALUE H 140  
 C VALUE L 100  
 LENGTH 80

Q GPM	HLH FEET	HL1 FEET	V FPS	ML FEET	Total Loss
1042	0.358	0.192	2.956	0.323	0.681

FC WL = 606.35  
 Weir 1 607.031121441411  
 WL in MLSS Splitter Box = 608.03 dist

Oxidation Ditch to Existing Final Clarifier

PIPE SIZE	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	PIPE REDUCER D RATIO	REDUCER 0.8 D RATIO	REDUCER 0.5 D RATIO	REDUCER 0.2 D RATIO	ENLARGER 0.8 D RATIO	ENLARGER 0.5 D RATIO	ENLARGER 0.2 D RATIO
0.5	0.22	9.2	1.48	0.08	-	0.49	0.81	0.43	0.43	0.54	1.62	2.7	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
0.75	0.2	8.5	1.38	0.08	-	0.45	0.75	0.4	0.4	0.5	1.5	2.5	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
1	0.18	7.8	1.27	0.07	-	0.41	0.69	0.37	0.37	0.46	1.38	2.3	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
1.25	0.18	7.5	1.21	0.07	-	0.4	0.66	0.35	0.35	0.44	1.32	2.2	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
1.5	0.15	7.1	1.16	0.06	-	0.38	0.63	0.34	0.34	0.42	1.26	2.1	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
2	0.15	6.5	1.05	0.06	0.86	0.34	0.57	0.3	0.3	0.38	1.14	1.9	2.3	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
2.5	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
3	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
4	0.14	5.8	0.94	0.05	0.77	0.31	0.51	0.27	0.27	0.34	1.02	1.7	2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
6	0.12	5.1	0.83	0.05	0.68	0.27	0.45	0.24	0.24	0.3	0.9	1.5	1.8	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
8	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
10	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
12	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
14	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
16	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
18	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
20	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
24	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
30	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
36	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
42	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
48	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
QUANTITY SUMMED K	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0

TOTAL K 2.17

DIAMETER: 14  
 C VALUE H 140  
 C VALUE L 100  
 LENGTH 55

	Q GPM	HLH FEET	HL1 FEET	V FPS	ML FEET	Total Loss
	1389	0.198	0.106	2.895	0.282	0.480
FC WL =				606.35		
Weir				1		606.830386542951
WL in MLSS Splitter Box =				607.83		

MLSB to Oxidation Ditch - Existing 16"

PIPE SIZE	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING VALVE	CHECK CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
0.5	0.22	9.2	1.48	0.08	-	0.49	0.81	0.43	0.43	0.54	1.62	2.7	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
0.75	0.2	8.5	1.38	0.08	-	0.45	0.75	0.4	0.4	0.5	1.5	2.5	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1	0.18	7.8	1.27	0.07	-	0.41	0.69	0.37	0.37	0.46	1.38	2.3	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.25	0.18	7.5	1.21	0.07	-	0.4	0.66	0.35	0.35	0.44	1.32	2.2	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.5	0.15	7.1	1.16	0.06	-	0.38	0.63	0.34	0.34	0.42	1.26	2.1	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2	0.15	6.5	1.05	0.06	0.86	0.34	0.57	0.3	0.3	0.38	1.14	1.9	2.3	2.3	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2.5	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
3	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
4	0.14	5.8	0.94	0.05	0.77	0.31	0.51	0.27	0.27	0.34	1.02	1.7	2	2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
6	0.12	5.1	0.83	0.05	0.68	0.27	0.45	0.24	0.24	0.3	0.9	1.5	1.8	1.8	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
8	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
10	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
12	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
14	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
16	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
18	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
20	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
24	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
30	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
36	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
42	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
48	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
QUANTITY	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING VALVE	CHECK CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
SUMMED K	0	0	0	0	0	0.23	0.39	0	0	0	0	0	0	0	0.78	1	0	0	0	0	0	0

TOTAL K 2.4  
 DIAMETER: 16  
 C VALUE H 140  
 C VALUE L 100  
 LENGTH 100

Q GPM	H <sub>L</sub> FEET	H <sub>L</sub> FEET	V FPS	ML FEET	Total Loss
2431	0.529	0.284	3.879	0.561	1.090

MLSB WL = 608.03  
 Ox Ditch Eff WL = 609.12

Scum Pump Discharge

PIPE SIZE	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
0.5	0.22	9.2	1.48	0.08	-	0.49	0.81	0.43	0.43	0.54	1.62	2.7	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
0.75	0.2	8.5	1.38	0.08	-	0.45	0.75	0.4	0.4	0.5	1.5	2.5	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1	0.18	7.8	1.27	0.07	-	0.41	0.69	0.37	0.37	0.46	1.38	2.3	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.25	0.18	7.5	1.21	0.07	-	0.4	0.66	0.35	0.35	0.44	1.32	2.2	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.5	0.15	7.1	1.16	0.06	-	0.38	0.63	0.34	0.34	0.42	1.26	2.1	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2	0.15	6.5	1.05	0.06	0.86	0.34	0.57	0.3	0.3	0.38	1.14	1.9	2.3	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2.5	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
3	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
4	0.14	5.8	0.94	0.05	0.77	0.31	0.51	0.27	0.27	0.34	1.02	1.7	2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
6	0.12	5.1	0.83	0.05	0.68	0.27	0.45	0.24	0.24	0.3	0.9	1.5	1.8	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
8	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
10	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
12	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
14	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
16	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
18	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
20	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
24	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
30	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
36	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
42	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
48	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13

QUANTITY	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
SUMMED K	0	0	0	0	0	0	4	4	0	0	0	0	0	1	1	0	0	0	0	0	0
TOTAL K	5.1						2.16	1.16	0	0	0	0	0	0.78	1	0	0	0	0	0	0

TOTAL K 5.1  
 DIAMETER 3  
 C VALUE H 140  
 C VALUE L 100  
 LENGTH 300

Q GPM	Hl FEET	HL FEET	V FPS	ML FEET	Total Loss
50	4.144	2.224	2.270	0.408	4.552

Digester HWL = 630  
 Digester LWL = 620  
 Scum Beach HWL = 611  
 Scum Beach LWL = 609  
 LOW TDH = 11.63 ft  
 HIGH TDH = 23.63 ft

**Mt. View Existing Oxidation Ditch**

Flow	0.95 MGD
BOD	200.00 mg/L
TSS	200.00 mg/L
TP	6.00 mg/L
NH3	30.00 mg/L
TKN	40.00 mg/L

Total Basin Volume	430,705.00 gal
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Mass Load

BOD	1,584.60 ppd
Organic Loading	27.52 ppd/mcf
Hyd. Detention Time	10.88 hr

10 S.S. REQUIRES < 40 FOR CONVENTIONAL AERATION, SRT < 15 DAYS

Ynet	0.90
Design MLSS	3,500.00 mg/L

SRT @ design flow	8.82 days
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Washout SRT @ 10°C	4.30 days
SF @0.95 MGD	2.05

from WERF Publication: Methods for Wastewater Characterization in Activated Sludge Modeling



THE FOLLOWING CALCULATIONS ARE  
THE ORIGINAL DESIGN  
CALCULATIONS FOR THE OXIDATION  
DITCH WHEN IT WAS INSTALLED -  
WITH DESIGN FLOW = 0.73 MGD.

**ORBAL DESIGN OUTLINE**

Project: Mt View - AR Orbal      Prepared: 07/18/2006  
Engineer: McClelland consulting engineer      Designer: Dennis Barnes

**Influent Characteristics**

Flow, MGD	0.73
BOD5, mg/L	200
TSS, mg/L	200
TP, mg/L	6
NH3-N, mg/L	40
TKN, mg/L	50

**Effluent Requirements**

BOD5, mg/L	10
TSS mg/L	15
TP, mg/L	1.5
NH3-N, mg/L	1.0
TN, mg/L	10.0

**Orbal Design Parameters**

Total Load, lb BOD5/day	1,218	MLSS, mg/L	3,470
Primary Clarifiers	NO	No. of Trains in Parallel	1
Organic Loading, lb/1000 cft/day	21.15	Solids under Aeration, Lbs.	12,466
Total Hydraulic Detention Time, Hr	14.2	Sludge Yield	0.85
		WAS per train, lb/day	1,039
		Sludge Age, days	12

**Basin Dimensions**

No. of Channels per Train	3	Wall Thickness, ft	1.00
Channel Depth, ft	12.00	Radius of Center Island, ft.	5.0
Channel Width, ft		Length of Short Axis Straight Section, ft.	0.0
Inner	10.00	Length of Long Axis Straight Section, ft.	14.0
Middle	10.00	Overall Width, ft.	76.0
Outer	10.00	Overall Length, ft.	90.0
		Volume per Train, cubic feet	57,581
		Volume per Train, gal	430,705

**Pumping Requirements**

RAS pumping rate at 150% of Q, (where Q is the average design flow rate)  
Pump MLSS containing Nitrates from Aerobic Inner channel to Anoxic Outer channel at 400% of Q

**Drives Recommendation**

Location	Channels spanned	Discs per aerator	Design rpm	Max. rpm	Quantity per train	HP
Outer	1	18	29	45	(2)	10.0
Center Island	2	36	43	55	(2)	30.0
Wall Pumps for Nitrate Recycle to Anoxic Outer Channel					1	5.6
Based on max. disc immersion of		21 inches		Installed HP per Train		86 HP
Based on motor efficiency of		90%		Operating electrical Hp per Train		38 HP
and design disc immersion of		14 inches				

Additional Costs	Concrete		Orbal Basin		
		Unit Price	Cubic Yards		
		Walls	\$550	320	\$176,000
		Floors	\$500	158	\$78,000
	Installation	Hourly Rate	Orbal	SmartBNR	
		\$55	130 man-hrs	100 man-hrs	\$13,000
<b>Total Additional Costs</b>					<b>\$267,000</b>

**Influent Characteristics**

		Ave. design flow, MGD	0.73		
BOD5, mg/L	200	NH3-N, mg/L	40		
TSS, mg/L	200	TKN, mg/L	50	TP, mg/L	6

**A) Determine Basin Volume**

Basin volume is determined by minimum sludge age required to maintain a healthy population of nitrifying organisms at the minimum wastewater temperature.  $\theta_{min} = 1 / (\mu_{max} * EXP(0.098 * (T_{min} - 15))) * TPF * SF$ , where:

Minimum wastewater temperature, $T_{min}$ =	53.6 degrees F
$\theta_{max}$ =	0.47 days <sup>-1</sup>
Diurnal Peak Factor, DPF =	1.2
Monthly Peak Factor, MPF =	1.3
DPF x MPF = Total Process Peak Factor, TPF =	1.56
Safety Factor, SF =	2.5
Minimum Solids Residence Time, $\theta_{min}$ =	11.1 days
Selected Solids Residence Time, $\theta_x$ =	12.0 days

Use McCarty kinetic equations to calculate basin volume required:

- 1) **Inert solids:**

$M_{i,IB} = (M_{o,TSS})(1 - f_{VSSo}) =$	
( 1218 lb/day influent TSS)(100 - 80% VSS) / (100%) =	244 lb/day
  
- 2) **Nonbiodegradable VSS:**

$M_{o,NS} = (M_{o,TSS})(f_{VSSo})(f_{NS}) =$	
( 1218 lb/day influent TSS)(80% VSS)(40% NBVSS) / (100%) =	390 lb/day
  
- 3) **Heterotrophic Kinetic Parameters**

Growth Rate, $Y_{true, 15} =$	0.6 lb VSS/lb BOD5
Decay rate, $b_{15} =$	0.06 days <sup>-1</sup>
BOD Half-saturation coefficient, $K_{BOD} =$	20 mg/l BOD
Adjusting for temperature, $b_T = b_{15}(1.04)^{(T-15)} =$	0.073 days <sup>-1</sup>
Maximum Growth Rate, $\mu_{MAX,H} =$	6

Estimate Effluent BOD<sub>5</sub>:

Soluble BOD, $S_o = [K_{BOD}(1+b_T \theta_x)] / [K_{MAX,H} - b_T] - 1 =$	0.54 mg/l
Effluent VSS concentration, $f =$	40%
$BOD_{5, total} = S_o + (TSS \times f) =$	
0.54 + (10mg/l effluent TSS)(40% VSS) / (100%) =	4.54 mg/l

Observed yield of heterotrophs:

$Y_{OBS,H} = Y_{true} / (1 + b_T \theta_x) =$	0.32
---	------

Heterotrophic Biomass Produced:

$M_H = (M_{o,BOD} - M_{o,BOD})(Y_{OBS,H}) =$	381 lb/day
--	------------
  
- 4) **Autotrophic Kinetic Parameters**

Growth Rate, $Y_{true, 15} =$	0.15 lb VSS/lb NH3-N
Decay Rate, $b =$	0.05 days <sup>-1</sup>
Ammonia half-saturation coefficient, $K_{am} =$	0.5 mg NH <sub>3</sub> -N/L
Oxygen half-saturation coefficient, $K_o =$	1 mg DO/L
$\theta_{max} =$	0.47 days <sup>-1</sup>
Adjusting for temperature: $\theta_{max T} = \theta_{max 15} e^{0.098(T-15)} =$	0.350 days <sup>-1</sup>
$b_T = b_{15}(1.04)^{(T-15)} =$	0.044 days <sup>-1</sup>

Calculate observed yield of autotrophs:

$Y_{OBS,A} = Y_{true} / (1 + b_T \theta_x) =$	0.098
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Nitrogen assimilated by heterotrophic biomass:

$$\begin{aligned} \text{Nitrogen content of biomass: } N_{cm} &= 12\% \\ \text{Nitrogen assimilated: } M_{NA-H} &= (M_H)(N_{cm}) = 46 \text{ lb/day} \end{aligned}$$

Nitrogen assimilated by autotrophic biomass (1st iteration):

$$\begin{aligned} \text{TKN oxidized: } M_{TKN-o} &= M_{o-TKN} - M_{NA-H} = 259 \text{ lb/day} \\ \text{Autotrophic Biomass Produced: } M_A &= (M_{TKN-o})(Y_{OBS A}) = 25 \text{ lb/day} \\ \text{Nitrogen assimilated by autotrophic biomass: } M_{NA-A} &= (M_A)(N_{cm}) = 3 \text{ lb/day} \end{aligned}$$

Nitrogen assimilated by autotrophic biomass (2nd iteration):

$$\begin{aligned} \text{TKN oxidized: } M_{TKN-o} &= M_{o-TKN} - M_{NA-H} - M_{NA-A} = 256 \text{ lb/day} \\ \text{Autotrophic Biomass Produced: } M_A &= (M_{TKN-o})(Y_{OBS A}) = 25 \text{ lb/day} \\ \text{Nitrogen assimilated by autotrophic biomass: } M_{NA-A} &= (M_A)(N_{cm}) = 3 \text{ lb/day} \\ \text{TKN oxidized: } M_{TKN-o} &= M_{o-TKN} - M_{NA-H} - M_{NA-A} = 256 \text{ lb/day} \\ \text{Oxidized TKN Concentration} &= (M_{TKN-o})(1000)/Q = 42 \text{ mg/l} \end{aligned}$$

5) **Total Solids Production Rate:**

$$\begin{aligned} P_x &= M_{o-BS} + M_{o-NS} + M_H + M_A = 1039 \text{ lb/day} \\ \text{Overall Yield: } Y_H &= P_x/M_{o-BOD} = 0.85 \\ \text{MLVSS: } (M_{o-NS} + M_H + M_A) / P_x &= 76.56\% \end{aligned}$$

6) **Orbal Basin Volume Calculations:**

Calculate required volume, based on MLSS concentration of 3500 mg/l

$$\begin{aligned} \text{Required Volume, } V &= (\theta_x)(P_x)(1,000,000)/8.34/\text{MLSS} = 427048 \text{ gallons} \\ \text{Selected Orbal basin volume} &= 430705 \text{ gallons} \\ \text{Actual MLSS: } X &= (\theta_x)(P_x)(1,000,000)/V/8.34 = 3470 \text{ mg/l} \end{aligned}$$

7) **Waste Activated Sludge:**

$$\begin{aligned} \text{WAS TSS: } X_{wv} &= (1 + F_R)(X)/(F_R) = 5784 \text{ mg/l} \\ \text{WAS Flow: } Q_W &= (P_x)(1000000)/(X_W)/8.34 = 21535 \text{ gal/day} \end{aligned}$$

**B. Determine Actual Oxygen Transfer Rate (AOTR) to be satisfied in Orbal**

1) **Carbonaceous O<sub>2</sub> demand**

$$\begin{aligned} \text{oxygen equivalent of cell mass, } B &= 1.42 \text{ lb O}_2/\text{lb VSS} \\ \text{Influent BOD}_{ULT}:\text{BOD}_5 \text{ RATIO:} &= 1.46 \\ \text{Effluent BOD}_{ULT}:\text{BOD}_5 \text{ RATIO:} &= 1.2 \\ \text{Carbonaceous oxygen demand design factor, } f_{c-o_2} &= 1.16 \end{aligned}$$

a) **Mass of BOD<sub>5</sub> O<sub>2</sub> demand equivalents entering the system:**

$$\begin{aligned} \text{lb BOD}_5/\text{d} \times \text{Influent BOD}_{ULT}:\text{BOD}_5 \text{ RATIO} &= \\ (1218 \text{ lb/day Influent BOD})(1.46) &= 1778 \text{ lb/day} \end{aligned}$$

b) **Mass of BOD<sub>5</sub> O<sub>2</sub> demand equivalents leaving the system:**

$$\begin{aligned} \text{lb BOD}_5/\text{day} \times \text{Effluent BOD}_{ULT}:\text{BOD}_5 \text{ RATIO} &= \\ (28 \text{ lb/day effluent BOD})(1.46) &= 33 \text{ lb/day} \end{aligned}$$

c) **Mass of O<sub>2</sub> equivalents leaving the system as biomass:**

$$\begin{aligned} \text{heterotrophic VSS/d} + \text{autotrophic VSS/d} \times \text{lb O}_2/\text{lb VSS} &= \\ (381 + 25.01)(1.42) &= 578 \text{ lb/day} \end{aligned}$$

d) **Carbonaceous O<sub>2</sub> demand (calc.):**  $f_{c-o_2}(a - b - c) = 1356 \text{ lb/day}$

e) **Carbonaceous O<sub>2</sub> demand (selected):** 1356 lb/day

2) **Nitrification oxygen demand:**

Nitrification oxygen equivalent: 4.6  
Denitrification oxygen credit: 2.9

Nitrification oxygen demand:  $\text{lb O}_2/\text{kg NH}_3\text{-N} \times \text{lb TKN oxidized}/\text{day} =$   
 $(256 \text{ lb}/\text{day TKN oxidized})(4.6) = 1176 \text{ lb}/\text{day}$

3) **Denitrification oxygen credit:**

As long as that the organic loading is high enough and the O<sub>2</sub> supply is distributed to multiple locations, the outer channel(s) of Orbal systems can be maintained in an anoxic state by limiting the percentage of the overall system AOR satisfied in each anoxic channel to a value close to the percentage of the overall system volume in that channel, resulting in simultaneous nitrification and denitrification. Ammonia oxidation will occur at a rate proportional to the percentage of AOR satisfied in each Orbal channel. With a strong oxygen deficit (DO = near zero mg/l), 100% of the ammonia oxidized will be denitrified. With a mild oxygen deficit condition (DO = near 0.5 mg/l), 65% of ammonia oxidized will be denitrified. Based on the process split listed in the table below, we can calculate the rate of denitrification for the Orbal system:

	Channel			Total
	1	2	3	
Volume Split	47.7%	33.3%	18.9%	100.0%
AOR Split	19.4%	44.2%	36.4%	100.0%
DO, mg/l	0.0	0.5	2.0	
Denite Rate	100%	65%	0%	

**Nitrogen Mass Balance**

Nitrogen components in clarifier return activated sludge, with RAS flow at 150% of design flow

Ammonia-N:  $M_{R-NH_3} = (C_e-NH_3)(Q)(RAS\%)(8.34) = 3 \text{ lb}/\text{day}$   
Nitrate-N:  $M_{R-NO_x} = (C_e-NO_x)(Q)(RAS\%)(8.34) = 32 \text{ lb}/\text{day}$   
Total-N:  $M_{R-TN} = (C_e-TN)(Q)(RAS\%)(8.34) = 52 \text{ lb}/\text{day}$

Nitrogen components in MLSS recycle stream, with internal recycle (IR) at 400% of design flow

Ammonia-N:  $M_{IR-NH_3} = (C_e-NH_3)(Q)(Recycle\%)(8.34) = 7 \text{ lb}/\text{day}$   
Nitrate-N:  $M_{IR-NO_x} = (C_e-NO_x)(Q)(Recycle\%)(8.34) = 86 \text{ lb}/\text{day}$   
Total-N:  $M_{IR-TN} = (C_e-TN)(Q)(Recycle\%)(8.34) = 140 \text{ lb}/\text{day}$

Nitrogen components in channel 1 influent:

Ammonia-N:  $M_{i-NH_3} = M_{e-NH_3} + M_{R-NH_3} + M_{IR-NH_3} = 266 \text{ lb}/\text{day}$   
Nitrate-N:  $M_{i-NO_x} = M_{e-NO_x} + M_{R-NO_x} + M_{IR-NO_x} = 118 \text{ lb}/\text{day}$

Nitrogen Components in Reactor 1 Effluent:

Ammonia-N:  $M_{1-NH_3} = M_{i-NH_3} - (M_{e-NH_3} - M_{e-NH_3})(f_{NH_3}) = 217 \text{ lb}/\text{day}$   
Nitrate-N:  $M_{1-NO_x} = (M_{i-NH_3} - M_{1-NH_3} + M_{i-NO_x})(1-f_{DN}) = 0 \text{ lb}/\text{day}$

Nitrogen Components in Reactor 2 Effluent:

$$\begin{aligned} \text{Ammonia-N: } M2\text{-NH3} &= M1\text{-NH3} - (M0\text{-NH3} - M0\text{-NH3})(fN2) = & 104 \text{ lb/day} \\ \text{Nitrate-N: } M2\text{-Nox} &= (M1\text{-NH3} - M2\text{-NH3} + N1\text{-NOx})(1-fD2) = & 39 \text{ lb/day} \end{aligned}$$

Nitrogen Components in Reactor 3 Effluent:

$$\begin{aligned} \text{Ammonia-N: } M3\text{-NH3} &= M2\text{-NH3} - (M0\text{-NH3} - M0\text{-NH3})(fN3) = & 5 \text{ lb/day} \\ \text{Nitrate-N: } M3\text{-NOx} &= (M2\text{-NH3} - M3\text{-NH3} + N2\text{-NOx})(1-fD3) = & 53 \text{ lb/day} \end{aligned}$$

Nitrogen Components in Clarifier Effluent:

$$\begin{aligned} \text{Ammonia-N: } M_{w\text{-NH3}} &= M_{w\text{-NH3}} - M_{R\text{-NH3}} = & 2 \text{ lb/day} \\ \text{Nitrate-N: } M_{e\text{-NOx}} &= M_{e\text{-NOx}} - M_{R\text{-NOx}} = & 21 \text{ lb/day} \\ \text{Effluent NH}_3\text{-N Concentration} &= (M_{w\text{-NH3}})(1000)/Q = & 0.3 \text{ mg/l} \\ \text{Effluent NO}_3\text{-N Concentration} &= (M_{e\text{-NOx}})(1000)/Q = & 3.5 \text{ mg/l} \end{aligned}$$

Denitrification oxygen credit:

$$\begin{aligned} &(\text{lb O}_2/\text{lb NO}_3\text{-N})(\text{lb TKN oxidized/d} - \text{lb effluent NO}_3\text{-N/day}) = \\ & (2.9)(258 - 21) = & 680 \text{ lb/day} \end{aligned}$$

4) Net oxygen demand, AOR:

$$\text{lb Carbonaceous O}_2/\text{d} + \text{lb Nitrogenous O}_2/\text{d} - \text{lb Denitrification Credit/day} = 1852 \text{ lb/day}$$

C) Determine Standard Oxygen Transfer Rate (SOTR) to be satisfied in Orbal

$$\text{SOTR} = \text{AOTR} / \text{FCF}$$

$$\text{FCF} = A \times (B \times \text{ACF} \times C_s - \text{DO}) \times \text{TCF} / 9.092$$

$$\begin{aligned} \text{Alpha, } A &= 0.95 & \text{Beta, } B &= 0.98 \\ \text{Elevation} &= 770 \text{ feet} & \text{Altitude Correction Factor (ACF)} &= 0.972 \\ \text{Design water temperature} &= 68\text{F} & \text{Temperature Correction Factor (TCF)} &= 1.000 \\ \text{Saturation Concentration of Oxygen at Design Water Temperature, } C_s &= & &= 9.09 \text{ mg/l} \end{aligned}$$

DO = Dissolved oxygen concentration in each reactor, mg/l

	Channel			
	1	2	3	Total
AOR, lb/hr	15	34	28	77
DO, mg/l	0.0	0.5	2.0	
FCF	0.905	0.853	0.696	
SOR, lb/hr	17	40	40	97

1) Calculate disc quantity required per channel # of discs required = SOTR / SOTR/disc

	Channel			
	1	2	3	
Design disc immersion (in.)	14.0	14.0	14.0	
Design disc speed (rpm)	29	43	43	
Design SOTR/disc lb/hr/disc	0.48	1.18	1.18	Total
Disc Quantity	36	36	36	108

2) Disc aerator drive selection

- (2) 10.0 Hp aerator(s) on periphery of basin, each turning 18 discs
- (2) 30.0 Hp aerator(s) on periphery of basin, each turning 36 discs

3) Check for adequate oxygen reserve capacity

	Channel		
	1	2	3
Max. disc immersion (in.)	21.0	21.0	21.0
Max. disc speed (rpm)	45	55	55
Max. SOTR/disc lb/hr/disc	1.80	2.50	2.50

RESERVE SOTR CAPACITY		
	All aerators in service	Largest aerator out
Maximum SOTR =	245 lb/hr	155 lb/hr
Reserve Over Design Load =	152%	80%

WITH LARGEST AERATOR OUT, CAPACITY = 0.73/0.6 = 1.2 MGD < 0.95 MGD PROPOSED DESIGN FLOW



1) Calculate disc quantity required per channel # of discs required = SOTR / SOTR/disc

	Channel			
	1	2	3	
Design disc immersion (in.)	15.0	16.0	16.0	
Design disc speed (rpm)	29	43	43	
Design SOTR/disc lb/hr/disc	0.54	1.32	1.32	Total
Disc Quantity	36	36	36	108

2) Disc aerator drive selection

- (2) 10.0 Hp aerator(s) on periphery of basin, each turning 18 discs
- (2) 30.0 Hp aerator(s) on periphery of basin, each turning 36 discs

80 Hp

3) Check for adequate oxygen reserve capacity

	Channel		
	1	2	3
Max. disc immersion (in.)	21.0	21.0	21.0
Max. disc speed (rpm)	45	55	55
Max. SOTR/disc lb/hr/disc	1.80	2.50	2.50

*Handwritten calculations:*  
 $1.8 \times 24 = 43.2 \frac{\text{lb O}_2}{\text{hr}}$   
 $2.5 \times 24 = 60 \frac{\text{lb O}_2}{\text{hr}}$   
 $2.5 \times 24 = 60 \frac{\text{lb O}_2}{\text{hr}}$

**RESERVE SOTR CAPACITY**

All aerators in service  
 Maximum SOTR = 245 lb/hr  
 Reserve Over Design Load = 115%

Largest aerator out  
 155 lb/hr  
 36%

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transfer rate =  $\frac{2 \text{ lbs O}_2}{1 \text{ hp} \cdot \text{hr}}$

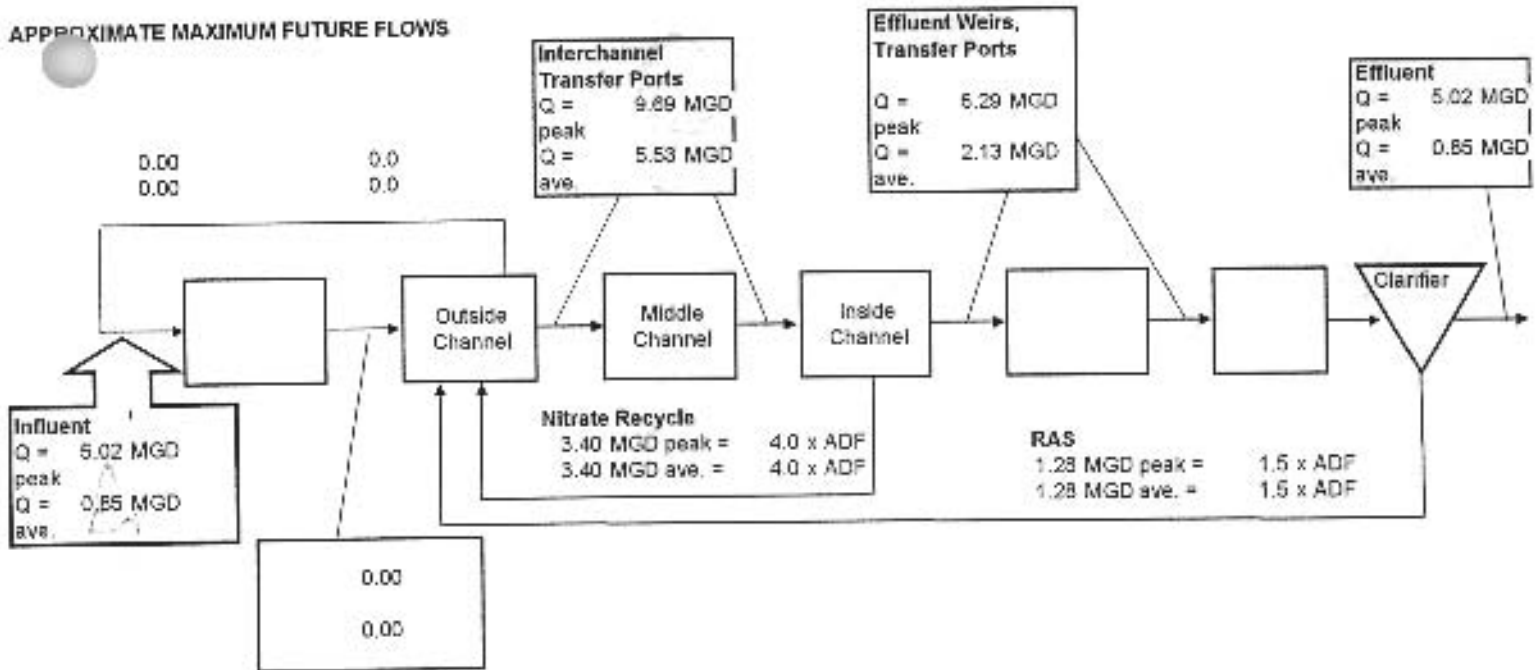
$$\frac{1 \text{ hp}}{2 \text{ lbs O}_2} = \frac{x \text{ hp}}{114 \text{ lb O}_2}$$

$$x = \frac{114 \text{ lb O}_2 \times 1 \text{ hp}}{2 \text{ lbs O}_2} = 57 \text{ hp}$$



Number of Channels in Orbal 3

APPROXIMATE MAXIMUM FUTURE FLOWS



SUGGESTED SIZING FOR INTERCHANNEL TRANSFER PORTS  
(ports between outer, middle, and inner channels)

Maximum flow = 9.89 MGD = 5.02 MGD peak + 1.28 MGD RAS + 3.40 MGD SIM-PRE  
Limit headloss to 0.50 inches at peak flow

Headloss Calculations:  $h = 1.21 (Q/A)^2$

where:  
h = headloss in inches  
Q = flow in MGD  
A = area in sq. ft.

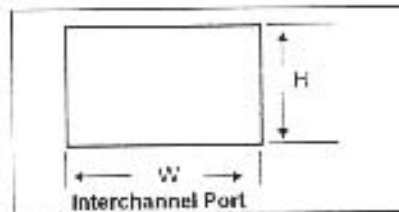
Solving for A, we have:

$A = (1.21 Q^2 / h)^{1/2} = 15.07 \text{ sq. ft.}$

Recommended port opening size =

Actual hl at peak, inches =	0.444
Actual hl at peak, ft =	0.037

15.00 sq. ft. = 48 inch x 48 inch  
Actual hl at average, inches = 0.144  
Actual hl at average, ft = 0.012



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**SUGGESTED SIZING FOR EFFLUENT CONTROL STRUCTURE GATE**

(gate between inner channel and effluent weirs)

Maximum flow = 6 290 MGD = 5.015 MGD peak + 1.275 MGD RAS  
 Limit headloss to 1 inches at peak flow

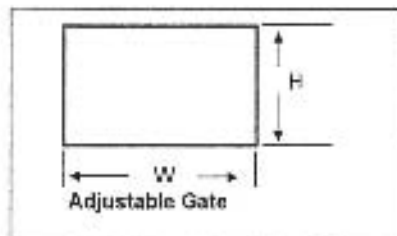
Headloss Calculations:  $h = 1.21 (Q/A)^2$

Where: h = headloss in inches  
 Q = flow in MGD  
 A = area in sq. ft.

Solving for A, we have:

$A = (1.21Q^2/h)^{1/2} = 6.919 \text{ sq. ft.}$

Recommended port opening size = 7.111 sq. ft. = 32 inch x 32 inch  
 Actual hl at peak, inches = 0.947  
 Actual hl at ave., ft = 0.079  
 Actual hl at average, inches = 0.1081  
 Actual hl at average, ft = 0.009



**HYDRAULIC CALCULATIONS FOR ORBAL SYSTEM**

**SUGGESTED SIZING FOR EFFLUENT WEIRS**

Maximum flow = 6 290 MGD = 5.015 MGD peak + 1.275 MGD RAS  
 Limit headloss to 3 inches at peak flow with adjustable gate at 100% closed

Headloss Calculations:  $h = (18.96Q/L)^{2/3}$

Where: h = headloss in inches  
 Q = flow in MGD  
 L = length of weir in feet

Solving for L, we have:

$(18.96Q/h^{3/2}) = 23.0 \text{ feet}$

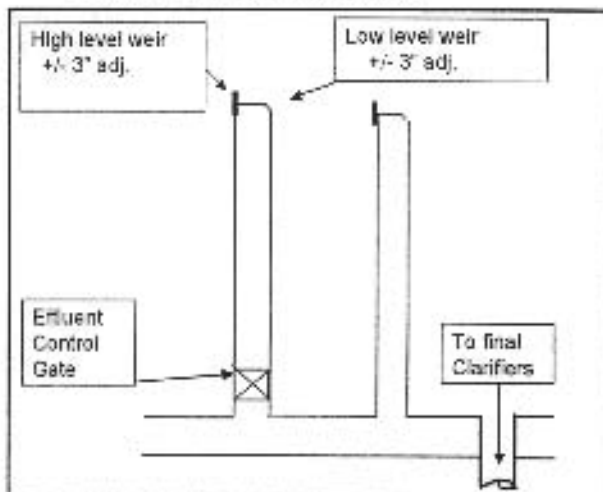
Recommended high weir length = 23 feet  
 Actual hl at peak, inches = 2.986  
 Actual hl at peak, ft = 0.250

Minimum recommended low weir length = 5.157 feet

Actual low weir length, feet = 6 feet  
 Actual hl at peak, inches = 7.338 inches  
 Actual hl at peak, ft = 0.611 feet

Maximum disc immersion = 21"  
 Minimum disc immersion = 9"  
 disc radius = 27"

Section view of Center Island Weirs



- Top of high level weir plate should

be placed:  $6" + \frac{(18.96Q/h)^{2/3}}{12} = 6" + \frac{9.58}{12} = 9.824 \text{ feet}$   
 below the centerline

of the shaft. Top of concrete weir support should be placed 3" below the high weir plate.

- Top of low level weir plate

should be placed 18" below the center line of the shaft. Top of concrete weir support to be 21" below the centerline of the shaft.

With high level weir at 0.8236 feet below shaft centerline, max. disc immersion at average flow = 18.68 inches

If chamber between low weir and gate has a cross-sectional area = 2 sq. ft. average velocity = 0.658 fps  
 peak velocity = 3.88 fps

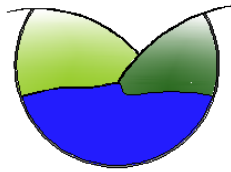
*Doc J*

**TECHNICAL SPECIFICATIONS**

**CITY OF MOUNTAIN VIEW  
WWTP IMPROVEMENTS  
2021**

**PREPARED FOR:**

**CITY OF MOUNTAIN VIEW  
MOUNTAIN VIEW, ARKANSAS**



***CWB Engineers, Inc.***  
***-Designing a Better Arkansas-***



**PROJECT NO. 20-018**

**MAY 2021**



5-12-21



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**END OF TOC**





SECTION 01 1101  
SUMMARY OF WORK

PART 1 GENERAL

1.01 LOCATION OF WORK

- A. The work of this Contract is located at 340 Westwood Ave., Mountain View, AR 72560, at the site of the existing Mt. View Wastewater Treatment Plant.

1.02 SCOPE OF WORK

- A. These general and detailed specifications form a part of the Contract Documents and shall govern the handling and installation of the equipment, pipe, and appurtenances.
- B. Furnish all labor, materials, equipment, and incidentals required and construct the improvements in their entirety as shown on the Plans and as specified herein.  
The Work may include, but is not necessarily limited to, the following major items of work:
  - 1. repair/maintenance work on existing basket screen
  - 2. repair/maintenance work on existing UV disinfection system
  - 3. rehabilitation of the existing 55 ft. diameter final clarifier
  - 4. the replacement of an existing nitrate recycle pump in the oxidation ditch
  - 5. the construction of a mixed liquor splitter box and associated weir gates, and ancillaries
  - 6. the construction of a proposed 40 ft. diameter final clarifier, clarifier equipment, scum pump equipment, piping, and ancillaries
  - 7. the installation of all yard piping
  - 8. mobilization and demobilization
  - 9. clearing, grubbing, earthwork, seeding, and erosion control
  - 10. site grading
  - 11. the installation of a proposed 480 Volt Wye, 3 Phase, Electric Service
  - 12. electrical and controls work
  - 13. miscellaneous appurtenances
  - 14. safety systems

15. items of construction work and/or materials not specifically addressed herein, but nonetheless required for a complete, operating, and acceptable installation of the work, shall be considered subsidiary to the lump sum bid item, and the cost thereof shall be considered to be included.

### 1.03 CONTRACTOR'S USE OF PREMISES

- A. CONTRACTOR shall have use of the premises for the performance of the Work.
- B. CONTRACTOR shall limit the use of the premises for his/her Work and for storage to allow for:
  1. Access to the infrastructure and equipment of the OWNER
  2. OWNER occupancy
- C. Coordinate use of premises with the OWNER.
- D. CONTRACTOR shall assume full responsibility for security of all his/her and his/her subcontractors' materials and equipment stored on the site.
- E. If directed by the OWNER, move any stored items which interfere with operations of the OWNER or other contractors.
- F. Obtain and pay for use of additional storage or work areas if needed to perform the Work.
- G. Provision of sanitary facilities for Contractor's use. See Specification Section 01-5000.

END OF SECTION

## SECTION 01 3000

### SUBMITTALS

#### PART 1 GENERAL

##### 1.01 SCOPE OF WORK

- A. This Section includes the requirements for compiling, processing, and transmitting submittals required for execution of the project.
- B. Submittals are categorized into two types: Action Submittals and Informational Submittals, as follows:
  - 1. **Action Submittal:** Written and graphic information submitted by the CONTRACTOR that requires the UTILITY's approval. The following are examples of action submittals:
    - a. Shop drawings (including working drawings and product data)
    - b. Samples
    - c. Operation & maintenance manuals
    - d. Site Usage Plan (CONTRACTOR's staging - including trailer siting and material laydown area)
    - e. Schedule of values
    - f. Payment application format
  - 2. **Informational Submittal:** Information submitted by the CONTRACTOR that does not require the UTILITY's approval. The following are examples of informational submittals:
    - a. Shop drawing schedule
    - b. Construction schedule
    - c. Statements of qualifications
    - d. Health and Safety Plans
    - e. Construction photography and videography
    - f. Work plans
    - g. Maintenance of traffic plans
    - h. Outage requests
    - i. Proposed testing procedures

- j. Test records and reports
- k. Vendor training outlines/plans
- l. Test and start-up reports
- m. Certifications
- n. Record Drawings
- o. Record Shop Drawings
- p. Submittals required by laws, regulations, and governing agencies
- q. Submittals required by funding agencies
- r. Other requirements found within the technical specifications
- s. Warranties and bonds
- t. As-built surveys
- u. Contract close-out documents

#### 1.02 RELATED WORK

- A. Additional requirements may be specified in the General Conditions for the Contract.
- B. Additional submittal requirements may be specified in the respective technical specification sections.
- C. Operation and Maintenance manuals are included in Section 01 8823.
- D. Contract closeout submittals are included in Section 01 7710.
- E. Warranties and Bonds are included in Section 01 7836.
- F. Applications for Payment are included in General and Supplementary Conditions.
- G. Project Record Documents are included in Section 01 7839.

#### 1.03 CONTRACTOR'S RESPONSIBILITIES

- A. All submittals shall be clearly identified as follows:
  - 1. Date of submission
  - 2. Project number
  - 3. Project name
  - 4. CONTRACTOR identification

- a. Contractor
  - b. Supplier
  - c. Manufacturer
  - d. Manufacturer or supplier representative
5. Identification of the product
  6. Reference to Contract drawing(s)
  7. Reference to specification section number, page and paragraph(s)
  8. Reference to applicable standards, such as ASTM or Federal Standards numbers
  9. Indication of CONTRACTOR's approval
  10. CONTRACTOR's Certification statement
  11. Identification of deviations from the Contract Documents if any
  12. Reference to previous submittal (for resubmittals)
- B. Submittals shall be clear and legible, and of sufficient size for legibility and clarity of the presented data.

C. SUBMITTAL LOG

Maintain a log of all submittals. The submittal log shall be kept accurate and up to date. This log should include the following items (as applicable):

1. Description
2. Submittal number
3. Date transmitted to the UTILITY
4. Date returned to CONTRACTOR (from UTILITY)
5. Status of Submittal (Approved/Not Approved/etc.)
6. Date of Resubmittal to UTILITY and Return from UTILITY (if applicable and repeat as necessary)
7. Date material released for fabrication
8. Projected (or actual) delivery date

#### D. NUMBERING SYSTEM

Utilize a 9-character submittal identification numbering system in the following manner:

1. The first character shall be a D, S, M or I which represents Shop Drawing (including working drawings and product data), Sample, Manual (Operating & Maintenance) or Informational, respectively.
2. The next six digits shall be the applicable Section Number.
3. The next two digits shall be the numbers 01 to 99 to sequentially number each separate item or drawing submitted under each specific Specification Section, in the order submitted.
4. The last character shall be a letter, A to Z, indicating the submission (or resubmission) of the same submittal, i.e., "A" = 1st submission, "B" = 2nd submission, "C" = 3rd submission, etc. A typical submittal number would be as follows:

D-400550-008-B

D = Shop Drawing  
40 0550 = Section for Valves  
08 = the eighth different submittal under this section  
B = the second submission (first resubmission) of that particular shop drawing.

#### E. VARIANCES

Notify the UTILITY in writing, at the time of submittal, of any deviations in the submittals from the requirements of the Contract Documents.

Notify the UTILITY in writing, at the time of re-submittal (resubmission), of all deviations from previous submissions of that particular shop drawing, except those deviations which are the specific result of prior comments from the UTILITY.

#### F. ACTION SUBMITTALS

1. SHOP DRAWINGS, WORKING DRAWINGS, PRODUCT DATA AND SAMPLES
  - a. SHOP DRAWINGS
    - 1) Shop drawings as defined in the General Conditions, and as specified in individual Sections include, but are not necessarily limited to, custom prepared data such as fabrication and erection/installation (working) drawings, scheduled information, setting diagrams, actual shop work manufacturing instructions, custom templates, wiring diagrams, coordination drawings, equipment inspection and test reports, including performance curves and certifications, as applicable to the work.
    - 2) CONTRACTOR shall verify all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and coordinate each item with other related shop drawings and the Contract requirements.

- 3) All details on shop drawings shall show clearly the relation of the various parts to the main members and lines of the structure and where correct fabrication of the work depends upon field measurements, such measurements shall be made and noted on the drawings before being submitted.
- 4) All shop drawings submitted by subcontractors and vendors shall be reviewed by the CONTRACTOR for field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and that it has been coordinated with other related shop drawings and the Contract requirements. Submittals directly from subcontractors or vendors will not be accepted by the UTILITY.
- 5) The CONTRACTOR shall be responsible the accuracy of the subcontractor's or vendor's submittal; and, for their submission in a timely manner to support the requirements of the CONTRACTOR's construction schedule. Shop drawings found to be inaccurate or otherwise in error shall be returned to the subcontractor or vendor to correct before submission to the UTILITY. All shop drawings shall be approved by the CONTRACTOR.
- 6) Delays to construction due to the untimely submission of submittals will constitute inexcusable delays, for which Contactor shall not be eligible for additional cost nor additional contract time. Inexcusable delays consist of any delay within the Contactor's control.

b. WORKING DRAWINGS

- 1) Detailed installation drawings (sewers, equipment, piping, electrical conduits and controls, HVAC work, and plumbing, etc.) shall be prepared and submitted for review and approval by the UTILITY prior to installing such work. Installation drawings shall be to-scale and shall be fully dimensioned.
- 2) Piping working drawings shall show the laying dimensions of all pipes, fittings, valves, as well as the equipment to which it is being connected. In addition, all pipe supports shall be shown.
- 3) Equipment working drawings shall show all equipment dimensions, anchor bolts, support pads, piping connections and electrical connections. In addition, show clearances required around such equipment for maintenance of the equipment.
- 4) Electrical working drawings shall show conduits, junction boxes, disconnects, control devices, lighting fixtures, support details, control panels, lighting and power panels, and Motor Control Centers. Coordinate all locations with the Contract Documents and the CONTRACTOR's other working drawings.

c. PRODUCT DATA

Product data, as specified in individual Specification Sections, include, but are not limited to, the manufacturer's standard prepared data for manufactured products (catalog data), such as the product specifications, installation instructions, availability of colors and patterns, rough-in diagrams and templates, product photographs (or diagrams), wiring diagrams, performance curves, quality control inspection and reports, certifications of compliance (as specified or otherwise required), mill reports,

product operating and maintenance instructions, recommended spare parts and product warranties, as applicable.

d. SAMPLES

- 1) Furnish, samples required by the Contract Documents for the UTILITY's approval. Samples shall be delivered to the UTILITY as specified or directed. Unless specified otherwise, provide at least two samples of each required item. Materials or equipment for which samples are required shall not be used in the work unless and until approved by the UTILITY.
- 2) Samples specified in individual Specification Sections, include, but are not limited to: physical examples of the work (such as sections of manufactured or fabricated work), small cuts or containers of materials, complete units of repetitively-used products, color/texture/pattern swatches and range sets, specimens for coordination of visual effect, graphic symbols, and other specified units of work.
- 3) Approval of a sample shall be only for the characteristics or use named in such approval and shall not be construed to change or modify Contract Requirements.
- 4) Approved samples not destroyed in testing shall be sent to the UTILITY or stored at the site of the work. Approved samples of the hardware in good condition will be marked for identification and may be used in the work. Materials and equipment incorporated in work shall match the approved samples. Samples which fail testing or are not approved will be returned to the CONTRACTOR at his expense, if so requested at time of submission.

e. PROFESSIONAL ENGINEER (P.E.) CERTIFICATION FORM

If specifically required in any of the technical Specification Sections, submit a Professional Engineer (P.E.) Certification for each item required, using the form appended to this Section, signed and sealed by the P.E. licensed or registered in the state wherein the work is located.

2. CONTRACTOR'S CERTIFICATION

- a. Each shop drawing, working drawings, product data, and sample shall have affixed to it the following Certification Statement:

*"Certification Statement: by this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements."*

- b. Shop drawings, working drawings, and product data sheets 11-in x 17-in and smaller shall be bound together in an orderly fashion and bear the above Certification Statement on the cover sheet. The transmittal cover sheet for each identified shop drawing shall fully describe the packaged data and include a listing of all items within the package.



3. The review and approval of shop drawings, working drawings, product data, or samples by the UTILITY shall not relieve the CONTRACTOR from the responsibility for the fulfillment of the terms of the Contract. All risks of error and omission are assumed by the CONTRACTOR and the UTILITY will have no responsibility therefor.
4. Project work, materials, fabrication, and installation shall conform to approved shop drawings (including working drawings and product data) and applicable samples.
5. No portion of the work requiring a shop drawing (including working drawings and product data) or sample shall be started, nor shall any materials be fabricated or installed before approval of such item. Procurement, fabrication, delivery or installation of products or materials that do not conform to approved shop drawings shall be at the CONTRACTOR's risk. Furthermore, such products or materials delivered or installed without approved shop drawings, or in non-conformance with the approved shop drawings will not be eligible for progress payment until such time as the product or material is approved or brought into compliance with approved shop drawings. Neither the UTILITY nor UTILITY will be liable for any expense or delay due to corrections or remedies required to accomplish conformity.

6. OPERATION AND MAINTENANCE DATA

Operation and maintenance data shall be submitted in assembled manuals as specified. Such manuals shall include detailed instructions for UTILITY personnel on safe operation procedures, controls, start-up, shut-down, emergency procedures, storage, protection, lubrication, testing, trouble-shooting, adjustments, repair procedures, and other maintenance requirements.

7. SCHEDULE OF VALUES

On projects consisting of lump sums (in whole or in part) submit a proposed schedule of values providing a breakdown of lump sum items into reasonably small components – generally disaggregated by building, area, and/or discipline. The purpose of the schedule of values is for processing partial payment applications. If requested by the UTILITY, provide sufficient substantiation for all or some items as necessary to determine the proposed schedule of values is a reasonable representation of the true cost breakdown of the Work. The schedule of values shall not be unbalanced to achieve early payment or over-payment in excess of the value of work or any other mis-distribution of the costs. If, in the opinion of the UTILITY, the schedule of values is unbalanced, CONTRACTOR shall reallocate components to achieve a balanced schedule acceptable to UTILITY.

8. PAYMENT APPLICATION FORMAT

If an application form is included in the **Contract Documents**, use that form unless otherwise approved by the UTILITY. If an application form is not included in the Contract Documents, CONTRACTOR may propose a form for approval.

9. SITE USAGE

Submit a proposed site staging plan, including but not limited to the location of office trailers, storage trailers and material laydown. Such plan shall be a graphic presentation (drawing) of the proposed locations; and, shall include on-site traffic modifications, and temporary utilities, as may be applicable.

## G. INFORMATIONAL SUBMITTALS

### 1. SHOP DRAWING SCHEDULE

Prepare and submit a schedule indicating when shop drawings are required to be submitted to support the as-planned construction schedule. The submittal schedule shall allow sufficient time for preparation and submittal, review and approval, and fabrication and delivery to support the construction schedule.

### 2. CONSTRUCTION SCHEDULE

Prepare and submit construction schedules and monthly status reports as specified.

### 3. STATEMENTS OF QUALIFICATIONS

Provide evidence of qualification, certification, or registration, as required in the Contract Documents, to verify qualifications of licensed land surveyor, professional engineer, materials testing laboratory, specialty subcontractor, technical specialist, consultant, specialty installer, and other professionals.

### 4. HEALTH AND SAFETY PLANS

When specified, prepare and submit a general company Health and Safety Plan (HSP), modified or supplemented to include job-specific considerations.

### 5. CONSTRUCTION PHOTOGRAPHY AND VIDEOGRAPHY

Provide periodic construction photographs and videography as specified – including but not limited to preconstruction photographs and/or video, monthly progress photos and/or video and post-construction photographs and/or video.

### 6. WORK PLANS

Prepare and submit copies of all work plans needed to demonstrate to the UTILITY that CONTRACTOR has adequately thought-out the means and methods of construction and their interface with existing facilities.

### 7. MAINTENANCE OF TRAFFIC PLANS

Prepare maintenance of traffic plans where and when required by the Contract Documents and by local ordinances or regulations. If CONTRACTOR is not already knowledgeable about local ordinances and regulations regarding maintenance of traffic requirements, become familiar with such requirements and include all costs for preparation and submittal of traffic management plans and all associated costs for permits and fees to implement the traffic management plan, in the bid amount. In addition, unless a supplemental payment provision is provided in the bid form, include the cost of police attendance, when required.

### 8. OUTAGE REQUESTS

Provide sufficient notification of any outages required (electrical, flow processes, etc) as may be required to tie-in new work into existing facilities. Unless specified otherwise elsewhere, a minimum of seven calendar days notice shall be provided.

9. PROPOSED TESTING PROCEDURES

Prepare and submit testing procedures it proposes to use to perform testing required by the various technical specifications.

10. TEST RECORDS AND REPORTS

Provide copies of all test records and reports as specified in the various technical specifications.

11. VENDOR TRAINING OUTLINES/PLANS

At least two weeks before scheduled training of UTILITY's personnel, provide lesson plans for vendor training in accordance with the specification for O&M manuals.

12. TEST AND START-UP REPORTS

Manufacture shall perform all pre-start-up installation inspection, calibrations, alignments, and performance testing as specified in the respective Specification Section. Provide copies of all such test and start-up reports.

13. CERTIFICATIONS

- a. Provide various certifications as required by the technical specifications. Such certifications shall be signed by an officer (of the firm) or other individual authorized to sign documents on behalf of that entity.
- b. Certifications may include, but are not limited to:
  - 1) Welding certifications and welders' qualifications
  - 2) Certifications of Installation, Testing and Training for all equipment
  - 3) Material Testing reports furnished by an independent testing firm
  - 4) Certifications from manufacturer(s) for specified factory testing
  - 5) Certifications required to indicate compliance with any sustainability or LEEDS accreditation requirements indicated in the Contract Documents

14. RECORD DRAWINGS

No later than Substantial Completion, submit a record of all changes during construction not already incorporated into drawings – in accordance with specification on Project Record Documents.

15. SUBMITTALS REQUIRED BY LAWS, REGULATIONS AND GOVERNING AGENCIES

Prepare and submit all documentation required by state or local law, regulation, or government agency directly to the applicable agency. This includes, but is not limited to, notifications, reports, certifications, certified payroll (for projects subject to wage

requirements) and other documentation required to satisfy all requirements. Provide to UTILITY one copy of each submittal made in accordance with this paragraph.

16. SUBMITTALS REQUIRED BY FUNDING AGENCIES

Prepare and submit all documentation required by funding agencies. This includes, but is not limited to segregated pay applications and change orders when required to properly allocate funds to different funding sources, and certified payrolls for projects subject to wage requirements. Provide one copy of each submittal made in accordance with this paragraph to the UTILITY.

17. OTHER REQUIREMENTS OF THE TECHNICAL SPECIFICATION SECTIONS

Comply with all other requirements of the technical specifications.

18. WARRANTIES AND BONDS

Assemble a book(let) of all warranties and bonds as specified in the various technical specifications and in accordance with the specification on Warranties and Bonds and provide to the UTILITY.

19. AS-BUILT SURVEYS

Engage the services of a licensed land surveyor in accordance with the Project Controls specification. Prior to Final Completion, provide an as-built survey of the constructed facility, as specified.

20. CONTRACT CLOSE-OUT DOCUMENTS

Submit Contract documentation as indicated in the specification for Contract Close-out.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SUBMITTAL SCHEDULE

- A. Provide an initial submittal schedule at the pre-construction meeting for review by UTILITY. Incorporate comments from UTILITY into a revised submittal schedule.
- B. Maintain the submittal schedule and provide sufficient copies for review by UTILITY. An up-to-date submittal schedule shall be provided at each project progress meeting.

3.02 TRANSMITTALS

- A. Prepare separate transmittal sheets for each submittal. Each transmittal sheet shall include at least the following: The CONTRACTOR's name and address, UTILITY's name, project name, project number, submittal number, description of submittal and number of copies submitted.
- B. Submittals shall be transmitted or delivered directly to the office of the UTILITY, as indicated in the Contact Documents, or as otherwise directed by the UTILITY.

- C. Provide copies of transmittals (only, i.e., without copies of the respective submittal) directly to the Resident Project Representative.

### 3.03 PROCEDURES

#### A. ACTION SUBMITTALS

##### 1. CONTRACTOR'S RESPONSIBILITIES

- a. Coordination of Submittal Times: Prepare and transmit each submittal sufficiently in advance of performing the related work or other applicable activities, or within the time specified in the individual work of other related Sections, so that the installation will not be delayed by processing times including disapproval and resubmittal (if required). Coordinate with other submittals, testing, purchasing, fabrication, delivery and similar sequenced activities. Extensions to the Contract Time will not be approved for the CONTRACTOR's failure to transmit submittals sufficiently in advance of the Work.
- b. The submittals of all shop drawings (including working drawings and product data) shall be sufficiently in advance of construction requirements to allow for possible need of re-submittals, including the specified review time for the UTILITY.
- c. No less than thirty (30) calendar days will be required for UTILITY's review time for shop drawings and O&M manuals involving only one engineering discipline. No less than forty-five (45) calendar days will be required for UTILITY's review time for shop drawings and O&M manuals that require review by more than one engineering discipline. Resubmittals will be subject to the same review time.
- d. Submittals of operation and maintenance data shall be provided within 30 days of approval of the related shop drawing(s).
- e. Before submission to the UTILITY, review shop drawings as follows:
  - 1) make corrections and add field measurements, as required
  - 2) use any color for its notations except red (reserved for the UTILITY's notations) and black (to be able to distinguish notations on black and white documents)
  - 3) identify and describe each and every deviation or variation from Contract documents or from previous submissions, except those specifically resulting from a comment from the UTILITY on a previous submission
  - 4) include the required CONTRACTOR's Certification statement
  - 5) provide field measurements (as needed)
  - 6) coordinate with other submittals
  - 7) indicate relationships to other features of the Work
  - 8) highlight information applicable to the Work and/or delete information not applicable to the Work

- f. Submit the following number of copies:
  - 1) Shop drawings (including working drawings and product data) – Submit no fewer than six, and no more than nine; five of which will be retained by the UTILITY.
  - 2) Samples – two
  - 3) Site Usage Plan – four copies
  - 4) Schedule of values – four copies
  - 5) Payment application format – four copies
  - 6) Operation and Maintenance Manuals – six copies
- g. If CONTRACTOR considers any correction indicated on the shop drawings to constitute a change to the Contract Documents, provide written notice thereof to the UTILITY immediately; and do not release for manufacture before such notice has been received by the UTILITY.
- h. When the shop drawings have been completed to the satisfaction of the UTILITY, carry out the construction in accordance therewith; and make no further changes therein except upon written instructions from the UTILITY.

## 2. UTILITY'S RESPONSIBILITIES

- a. UTILITY will not review shop drawings (including working drawings and product data) that do not include the CONTRACTOR's approval stamp. Such submittals will be returned to the CONTRACTOR, without action, for correction.
- b. Partial shop drawings (including working drawings and product data) will not be reviewed. If, in the opinion of the UTILITY, a submittal is incomplete, that submittal will be returned to the CONTRACTOR for completion. Such submittals may be returned with comments from UTILITY indicating the deficiencies requiring correction.
- c. If shop drawings (including working drawings and product data) meet the submittal requirements, UTILITY will forward copies to appropriate reviewer(s). Otherwise, noncompliant submittals will be returned to the CONTRACTOR without action - with the UTILITY retaining one copy.
- d. Submittals which are transmitted in accordance with the specified requirements will be reviewed by the UTILITY within the time specified herein. The time for review will commence upon receipt of submittal by UTILITY.

## 3. REVIEW OF SHOP DRAWINGS (INCLUDING WORKING DRAWINGS AND PRODUCT DATA) AND SAMPLES

- a. The review of shop drawings, working drawings, data and samples will be for general conformance with the design concept and Contract Documents. They shall not be construed:

- 1) as permitting any departure from the Contract requirements
  - 2) as relieving the CONTRACTOR of responsibility for any errors, including details, dimensions, and materials
  - 3) as approving departures from details furnished by the UTILITY, except as otherwise provided herein
- b. The CONTRACTOR remains responsible for details and accuracy, for coordinating the work with all other associated work and trades, for selecting fabrication processes, for techniques of assembly, and for performing work in a safe manner.
  - c. If the shop drawings (including working drawings and product data) or samples as submitted describe variations and indicate a deviation from the Contract requirements that, in the opinion of the UTILITY are in the interest of the UTILITY and are so minor as not to involve a change in Contract Price or Contract Time, the UTILITY may return the reviewed drawings without noting an exception.
  - d. Only the UTILITY will utilize the color "RED" in marking submittals.
  - e. Shop drawings will be returned to the CONTRACTOR with one of the following codes.

Code 1 – "APPROVED" – This code is assigned when there are no notations or comments on the submittal. When returned under this code the CONTRACTOR may release the equipment and/or material for manufacture.

Code 2 - "APPROVED AS NOTED" - This code is assigned when a confirmation of the notations and comments IS NOT required by the CONTRACTOR. The CONTRACTOR may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product.

Code 3 - "APPROVED AS NOTED/CONFIRM" - This combination of codes is assigned when a confirmation of the notations and comments is required by the CONTRACTOR. The CONTRACTOR may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product. This confirmation shall specifically address each omission and nonconforming item that was noted. Confirmation is to be received by the UTILITY within fifteen (15) calendar days of the date of the UTILITY's transmittal requiring the confirmation.

Code 4 - "APPROVED AS NOTED/RESUBMIT" - This combination of codes is assigned when notations and comments are extensive enough to require a resubmittal of the entire package. This resubmittal is to address all comments, omissions and non-conforming items that were noted. Resubmittal is to be received by the UTILITY within thirty (30) calendar days of the date of the UTILITY's transmittal requiring the resubmittal.

Code 5 – "NOT APPROVED" – This code is assigned when the submittal does not meet the intent of the contract documents. The CONTRACTOR must resubmit the entire package revised to bring the submittal into conformance.

It may be necessary to resubmit using a different manufacturer/vendor to meet the requirements of the contract documents.

Code 6 – “COMMENTS ATTACHED” – This code is assigned where there are comments attached to the returned submittal, which provide additional data to aid the CONTRACTOR.

Code 7 – “RECEIPT ACKNOWLEDGED (Not subject to UTILITY’s Review or Approval)” – This code is assigned to acknowledge receipt of a submittal that is not subject to the UTILITY’s review and approval, and is being filed for informational purposes only. This code is generally used in acknowledging receipt of means and methods of construction work plans, field conformance test reports, and health and safety plans.

Codes 1 through 5 designate the status of the reviewed submittal with Code 6 showing there has been an attachment of additional data.

- f. REPETITIVE REVIEWS: Shop drawings, O&M manuals and other submittals will be reviewed no more than twice at the UTILITY’s expense. All subsequent reviews will be performed at the CONTRACTOR’s expense. Reimburse the UTILITY for all costs invoiced by UTILITY for the third and subsequent reviews.

#### 4. ELECTRONIC TRANSMISSION

- a. ACTION SUBMITTALS may be transmitted by electronic means provided the following conditions are met:
  - 1) The above-specified transmittal form is included.
  - 2) All other requirements specified above have been met including, but not limited to, coordination by the CONTRACTOR, review and approval by the Contactor, and the CONTRACTOR’s Certification.
  - 3) With the exception of the transmittal sheet, the entire submittal is included in a single file.
  - 4) The electronic files are PDF format (with printing enabled).
  - 5) In addition, transmit three hard-copy (paper) originals to the UTILITY.
  - 6) For Submittals that require certification, corporate seal, or professional embossment (i.e. P.E.s, Surveyors, etc) transmit at least two hard-copy originals to the UTILITY. In addition, provide additional photocopied or scanned copies, as specified above, showing the required certification, corporate seal, or professional seal.

#### B. INFORMATIONAL SUBMITTALS

##### 1. CONTRACTOR’S RESPONSIBILITIES

- a. Number of copies: Submit three copies, unless otherwise indicated in individual Specification sections



- b. Refer to individual technical Specification Sections for specific submittal requirements.

## 2. UTILITY'S RESPONSIBILITIES

- a. The UTILITY will review each informational submittal within fifteen (15) days. If the informational submittal complies with the Contract requirements, UTILITY will file for the project record. UTILITY may elect not to respond to CONTRACTOR regarding informational submittals meeting the Contract requirements.
- b. If an informational submittal does not comply with the Contract requirements, UTILITY will respond accordingly to the CONTRACTOR within fifteen (15) days. Thereafter, the CONTRACTOR shall perform the required corrective action, including retesting, if needed, until the submittal, in the opinion of the UTILITY, is in conformance with the Contract Documents.

## 3. ELECTRONIC TRANSMISSION

- a. INFORMATIONAL SUBMITTALS may be transmitted by electronic means providing all of the following conditions are met:
  - 1) The above-specified transmittal form is included.
  - 2) With the exception of the transmittal sheet, the entire submittal is included in a single file.
  - 3) The electronic files are PDF format (printing enabled).
  - 4) For Submittals that require certification, corporate seal, or professional embossment (i.e. P.E.s, Surveyors, etc)) transmit two hard-copy originals to the UTILITY.

END OF SECTION

P.E. CERTIFICATION FORM

The undersigned hereby certifies that he/she is a professional engineer registered in the [State]  
[Commonwealth] of \_\_\_\_\_ and that he/she has been employed by

\_\_\_\_\_ to design  
(Name of CONTRACTOR)

\_\_\_\_\_  
(Insert P.E. Responsibilities)

In accordance with Specification Section \_\_\_\_\_ for the

\_\_\_\_\_.  
(Name of Project)

The undersigned further certifies that he/she has performed the said design in conformance with all applicable local, state and federal codes, rules and regulations; and, that his/her signature and P.E. stamp have been affixed to all calculations and drawings used in, and resulting from, the design.

The undersigned hereby agrees to make all original design drawings and calculations available to the City of Blytheville Water and Sewer Utility or their authorized representative, within seven days following written request therefor by the UTILITY.

\_\_\_\_\_  
P.E. Name

\_\_\_\_\_  
CONTRACTOR's Name

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Address

\_\_\_\_\_  
Title

\_\_\_\_\_  
Address

SECTION 01 3119

PROJECT MEETINGS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

- A. The Engineer shall schedule and administer a pre-construction meeting, periodic progress meetings and specially called meetings throughout progress of the work.
  - 1. Prepare agenda for meetings.
  - 2. Make physical arrangements for meetings.
  - 3. Preside at meetings.
  - 4. Record the minutes; include significant proceedings and decisions.
  - 5. Reproduce and distribute copies of minutes within 10 working days after each meeting.
    - a. To participants in the meeting.
    - b. To parties affected by decisions made at the meeting.
- B. Representatives of Contractors, subcontractors and suppliers attending meetings shall be qualified and authorized to act on behalf of the entity each represents.
- C. Attend meetings to ascertain that work is expedited consistent with Contract Documents and construction schedules.

1.02 RELATED REQUIREMENTS

- A. Instructions to Bidders are included in Division 0.
- B. Submittals are included in Section 01\_3000.
- D. Project Record Documents are included in Section 01\_7839.
- E. Operating and Maintenance Data is included in Section 01\_8823.

1.03 PRE-CONSTRUCTION MEETING

- A. Schedule a preconstruction meeting no later than ten (10) days after date of Notice to Proceed.
- B. Location: A central site, convenient for all parties, designated by the Owner.
- C. Attendance

1. UTILITY Representative.
2. Engineer and his/her professional consultants.
3. Resident Project Representative.
4. Contractor's Superintendent.
5. Major Subcontractors.
6. Major suppliers.
7. Utility Companies
8. Others as appropriate.

D. Suggested Agenda

1. Distribution and discussion of:
  - a. List of major subcontractors and suppliers.
  - b. Projected Construction Schedules.
2. Critical work sequencing.
3. Major equipment deliveries and priorities.
4. Project Coordination.
  - a. Designation of responsible personnel.
5. Procedures and processing of:
  - a. Field decisions.
  - b. Proposal requests.
  - c. Submittals.
  - d. Change Orders.
  - e. Applications for Payment.
6. Adequacy of distribution of Contract Documents.
7. Procedures for maintaining Record Documents.
8. Use of premises:

- a. Office, work, and storage areas.
- b. Owner's requirements.
9. Construction facilities, controls, and construction aids.
10. Temporary utilities.
11. Housekeeping procedures.

#### 1.04 PROGRESS MEETINGS

- A. Schedule regular periodic meetings. The progress meetings will be held every week with the first meeting no later than 11 calendar days after the pre-construction meeting.
- B. Hold called meetings as required by progress of the work.
- C. Location of the meetings: Project field office of Contractor or Engineer.
- D. Attendance
  1. Engineer and his/her professional consultants as needed.
  2. Contractor's Superintendent
  3. Subcontractors as appropriate to the agenda.
  4. Suppliers as appropriate to the agenda. For suppliers, a call-in to the meeting will be acceptable unless physical presence is required.
  5. Others as appropriate.
- E. Suggested Agenda
  1. Review, approval of minutes of previous meeting.
  2. Review of work progress since previous meeting.
  3. Field observations, problems, and conflicts.
  4. Problems which impede Construction Schedule.
  5. Review of off-site fabrication, delivery schedules.
  6. Corrective measures and procedures to regain projected schedule.
  7. Revisions to Construction Schedule.
  8. Progress, schedule, during succeeding work period.
  9. Coordination of schedules.

10. Review submittal schedules; expedite as required.
  11. Maintenance of quality standards.
  12. Pending changes and substitutions.
  13. Review proposed changes for:
    - a. Effect on Construction Schedule and on completion date.
    - b. Effect on other contracts of the project.
  14. Other business.
  15. Construction schedule.
  16. Critical/long lead items.
- F. Attend progress meetings and is to study previous meeting minutes and current agenda items, in order to be prepared to discuss pertinent topics such as deliveries of materials and equipment, progress of the work, etc.
- G. Provide a current submittal log at each progress meeting in accordance with Section 01300.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 4527

EQUIPMENT TESTING AND STARTUP

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Provide a competent field services technician of the manufacturers of all equipment furnished, to supervise installation, adjustment, initial operation and testing, performance testing, final acceptance testing and startup of the equipment.
- B. Perform specified equipment field performance tests, final acceptance tests and startup services.

1.02 RELATED WORK

- A. Operation and Maintenance Data is included in Section 01 8823.
- B. Performance and acceptance testing and startup requirements are included in the respective sections of the equipment specifications.

1.03 SUBMITTALS

- A. Submit name, address and resume' of proposed field services technicians at least 30 days in advance of the need for such services.
- B. Submit, in accordance with Section 01\_3000, detailed testing procedures for shop tests, field performance tests and final acceptance tests as specified in the various equipment sections. Submittals shall include the following:
  - 1. Test procedures shall be submitted at least 30 days in advance of the proposed test dates and shall include at least the following information:
    - a. Name of equipment to be tested, including reference to specifications section number and title.
    - b. Testing schedule of proposed dates and times for testing.
    - c. Summary of power, lighting, chemical, water, sludge, gas, etc, needs and identification of who will provide them.
    - d. Outline specific assignment of the responsibilities of the Contractor and manufacturers' factory representatives or field service personnel.
    - e. Detailed description of step-by-step testing requirements, with reference to appropriate standardized testing procedures and laboratory analyses by established technical organizations (e.g., ASTM, WPCF Standard Methods, etc).
    - f. Samples of forms to be used to collect and record test data and to present tabulated test results.

2. Copies of test reports upon completion of specified shop, performance and acceptance tests. Test reports shall incorporate the information provided in the test procedures submittals and modified to reflect actual conduct of the tests and the following additional information:
  - a. Copy of all test data sheets and results of lab analyses.
  - b. Summary comparison of specified test and performance requirements vs actual test results.
  - c. Should actual test results fail to meet specified test and performance requirements, describe action to be taken prior to re-testing the equipment.
3. Copies of the manufacturer's field service technician's report summarizing the results of his/her initial inspection, operation, adjustment and pre-tests. The report shall include detailed descriptions and tabulations of the points inspected, tests and adjustments made, quantitative results obtained, suggestions for precautions to be taken to ensure proper maintenance, and the equipment supplier's Certificate of Installation in the format specified herein.

#### 1.04 REFERENCE STANDARDS

- A. American Water Works Association (AWWA)
  1. AWWA C653 - Disinfection for Water Treatment Plants.
- B. American Society for Testing and Materials (ASTM)
- C. Water Pollution Control Federation (WPCF)
- D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

#### 1.05 QUALITY ASSURANCE

- A. Field service technicians shall be competent and experienced in the proper installation, adjustment, operation, testing and startup of the equipment and systems being installed.
- B. Manufacturers' sales and marketing personnel will not be accepted as field service technicians.

### PART 2 PRODUCTS (NOT USED)

### PART 3 EXECUTION

#### 3.01 PRELIMINARY REQUIREMENTS

- A. After installation of the equipment has been completed and the equipment is presumably ready for operation, before it is operated by others, the manufacturer's field service technician shall inspect, operate, test and adjust the equipment. The inspection shall include at least the following points where applicable:



1. Soundness (without crack or otherwise damaged parts).
  2. Completeness in all details, as specified and required.
  3. Correctness of setting, alignment, and relative arrangement of various parts.
  4. Adequacy and correctness of packing, sealing and lubricants.
- B. The operation, testing and adjustment shall be as required to prove that the equipment has been left in proper condition for satisfactory operation under the conditions specified.
- C. Upon completion of this work, the manufacturer's field service technician shall submit a signed report of the results of his/her inspection, operation, adjustments, and tests.

### 3.02 WITNESS REQUIREMENTS

- A. Shop tests or factory tests may be witnessed by the Owner and/or Owner's representatives, as required by the various equipment specifications.
- B. Field performance and acceptance tests shall be performed in the presence of the Owner, the Owner's designed personnel and/or Owner's representatives.

EQUIPMENT SUPPLIER'S CERTIFICATE OF INSTALLATION

Owner \_\_\_\_\_

Project \_\_\_\_\_

Contract No. \_\_\_\_\_

EQUIPMENT SPECIFICATION SECTION \_\_\_\_\_

EQUIPMENT DESCRIPTION \_\_\_\_\_

I \_\_\_\_\_, Authorized representative of  
(Print Name)

\_\_\_\_\_  
(Print Manufacturer's Name)

hereby CERTIFY that \_\_\_\_\_  
(Print equipment name and model with serial no.)

\_\_\_\_\_  
installed for the subject project has (have) been installed in a satisfactory manner, has (have) been tested and adjusted, and is (are) ready for final acceptance testing and operation on:

Date \_\_\_\_\_

Time \_\_\_\_\_

CERTIFIED BY: \_\_\_\_\_  
(Signature of Manufacturer's Representative)

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

END OF SECTION

SECTION 015000  
TEMPORARY FACILITIES

1. GENERAL

1.01 TEMPORARY SANITARY FACILITIES

- A. Sanitary facilities will not be provided by owner. Contractor shall provide on-site facilities or use portable facilities at Contractor's expense. Portable facilities shall be located as directed by Engineer, Owner, or Representatives of Engineer/Owner and serviced and cleaned regularly.

1.02 PROTECTION OF INSTALLED WORK

- A. Contractor is responsible for providing temporary and removable protection for installed products.

1.03 TEMPORARY ACCESS AND PARKING

- A. Contractor shall provide adequate temporary access to working areas as approved by Owner/Engineer.
- B. Contractor shall not park any vehicles on any street or private property without permission from the Owner.

1.04 PROGRESS CLEANING

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.

1.05 REMOVAL OF FACILITIES AND FINAL CLEANUP

- A. Remove all equipment, facilities, and materials prior to final inspection.
- B. Restore existing facilities and area used during construction to original condition.

1.06 STAGING AREA/MATERIALS STORED

- A. Contractor shall be responsible for location a site for materials stored, equipment, and staging area for construction.
- B. Contractor shall provide owner written documentation between property owner and contractor as to the agreement to utilize property for staging area.

1.07 TRAFFIC CONTROL

- A. Contractor shall submit a barricade and traffic control plan to the public works director for approval.
- B. Contractor shall be responsible for implementing barricade plan, flagging, signage, and traffic flow.

END OF SECTION 015000

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SECTION 01 6610

DELIVERY, STORAGE AND HANDLING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section specifies the general requirements for the delivery handling, storage and protection for all items required in the construction of the work. Specific requirements, if any, are specified with the related item.

1.02 TRANSPORTATION AND DELIVERY

- A. Transport and handle items in accordance with manufacturer's instructions.
- B. Schedule delivery to reduce long term on-site storage prior to installation and/or operation. Under no circumstances shall equipment be delivered to the site more than one month prior to installation without written authorization from the UTILITY.
- C. Coordinate delivery with installation to ensure minimum holding time for items that are hazardous, flammable, easily damaged or sensitive to deterioration.
- D. Deliver products to the site in manufacturer's original sealed containers or other packing systems, complete with instructions for handling, storing, unpacking, protecting, and installing.
- E. All items delivered to the site shall be unloaded and placed in a manner which will not hamper the Contractor's normal construction operation or those of subcontractors and other contractors and will not interfere with the flow of necessary traffic.
- F. Provide necessary equipment and personnel to unload all items delivered to the site.
- G. Promptly inspect shipment to assure that products comply with requirements, quantities are correct, and items are undamaged. For items furnished by others (i.e. UTILITY, other Contractors), perform inspection in the presence of the UTILITY. Notify UTILITY verbally, and in writing, of any problems.
- H. If any item has been damaged, such damage shall be repaired at no additional cost to the UTILITY.

1.03 STORAGE AND PROTECTION

- A. Store and protect products in accordance with the manufacturer's instructions, with seals and labels intact and legible. Storage instruction shall be studied by the Contractor and reviewed with the UTILITY by him/her. Instruction shall be carefully followed and a written record of this kept by the Contractor. Arrange storage to permit access for inspection.
- B. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.
- C. Cement and lime shall be stored under a roof and off the ground and shall always be kept completely dry. All structural, miscellaneous, and reinforcing steel shall be stored off the

ground or otherwise to prevent accumulations of dirt or grease and in a position to prevent accumulations of standing water and to minimize rusting. Beams shall be stored with the webs vertical. Precast concrete shall be handled and stored in a manner to prevent accumulations of dirt, standing water, staining, chipping, or cracking. Brick, block, and similar masonry products shall be handled and stored in a manner to reduce breakage, cracking, and spalling to a minimum.

- D. All mechanical and electrical equipment and instruments subject to corrosive damage by the atmosphere if stored outdoors (even though covered by canvas) shall be stored in a weathertight building to prevent injury. The building may be a temporary structure on the site or elsewhere, but it must be satisfactory to the UTILITY. Building shall be provided with adequate ventilation to prevent condensation. Maintain temperature and humidity within range required by manufacturer. The UTILITY may offer existing spaces available to the Contractor for storage of these items but this is in no way guaranteed and the UTILITY does not accept any liability for theft, damage, or loss occurring while the material is stored in their space. The Contractor must coordinate with the UTILITY if space has been offered and the Contractor chooses to utilize said UTILITY space.
1. All equipment shall be stored fully lubricated with oil, grease and other lubricants unless otherwise instructed by the manufacturer.
  2. Moving parts shall be rotated a minimum of once weekly to ensure proper lubrication and to avoid metal-to-metal "welding". Upon installation of the equipment, the Contractor shall start the equipment, at least half load, once weekly for an adequate period of time to ensure that the equipment does not deteriorate from lack of use.
  3. Lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. New lubricants shall be put into the equipment at the time of acceptance, unless the period between installation and acceptance is less than  $\frac{1}{2}$  the time period between factory recommended lubricant changes.
  4. Prior to acceptance of the equipment, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the long storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equal to that of equipment that has been shipped, installed, tested and accepted in a minimum time period. As such, the manufacturer will guaranty the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective. It shall be removed and replaced at the Contractor's expense.
- E. All paint and other coating products shall be stored in areas protected from the weather. Follow all storage requirements set forth by the paint and coating manufacturers.

#### 1.04 HANDLING PIPELINE MATERIALS

- A. The CONTRACTOR shall handle the material with utmost care and in a manner to prevent damage to the materials, material coating, and lining, during loading, hauling, unloading, and installation operations. Damaged material shall be replaced or repaired by the CONTRACTOR at his/her expense.
- B. Hooks shall not be in contact with the pipe exterior.
- C. The interior of the pipeline materials shall always be kept free from dirt and foreign matter .

- D. Pipeline materials, especially valves, hydrants, and fittings shall be drained and stored in a manner to protect them from damage by freezing.

END OF SECTION

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SECTION 01 7710  
CONTRACT CLOSEOUT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section specifies administrative, verification and procedural requirements for project closeout, including but not limited to:
  - 1. Operation and Maintenance Data (Section 01\_8823).
  - 2. Project Record Documents (Section 01\_7839).
  - 4. Spare parts and maintenance materials (spare paint, lubricants, special tools).
  - 5. Record Shop Drawings (Section (01\_3000).
  - 6. Warranties and Bonds (Section (01\_7836).
  - 7. Reconciliation of final accounting, final change order, final payment application (General Conditions) and Contractor's releases.
  - 8. Permit close-outs including Certificate of Occupancy or Certificate of Completion.

1.02 RELATED WORK

- A. Operation and Maintenance (O&M) data and manuals (Section 01\_8823) and applicable Sections in Technical Divisions.
- B. Project Record Documents (Section 01\_7839).

1.03 CLOSEOUT PROCEDURES

- A. Provide all deliverables as specified, prior to submitting the final payment application.
- B. Provide submittals to Engineer that are required by governing or other authorities having applicable jurisdiction including but not limited to permit close out information, certificates of occupancy, etc.
- C. Submit Application for Final Payment identifying total adjusted Contract Sum, previous payments and sum remaining due, following submittal and approval of Record Documents and Record Drawings.
- D. Submit Contractor's Final Release and Release of Liens with final payment application.

1.04 FINAL CLEANING

- A. CONTRACTOR to complete final cleaning prior to submittal of the final application for payment.
- B. The CONTRACTOR shall remove all materials, equipment, tools, temporary structures, barricades, and trees and other vegetation that have been cut or have died as a result from the work, from both public and private property along the job site.
- C. There shall be no burning on the job site unless approved, in advance, by the UTILITY.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

## SECTION 01 7836

### WARRANTIES AND BONDS

#### PART 1 GENERAL

##### 1.01 SCOPE OF WORK

- A. This Section specifies general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturer's standard warranties on products and special warranties.

##### 1.02 RELATED WORK

- A. Refer to Conditions of Contract for the general requirements relating to warranties and bonds.
- B. General closeout requirements are included in Section 01\_7710 - Project Closeout.
- C. Specific requirements for warranties for the work and products and installations that are specified to be warranted are included in the individual Sections.

##### 1.03 SUBMITTALS

- A. Submit written warranties to the OWNER prior to the date fixed by the Engineer for Substantial Completion. If the Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the work, or a designated portion of the work, submit written warranties upon request of the OWNER.
- B. When a designated portion of the work is completed and occupied or used by the UTILITY, by separate agreement with the CONTRACTOR during the construction period, submit properly executed warranties to the OWNER within 15 days of completion of that designated portion of the Work.
- C. When a special warranty is required to be executed by the CONTRACTOR, or the CONTRACTOR and a subcontractor, supplier, or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the OWNER for approval prior to final execution.
- D. Refer to individual Sections for specific content requirements, and particular requirements for submittal of special warranties.

##### 1.04 WARRANTY REQUIREMENT

- A. Related Damages and Losses: When correcting warranted work that has failed, remove and replace other work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted work.
- B. Reinstatement of Warranty: When work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

- C. Replacement Cost: Upon determination that work covered by a warranty has failed, replace or rebuild the work to an acceptable condition complying with requirements of Contract Documents. The CONTRACTOR is responsible for the cost of replacing or rebuilding defective work regardless of whether the OWNER has benefited from use of the work through a portion of its anticipated useful service life.
- D. UTILITY's Recourse: Written warranties made to the OWNER are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the OWNER can enforce such other duties, obligations, rights, or remedies.
- E. Rejection of Warranties: The OWNER reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the contract Documents.
- F. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the CONTRACTOR of the warranty on the work that incorporates the products, nor does it relieve suppliers, manufacturers and subcontractors required to countersign special warranties with the CONTRACTOR.

#### 1.05 MANUFACTURERS CERTIFICATIONS

- A. Where required, the CONTRACTOR shall supply evidence, satisfactory to the Engineer, that the CONTRACTOR can obtain manufacturers' certifications as to the CONTRACTOR's installation of equipment.

#### 1.06 DEFINITIONS

- A. Standard Product Warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the UTILITY.
- B. Special Warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the UTILITY.

#### PART 2 PRODUCTS (NOT USED)

#### PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 7839

PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.01 SCOPE

The CONTRACTOR shall keep and maintain, at the job site, a copy of contract documents, marked up to indicate all changes made during the course of a project, as specified herein.

1.02 RELATED REQUIREMENTS

- A. Contract close-out submittals are included in Section 01\_7710.
- B. Warranties and bonds are included in Section 01\_7836.
- C. Record shop drawings are included in Section 01\_3000.

1.03 REQUIREMENTS INCLUDED

- A. CONTRACTOR shall maintain a record copy of the following documents, marked up to indicate all changes made during the course of a project:

- 1. Contract Drawings

- B. CONTRACTOR shall assemble copies of the following documents for turnover to the Engineer at the end of the project, as specified.

- 1. Field Orders, Change Orders, Design Modifications, and RFIs

- 2. Field Test records

- 2. Permits and permit close-outs (final approvals)

- 3. Certificate of Occupancy or Certificate of Completion, as applicable

- 4. Laboratory test reports (e.g., bacteriological and primary & secondary water quality)

- 5. Certificates of Compliance for materials and equipment

- 6. Samples

- C. RECORD DRAWINGS

- 1. The CONTRACTOR shall annotate (mark-up) the Contract Drawings to indicate all project conditions, locations, configurations, and any other changes or deviations that vary from the original Contract Drawings. This requirement includes, but is not limited to, buried or concealed construction, and utility features that are revealed during the course of construction. Special attention shall be given to recording the locations (horizontal and vertical) and material of all buried utilities that are encountered during construction – whether or not they were indicated on the Contract Drawings. The record information

added to the drawings may be supplemented by detailed sketches, if necessary, clearly indicating, the WORK, as constructed.

2. These annotated Contract Drawings constitute The CONTRACTOR's Record Drawings and are actual representations of as-built conditions, including all revisions made necessary by change orders, design modifications, requests for information and field orders.
3. Record drawings shall be accessible to the OWNER and Engineer at all times during the construction period.

## PART 2 – PRODUCTS (NOT USED)

## PART 3 – EXECUTION

### 3.01 MAINTENANCE OF RECORD DOCUMENTS AND SAMPLES

- A. Store documents and samples in CONTRACTOR's field office apart from documents used for construction.
  1. Provide files and racks for storage of the record documents.
  2. Provide locked cabinet(s) or secure storage space for storage of samples.
- B. File documents and samples in accordance with Construction Specifications Institute (CSI) format.
- C. Maintain documents in a clean, dry, legible, condition and in good order. Do not use record documents for construction purposes.
- D. Make documents and sample available for inspection by the Engineer or OWNER at all times.

### 3.02 MARKING METHOD

- A. Use the color *Red* (indelible ink) to record information on the Drawings.
- B. Label each document "PROJECT RECORD" in neat large printed letters.
- C. Unless otherwise specified elsewhere, notations shall be affixed to hardcopies of documents.
- D. Record information contemporaneously with construction progress.
- E. Legibly mark drawings with as-built information:
  1. Elevations and dimensions of structures and structural elements.
  2. All underground utilities (piping and electrical), structures, and appurtenances
    - a. Changes to existing structure, piping and appurtenance locations.
    - b. Record horizontal and vertical locations of underground structures, piping, utilities and appurtenances, referenced to permanent surface improvements.

- c. Record actual installed pipe material, class, size, joint type, etc

### 3.03 RECORD INFORMATION COMPILATION

- A. Do not conceal any work until the required information is acquired.
- B. Items to be recorded include, but are not limited to:
  - 1. Location of internal utilities and appurtenances concealed in the construction – referenced to visible and accessible features.
  - 2. Field changes of dimensions and/or details
    - 1) Interior equipment and piping relocations.
    - 2) Architectural and structural changes, including relocation of doors, windows, etc.
    - 3) Architectural schedule changes.
- C. Changes made by Field Order, Change Order, design modification, and RFI.
- D. Details not indicated on the original Contract Drawings.

### 3.04 SUBMITTAL

- A. If requested by the Engineer or OWNER, CONTRACTOR shall provide a copy of the Record Drawings, or present them for review prior to processing monthly applications for payment.
- B. Upon substantial completion of the WORK and prior to final acceptance, the CONTRACTOR shall finalize and deliver a complete set of Record Drawings to the ENGINEER conforming to the construction records of the CONTRACTOR. The set of drawings shall consist of corrected and annotated drawings showing the recorded location(s) of the WORK. Unless specified otherwise elsewhere, Record Drawings shall be in the form of a set of prints with annotations carefully and neatly superimposed on the drawings in red.
- C. Upon substantial completion of the WORK and prior to final acceptance, the CONTRACTOR shall finalize and deliver a complete set of Record Documents to the ENGINEER conforming to the construction records of the CONTRACTOR. The set of documents shall consist of corrected and annotated documents showing the as-installed equipment and all other as-built conditions not indicated on the Record Drawings.
- D. The information submitted by the CONTRACTOR into the Record Drawings and Record Documents will be assumed to be correct, and the CONTRACTOR shall be responsible for the accuracy of such information, and shall bear the costs resulting from the correction of incorrect data.
- E. Delivery of Record Drawings and Record Documents to the ENGINEER will be a prerequisite to Final payment.
- F. The CONTRACTOR shall maintain a copy of all books, records, and documents pertinent to the performance under this Agreement for a period of five years following completion of the contract.

END OF SECTION



SECTION 01 8823

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes procedural requirements for compiling and submitting operation and maintenance data required to complete the project.

1.02 RELATED WORK

- A. Submittals are included in Section 01\_3000.
- B. Contract closeout is included in Section 01\_7710
- C. Warranties and Bonds are included in Section 01\_7836.

1.03 OPERATING MANUALS

- A. Provide operation and maintenance instructions for all electrical, mechanical, and instrumentation & controls equipment furnished under various technical specifications Sections.
- B. Separate manuals shall be provided for each type of equipment, or each Section number. Each manual shall contain the following:
  - 1. Format and Materials
    - a. Binders:
      - 1) Commercial quality three ring binders with durable and cleanable plastic covers
      - 2) Maximum ring width capacity: 3 inches
      - 3) When multiple binders are used, correlate the data into related consistent groupings/volumes.
    - b. Identification: Identify each volume on the cover and spine with typed or printed title "OPERATING AND MAINTENANCE INSTRUCTIONS". Include the following:
      - 1) Title of Project.
      - 2) Identify the general subject matter covered in the manual
      - 3) Identify structure(s) and/or location(s), as applicable
      - 4) Specification Section number
    - c. 20 lb loose leaf paper, with hole reinforcement

- d. Page size: 8-1/2 inch by 11 inch
  - e. Provide heavy-duty fly leafs (section separators), matching the table of contents, for each separate product, each piece of operating equipment, and organizational sections of the manual.
  - f. Provide reinforced punched binder tab; bind in with text.
  - g. Reduce larger drawings and fold to the size of text pages - but not larger than 11 inches x 17 inches - or provide a suitable clear plastic pocket (with drawing identification) for such folded drawings/diagrams.
2. Contents:
- a. A table of contents/Index
  - b. Specific description of each system and components
  - c. Name, address, telephone number(s) and e-mail address(es) of vendor(s) and local service representative(s)
  - d. Specific on-site operating instructions (including starting and stopping procedures)
  - e. Safety considerations
  - f. Project specific operational procedures
  - g. Project specific maintenance procedures
  - h. Manufacturer's operating and maintenance instructions – specific to the project
  - i. Copy of each wiring diagram
  - j. Copy of approved shop drawing(s) and CONTRACTOR's coordination/layout drawing(s)
  - k. List of spare parts and recommended quantities
  - l. Product Data: Mark each sheet to clearly identify specific products and component parts and data applicable to installation. Delete inapplicable information.
  - m. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams
  - n. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified.
  - o. Warranties and Bonds, as specified in the General Conditions
3. Transmittals

- a. Prepare separate transmittal sheets for each manual. Each transmittal sheet shall include at least the following: the CONTRACTOR's name and address, OWNER's name, project name, project number, submittal number, description of submittal and number of copies submitted.
  - b. Submittals shall be transmitted or delivered directly to the office of the Engineer, as indicated in the Contact Documents or otherwise directed by the Engineer.
  - c. Provide copies of transmittals (only, i.e., without copies of the respective submittal) directly to the Resident Project Representative.
- C. Manuals for Equipment and Systems - In addition to the requirements listed above, for each System, provide the following:
1. Overview of system and description of unit or system and component parts. Identify function, normal operating characteristics and limiting conditions. Include performance curves, with engineering data and tests and complete nomenclature and commercial number of replaceable parts.
  2. Panelboard circuit directories including electrical service characteristics, controls and communications and color coded wiring diagrams as installed.
  3. Operating procedures: include start-up, break-in and routine normal operating instructions and sequences; regulation, control, stopping, shut-down and emergency instructions; and summer, winter and any special operating instructions.
  4. Maintenance Requirements
    - a. Procedures and guides for trouble-shooting; disassembly, repair, and reassembly instructions
    - b. Alignment, adjusting, balancing and checking instructions
    - c. Servicing and lubrication schedule and list of recommended lubricants
    - d. Manufacturer's printed operation and maintenance instructions
    - e. Sequence of operation by instrumentation and controls manufacturer
    - f. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance
  5. Control diagrams by controls manufacturer as installed (as-built)
  6. CONTRACTOR's coordination drawings, with color coded piping diagrams, as installed (as-built)
  7. Charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams. Include equipment and instrument tag numbers on diagrams.
  8. List of original manufacturer's spare parts and recommended quantities to be maintained in storage

9. Test and balancing reports, as required
10. Additional Requirements as specified in individual product specification
11. Design data for systems engineered by the CONTRACTOR or its Suppliers

D. Electronic Transmission of O&M Manuals

1. Unless otherwise approved by the Engineer, O&M manuals may not be transmitted by electronic means other than by CD-ROM. Electronic O&M manuals shall meet the following conditions:
  - a. The above-specified transmittal form is included.
  - b. All other requirements specified above have been met, including, but not limited to, coordination by the CONTRACTOR, review and approval by the Contractor.
  - c. The submittal contains no pages or sheets large than 11 x 17 inches.
  - d. With the exception of the transmittal sheet, the entire submittal is included in a single file.
  - e. Files are Portable Document Format (PDF) – with the printing function enabled.
2. When electronic copies are provided, transmit two hard-copy (paper) originals to the Engineer with an electronic copy on CD-ROM.
3. The electronic copy of the O&M manual must be identical in organization, format and content to the hard copies of the manual.

1.04 SERVICES OF MANUFACTURERS' REPRESENTATIVE

- A. All electrical, mechanical, and instrumentation & controls equipment furnished under various technical specifications Sections shall include the cost of a competent representative of the manufacturers of all equipment to supervise the installation, adjustment and testing of the equipment; and, to instruct the OWNER's operating personnel on operation and maintenance. This supervision may be divided into two or more time periods to suit the CONTRACTOR's schedule and/or the OWNER's personnel availability.
- B. See the detailed specifications for additional requirements for furnishing the services of manufacturer's representatives.
- C. The manufacturer's representative shall certify that the installation of the equipment is satisfactory; that the unit has been satisfactorily tested; that the equipment is ready for operation; and, that the operating personnel have been suitably instructed in the operation, maintenance, care, and safe operation of the equipment. The *Equipment Manufacturer's Certificate of Installation, Testing, and Instruction* attached to this Section shall be used for this certification.
- D. For other materials furnished under other specification Sections, furnish the services of approved representative(s) of the manufacturer when, in the opinion of the Engineer, some evident product failure or malfunction makes such services necessary.

PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

### 3.01 SUBMITTAL SCHEDULE

- A. Operation and maintenance manuals shall be delivered directly to the office of the Engineer, as follows:
  - 1. Preliminary copies of manuals shall be submitted to the office of the Engineer, no later than 30 days following approval of the respective shop drawings.
  - 2. Provide one (1) hard copy and six (6) electronic copies on separate labeled CD's of complete manuals prior to testing and start-up.
- B. The Engineer will review Operation and Maintenance manuals submittals on operating equipment for conformance with the requirements of the applicable specification Section. The review will generally be based on the *O&M Manual Review Checklist* appended to this Section.
- C. If during test and start-up of equipment, any changes were made to the equipment, provide copies (the number specified in paragraph 3.01.A.2) of as-built drawings or any other amendments for insertion in the final manuals. Submit the required number within 30 days of start-up and testing of the facility.

### 3.02 VENDOR TRAINING/INSTRUCTIONS (TO OWNER'S PERSONNEL)

- A. Before final initiation of operation, CONTRACTOR's vendors shall train/instruct OWNER's designated personnel in the operation, adjustment, and maintenance of products, equipment and systems at times convenient to the OWNER.
- B. Unless specified otherwise under the respective equipment specification section, vendor training/instruction shall consist of two hours of training for each type of equipment. Such training/instruction shall be scheduled and held at times to accommodate the work schedules of OWNER's personnel, including splitting the required training/instruction time into separate sessions and/or presented at reasonable times other than the CONTRACTOR's "normal working hours" or the OWNER's normal day shift.
- C. Use operation and maintenance manuals as basis for instruction. Train/instruct the OWNER's personnel, in detail, based on the contents of manual explaining all aspects of operation and maintenance of the equipment. If the respective equipment is inter-related to the operation of other equipment, all interlock, constraints, and permissives shall be explained.
- D. Prepare and insert additional data in each Operation and Maintenance Manual when the need for such data becomes apparent during training/instruction.
- E. Vendor's training/instruction will be considered acceptable based on the completed *OWNER's Acknowledgement of Manufacturer's Instruction* as indicated on the Equipment Manufacturer's Certification of Installation, Testing, and Instruction appended to this Section.

END OF SECTION

EQUIPMENT MANUFACTURER'S CERTIFICATE OF INSTALLATION, TESTING  
AND INSTRUCTION

OWNER: \_\_\_\_\_

Project: \_\_\_\_\_

Contract No. \_\_\_\_\_

CDM Project No. \_\_\_\_\_

EQUIPMENT SPECIFICATION SECTION \_\_\_\_\_

EQUIPMENT DESCRIPTION \_\_\_\_\_

I \_\_\_\_\_, Authorized representative of  
(Print Name)

\_\_\_\_\_  
(Print Manufacturer's Name)

hereby CERTIFY that \_\_\_\_\_  
(Print equipment name and model with serial No.)

installed for the subject project [has] [have] been installed in a satisfactory manner, [has] [have] been satisfactorily tested, [is] [are] ready for operation, and that OWNER assigned operating personnel have been suitably instructed in the operation, lubrication, and care of the unit[s] on Date: \_\_\_\_\_ Time: \_\_\_\_\_.

CERTIFIED BY: \_\_\_\_\_ DATE: \_\_\_\_\_  
(Signature of Manufacturer's Representative)

OWNER'S ACKNOWLEDGMENT OF MANUFACTURER'S INSTRUCTION

[I] [We] the undersigned, authorized representatives of the \_\_\_\_\_ and/or Plant Operating Personnel have received classroom and hands on instruction on the operation, lubrication, and maintenance of the subject equipment and [am] [are] prepared to assume normal operational responsibility for the equipment:

\_\_\_\_\_  
DATE: \_\_\_\_\_

\_\_\_\_\_  
DATE: \_\_\_\_\_

\_\_\_\_\_  
DATE: \_\_\_\_\_

*O&M Manual Review Checklist*

Submittal No.: \_\_\_\_\_

Project No.: \_\_\_\_\_

Manufacturer: \_\_\_\_\_

Equipment Submitted: \_\_\_\_\_

Specification Section: \_\_\_\_\_

Date of Submittal: \_\_\_\_\_

**General Data**

- \_\_\_\_\_ 1. Are the area representative's name, address, e-mail address and telephone number included?
- \_\_\_\_\_ 2. Is the nameplate data for each component included?
- \_\_\_\_\_ 3. Are all associated components related to the specific equipment included?
- \_\_\_\_\_ 4. Is non-pertinent data crossed out or deleted?
- \_\_\_\_\_ 5. Are drawings neatly folded and/or inserted into packets?

**Operations and Maintenance Data**

- \_\_\_\_\_ 6. Is an overview description of the equipment and/or process included?
- \_\_\_\_\_ 7. Does the description include the practical theory of operation?
- \_\_\_\_\_ 8. Does each equipment component include specific details (design characteristics, operating parameters, control descriptions, and selector switch positions and functions)?
- \_\_\_\_\_ 9. Are alarm and shutdown conditions clearly identified? Does it describe possible causes and recommended remedies?
- \_\_\_\_\_ 10. Are step procedures for starting, stopping, and troubleshooting the equipment included?
- \_\_\_\_\_ 11. Is a list of operational parameters to monitor and record for specific equipment included?
- \_\_\_\_\_ 12. Is a proposed operating log sheet included?
- \_\_\_\_\_ 13. Is a spare parts inventory list included for each component?
- \_\_\_\_\_ 14. Is a lubrication schedule for each component included - or does it clearly state "No Lubrication Required"?
- \_\_\_\_\_ 15. Is a maintenance schedule for each component included?
- \_\_\_\_\_ 16. Is a copy of the warranty information included?

**Review Comments**

Is the submittal fully approved (yes/no)?

If not, see the following are the points of rejection that must be addressed and require resubmittal by the CONTRACTOR:

Item No.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_
7. \_\_\_\_\_
8. \_\_\_\_\_
9. \_\_\_\_\_
10. \_\_\_\_\_
11. \_\_\_\_\_
12. \_\_\_\_\_
13. \_\_\_\_\_
14. \_\_\_\_\_
15. \_\_\_\_\_

Reviewed By: \_\_\_\_\_ Date: \_\_\_\_\_

Legend

- 1 = OK
- 2 = Not Adequate
- 3 = Not Included

Note: This submittal has been reviewed for compliance with the Contract Documents.



SECTION 03 3100

CONCRETE FORMWORK

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required and design, install and remove formwork for cast-in-place concrete complete as shown on the Drawings and as specified herein.
- B. Secure to forms or set for embedment all miscellaneous metal items, sleeves, reglets, anchor bolts, inserts, waterstops, and other items furnished under other Sections and required to be cast into concrete.

1.02 RELATED WORK

- A. Concrete reinforcement is included in Section 03\_3200.
- B. Cast-in-place concrete is included in Section 03\_3300.
- C. Miscellaneous metals are furnished under Sections 05\_5000.
- D. Anchor bolts for equipment are furnished under Divisions 11, 13, 14, 15 and 16.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01\_3000, shop drawings and product data showing materials of construction and details of installation for:
  - 1. Form release agent
  - 2. Form ties
- B. Review will be for appearance, performance, and strength of the completed structure only. Approval by the Engineer will not relieve the CONTRACTOR of responsibility for the strength, safety or correctness of methods used, the adequacy of equipment, or from carrying out the work as shown on the Drawings and as specified herein.

C. Sample Substrate

1. Demonstrate to the Engineer on a designated area of the concrete substructure exterior surface that the form release agent will not impair the bond of paint, sealant, waterproofing, dampproofing, or other coatings and will not affect the forming materials.

D. Certificates

1. Submit completed PE Certification Form for design of formwork in accordance with Section 01\_3000. The PE Certification Form shall be completed and stamped by a professional engineer registered in the State of Arkansas.
2. Certify that form release agent complies with Federal, State and local VOC limitations.

1.04 REFERENCE STANDARDS

A. American Concrete Institute (ACI)

1. ACI 301 - Specifications for Structural Concrete
2. ACI 318 - Building Code Requirements for Structural Concrete
3. ACI 347 - Guide to Formwork for Concrete
4. ACI 350 - Code Requirements for Environmental Engineering Concrete Structures

B. APA - The Engineered Wood Association (APA)

1. Material grades and designations as specified

C. 2006 International Building Code (IBC).

- D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 SYSTEM DESCRIPTION

- A. Structural concrete is defined as concrete that is not architectural concrete.

- B. Structural design responsibility: CONTRACTOR shall provide all forms and shoring designed by a professional engineer registered in the State of Arkansas. Design and erect formwork in accordance with the requirements of ACI 301, ACI 318/350 and ACI 347. Comply with all applicable regulations and codes. Consider any special requirements due to the use of plasticized and/or retarded set concrete.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. The usage of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configurations desired.

### 2.02 MATERIALS

#### A. Forms, General

- 1. Make forms for cast-in-place concrete of wood, steel or other approved materials, except as specified in Paragraphs 2.02B and 2.02C.2. Construct wood forms of sound lumber or plywood free from knotholes and loose knots. Construct steel forms to produce surfaces equivalent in smoothness and appearance to those produced by new plywood panels. Design and construct all forms to provide a flat, uniform concrete surface requiring no grinding, repairs, or finishing except as specified.

#### B. Forms for Exposed Structural Concrete

- 1. Make forms for all exposed and non-submerged exterior and interior concrete of new and unused Plyform exterior grade plywood panels manufactured in compliance with the APA and bearing the APA trademark. Provide B grade or better veneer on all faces to be in contact with concrete. Design and construct all forms to provide a flat, uniform concrete surface requiring no grinding, repairs, or finishing except as specified.
- 2. Provide rigid forms that will not deflect, move, or leak. Design forms to withstand the high hydraulic pressures resulting from rapid filling of the forms and heavy high frequency vibration of the concrete. Limit deflection to 1/400 of each component span. Lay out form joints in a uniform pattern.
- 3. Dress and match boards. Sand plywood smooth and fit adjacent panels with tight joints. Tape, gasket, plug, and/or caulk all joints and gaps in forms to provide watertight joints that will withstand placing pressures without exceeding specified deflection limit or creating surface patterns.
- 4. Provide 3/4-inch chamfer on all corners unless otherwise indicated.

#### C. Column Forms

- 1. Form rectangular columns as specified for exposed structural concrete. Provide 3/4-in chamfer on all corners unless otherwise indicated.

- D. Provide rustications as indicated. Mill and plane smooth moldings for chamfers and rustications. Provide rustications and chamfer strips of nonabsorbent material, compatible with the form surface and fully sealed on all sides to prevent the loss of paste or water between the two surfaces.

- E. Form Release Agent. Coat all form surfaces in contact with concrete with an effective, non-staining, non-residual, water based or vegetable oil based, bond-breaking form coating unless otherwise indicated or specified. Form release agent shall not impair the bond of special coating systems where applicable.
  - 1. Water based form release agent shall be DUOGARD II by W.R. Meadows, GCC-100FR by SEI Chemicals, or approved equal.
  - 2. Vegetable oil based form release agent shall be FARM FRESH by CMC Construction Services, Bio Release EF by DS Construction Chemicals, or approved equal.
  
- F. Form Ties
  - 1. Coil and Wire Ties: Provide ties manufactured so that, after removal of the projecting part, no metal remains within 1-1/2-in of the face of the concrete. The part of the tie to be removed shall be at least 1/2-in diameter or be provided with a plastic or wooden cone at least 1/2-in diameter and 1-1/2-in long. Provide cone washer type form ties in concrete exposed to view.
  - 2. Flat Bar Ties for Panel Forms: Provide ties that have plastic or rubber inserts with a minimum depth of 1-1/2-in and manufactured to permit patching of the tie hole.
  - 3. Provide ties for liquid retaining structures and exterior below grade walls that have a steel waterstop tightly attached to each strut or that have a neoprene rubber washer on each strut.
  - 4. Do not use common wire for form ties.
  - 5. Alternate form ties consisting of tapered through-bolts at least 1-in in diameter at smallest end or through-bolts that utilize a removable tapered sleeve of the same minimum size may be used. Install in forms so that large end is, where applicable, on the liquid or backfilled side of the wall. Clean, fill and seal form tie hole with non-shrink cement grout to provide watertight form tie holes and make all repairs needed to make watertight.
  - 6. Alternate form ties specified in Paragraph 2.02F.5 may be used when forms are to be set against previously placed or existing concrete walls. Use in conjunction with cast-in threaded inserts or drilled-in threaded anchors so that no metal remains within expansion joint upon removal of tapered through bolt. Conform to requirements specified in Paragraph 2.02I.5.

## PART 3 EXECUTION

### 3.01 GENERAL

- A. Provide forms for all cast-in-place concrete including sides of footings. Construct and place forms to provide concrete of the shape, lines, dimensions, and appearance indicated.

- B. Provide removable panels at the bottom of forms for walls and columns to allow cleaning, inspection, and joint surface preparation. Provide closable intermediate inspection ports in forms for walls. Provide tremies and hoppers for placing concrete and to allow concrete sampling, prevent segregation and prevent the accumulation of hardened concrete on the forms and reinforcement above the fresh concrete.
- C. Place molding, bevels, or other types of chamfer strips to produce blockouts, rustications, or chamfers as indicated on the Drawings or as specified herein. Provide chamfer strips at horizontal and vertical projecting corners to produce a 3/4-in chamfer. Provide rectangular moldings at locations requiring sealants where shown on the Drawings or specified herein.
- D. Provide rigid forms to withstand construction loads and vibration and meeting specified deflection limits and tolerances. Construct forms so that the concrete will not be damaged by form removal.
- E. Accessories which remain embedded in the concrete after formwork removal will be subject to the approval of the Engineer. Permanent embedments shall have sufficient concrete cover or be of suitable materials for the exposure condition as approved by the Engineer. Remove unsatisfactory embedded items at no additional cost to the UTILITY.

### 3.02 FORM TOLERANCES

- A. Design, construct and surface forms in accordance with ACI 347 and meet the following additional requirements for the specified finishes.
- B. Forms for Exposed Structural Concrete: Edges of all form panels in contact with concrete flush within 1/8-in and forms for plane surfaces plane within 1/8-in in 4-ft. Maximum deviation of the finished surface at any point not to exceed 1/4-in from the intended surface indicated. Arrange form panels symmetrically and orderly to minimize the number of seams. Provide tight forms to prevent the passage of mortar, water, and grout.
- C. Formed Surface Not Exposed to View or Buried: Class "C" Surface per ACI 347.
- D. Formed Surface Including Mass Concrete, Pipe Encasement, Electrical Raceway Encasement and Other Similar Installations: No minimum requirements for surface irregularities and surface alignment. The overall dimensions of the concrete shall be plus or minus 1-in from the intended surface indicated.

### 3.03 FORM PREPARATION

- A. Clean, repair, remove projecting nails and fill holes, and smooth protrusions on all form surfaces to be in contact with concrete before reuse. Do not reuse forms for exposed concrete unless a "like new" condition of the form is maintained that will produce surfaces equivalent in smoothness and appearance to those produced by new plywood panels.
- B. Coat wood forms in contact with concrete using form release agent prior to form installation.
- C. Clean steel forms by sandblasting or other method to remove mill scale and other ferrous deposits from the contact surface of all forms. Coat steel forms in contact with concrete using form release agent prior to form installation.

### 3.04 REMOVAL OF FORMS

- A. The CONTRACTOR shall be responsible for all damage resulting from removal of forms and make repairs at no additional cost to the UTILITY. Leave in place forms and shoring for horizontal structural members in accordance with ACI 301 and ACI 347. Conform to the requirements for form removal specified in Section 03\_3000.

### 3.05 INSPECTION

- A. The UTILITY or the registered design professional in responsible charge acting as the UTILITY's agent shall employ one or more special inspectors to provide inspections during construction.
- B. Special inspection shall be performed in accordance with Section 1704.4 and table 1704.4 of the IBC.
- C. The Engineer shall be notified when the forms are complete and ready for inspection at least 6 hours prior to the proposed concrete placement.
- D. Failure of the forms to comply with the requirements specified, or to produce concrete complying with requirements specified shall be grounds for rejection of that portion of the concrete work. Repair or replace rejected work as directed by the Engineer at no additional cost to the UTILITY. Such repair or replacement shall be subject to the requirements of these Specifications and approval of the Engineer.

END OF SECTION

## SECTION 03 3200

### CONCRETE REINFORCEMENT

#### PART 1 GENERAL

##### 1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required and install all concrete reinforcement complete as shown on the Drawings and as specified herein, including dowels embedded into concrete or masonry.

##### 1.02 RELATED WORK

- A. Concrete formwork is included in Section 03\_3100.
- B. Cast-in-place concrete is included in Section 03\_3300.
- C. Modifications to existing concrete are included in Section 03\_3750.

##### 1.03 SUBMITTALS

- A. Submit, in accordance with Section 01\_3000, shop drawings and product data showing materials of construction and details of installation for:
  - 1. Reinforcing steel. Drawings for fabrication, bending, and placement of concrete reinforcement shall conform to the recommendations of ACI 315 for placement drawings and as specified herein.
    - a. Placement drawings. For walls, show elevations from the outside, looking towards the structure, at a minimum scale of 1/4-in to one foot. For slabs, show top and bottom reinforcement on separate plan views, as needed for clarity. For beams and columns, show schedules with sections and/or elevations and stirrup/tie spacing. Show additional reinforcement around openings, at corners and at other locations indicated, diagrams of bent bars, arrangements, and assemblies, all as required for the fabrication and placement of concrete reinforcement. Reference bars to the same identification marks shown on the bar bending details. Identify bars to have special coatings and/or to be of special steel or special yield strength. Regardless, all reinforcing steel yield strength shall be indicated on the drawings.
    - b. Bar bending details. Reference bars to the same identification marks shown on the placement drawings. Identify bars to have special coatings and/or to be of special steel or special yield strength.

2. Fiber reinforcement. Submit manufacturer's data for synthetic reinforcing fibers. Identify all placements that are to contain synthetic reinforcing fibers. The fiber length and amount of fibers per cubic yard to be used for each placement shall be noted. Submit two samples of synthetic reinforcing fibers.

B. Submit samples of each of the following items.

1. Two samples of each type of mechanical reinforcing steel coupling system, if used.

C. Submit, in accordance with Section 01\_3000, Test Reports of each of the following items.

1. Certified copy of mill tests on each heat of each steel proposed for use showing the physical properties of the steel and the chemical analysis for all indicated reinforcement sizes.
2. Welder's certification in accordance with AWS D1.4 when welding of reinforcement is indicated, specified, or approved.

#### 1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
2. ASTM A184 - Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement.
3. ASTM A185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
4. ASTM A496 - Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
5. ASTM A497 - Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
6. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
7. ASTM A704 - Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement.
8. ASTM A706 - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
9. ASTM D7357 - Standard Specification for Cellulose Fibers for Fiber Reinforced Concrete



B. American Concrete Institute (ACI)

1. ACI 301 - Specifications for Structural Concrete.
2. ACI 315 - Details and Detailing of Concrete Reinforcement.
3. ACI 318 - Building Code Requirements for Structural Concrete.
4. ACI 350 – Building Code Requirements for Environmental Engineering Concrete Structures
5. SP-66 (ACI 315) ACI Detailing Manual.

C. Concrete Reinforcing Steel Institute (CRSI)

1. Manual of Standard Practice

D. American Welding Society (AWS)

1. AWS D1.4 Structural Welding Code - Reinforcing Steel

E. ICC Evaluation Service

1. ICC-ES AC217 – Acceptance Criteria for Concrete with Virgin Cellulose Fibers

F. 2006 International Building Code (IBC).

G. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. Fiber Reinforcement. Provide services of a manufacturer's representative, with at least 2 years experience in the use of the synthetic reinforcing fibers for a preconstruction meeting and assistance during the first placement of the material.

1.06 DELIVERY, HANDLING AND STORAGE

- A. Provide reinforcement free from mill scale, rust, mud, dirt, grease, oil, ice, or other foreign matter.
- B. Ship and store reinforcement with bars of the same size and shape fastened in bundles with durable tags, marked in a legible manner with waterproof markings showing the same "mark" designations as those shown on the submitted placement drawings. Tags for ASTM A706 reinforcing and for ASTM A615 reinforcing meeting the requirements of Paragraph 2.01.C.1 shall indicate that the reinforcing is weldable.
- C. Store reinforcement off the ground, protect from moisture and keep free from rust, mud, dirt, grease, oil, ice, or other injurious contaminants.

## PART 2 PRODUCTS

### 2.01 MATERIALS

- A. Provide new materials of domestic manufacture complying with the following material specifications.
- B. Deformed Concrete Reinforcing Bars: ASTM A615, Grade 60 deformed bars.
- C. Deformed Concrete Reinforcing Bars required on the Drawings to be Field Bent or Welded: ASTM A706.
  - 1. ASTM A615, Grade 60 may be substituted for ASTM A706 subject to the following:
    - a. The actual yield strength of the reinforcing steel based on mill tests does not exceed the specified yield strength by more than 18,000 psi. Retests not to exceed this value by more than an additional 3,000 psi.
    - b. The ratio of the actual ultimate tensile strength to the actual tensile yield strength of the reinforcement is not less than 1.25.
    - c. The carbon equivalency (CE) is 0.55 percent or less.
- D. Welded Steel Wire Fabric: ASTM A185. Provide in flat sheets.
- E. Welded Deformed Steel Wire Fabric: ASTM A497.
- F. Reinforcing Steel Accessories
  - 1. Plastic Protected Wire Bar Supports: CRSI Bar Supports, Class 1 - Maximum Protection.
  - 2. Stainless Steel Protected Wire Bar Supports: CRSI Bar Supports, Class 2 - Moderate Protection with legs made wholly from stainless steel wire.
  - 3. Precast Concrete Bar Supports: CRSI Bar Supports, Precast Concrete Bar Supports. Precast concrete blocks that have equal or greater strength than the surrounding concrete.
- G. Tie Wire
  - 1. Tie Wires for Reinforcement: 16-gauge or heavier black annealed wire.
- H. Mechanical Reinforcing Steel Coupling System
  - 1. Use only where indicated. Mechanical reinforcing steel coupling system shall be positive connecting taper threaded type employing a hexagonal coupler such as Lenton Lock rebar splices as manufactured by Erico Products Inc., Solon, OH or approved equal. Coupling system shall meet all ACI 318/350 requirements. Bar ends must be taper threaded with coupler manufacturer's bar threader to ensure proper taper and thread engagement. Provide with cap on female end to exclude dirt, debris and wet concrete. Couplers shall be torqued to manufacturer's recommended value.

2. Unless otherwise noted on the Drawings, mechanical reinforcing steel coupling system shall produce a splice strength in tension or compression of not less than 125 percent of the ASTM specified minimum yield strength of the reinforcing bar. Base yield strength on Grade 60 reinforcing unless otherwise indicated or specified.
3. Compression type mechanical splices shall provide concentric bearing from one bar to the other bar.

I. Fiber Reinforcement

1. Synthetic reinforcing fibers for concrete grout shall be 100 percent polypropylene collated, fibrillated fibers, Fibermesh 300 as manufactured by Propex Concrete Systems Corp, Chattanooga, TN, or equal. Fiber length and quantity for the concrete grout mix shall be in strict compliance with the manufacturer's recommendations and as approved by the Engineer.
2. Alternatively, virgin cellulose fiber reinforcing may be substituted for use in concrete grout applications. The fiber material shall be Ultrafiber 500 by Buckeye Technologies or an approved equal conforming to ASTM D7357. Fiber application rate shall be in strict compliance with the manufacturer's recommendations and as approved by the Engineer.

J. Form Savers

1. Form savers are to be used only where shown in the Drawings or where approved, in writing, by the Engineer. Form savers shall be a Lenton Form Saver by Erico Products Inc., Solon, OH or approved equal.

2.02 FABRICATION

- A. Comply with the CRSI Manual of Standard Practice.
- B. Bend bars cold. Do not straighten or rebend bars.
- C. Bend bars around a revolving collar having a diameter not less than that recommended by the CRSI or ACI 318/350.
- D. Saw cut bar ends that are to be butt spliced, placed through limited diameter holes in metal, or threaded. Terminate saw cut ends in flat surfaces within 1-1/2 degrees of a right angle to the axis of the bar.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Comply with the CRSI Manual of Standard Practice for surface condition, bending, spacing and tolerances of placement for reinforcement. Provide the amount of reinforcing indicated at the spacing and clearances indicated on the Drawings.
- B. Determine clear concrete cover based on exposure to the environment. Unless indicated otherwise on the Drawings, provide the following minimum clear concrete cover over reinforcement:

1. Concrete cast against and permanently exposed to earth: 3-in
2. Concrete exposed to soil, water, chemicals, and/or weather:
  - a. Slabs (top and bottom cover), walls: 2-in
  - b. Beams and columns (ties, spirals and stirrups): 2-in
3. Concrete not exposed to soil, water, sewage, sludge and/or weather:
  - a. Slabs (top and bottom cover [#11 bars and smaller]), walls: 3/4-in
  - b. Beams and columns (ties, spirals and stirrups): 1-1/2-in

For conditions or elements not described above, refer to Chapter 7 in ACI 318/350.

- C. Coat uncoated reinforcement which will be exposed for more than 60 days after placement with a heavy coat of neat cement slurry.
- D. Do not weld reinforcing steel bars either during fabrication or erection unless indicated on the Drawings or as specified herein, or unless prior written approval has been obtained from the Engineer. Remove immediately all bars that have been welded, including tack welds, without such approval. Comply with AWS D1.4 when welding of reinforcement is shown on the Drawings, specified, or approved.
- E. Reinforcing steel interfering with the location of other reinforcing steel, piping, conduits or embedded items may be moved within the specified tolerances or one bar diameter, whichever is greater. Obtain the approval of the Engineer if greater displacement of bars to avoid interference is needed. Do not cut reinforcement to install inserts, conduits, mechanical openings or other items without the prior approval of the Engineer.
- F. Secure, support and tie reinforcing steel to prevent movement during concrete placement. Secure dowels in place before placing concrete.
- G. Do not field bend reinforcing unless indicated or specifically authorized in writing by the Engineer. Cold-bend bars indicated or authorized to be field bent around the standard diameter spool specified in the CRSI. Do not heat bars. Closely inspect the reinforcing steel for breaks. Replace, repair by cutting out damaged bars and splicing new bars using coupling sleeves filled with ferrous material, or otherwise repair damaged reinforcing bars as directed by the Engineer at no additional cost to the UTILITY. Do not bend reinforcement after it is embedded in concrete.

### 3.02 REINFORCEMENT AROUND OPENINGS

- A. Provide additional reinforcing steel on each side of the opening equivalent to one half of the cross-sectional area of the reinforcing steel interrupted by the opening unless indicated otherwise on the Drawings. Extend each end of each bar beyond the edge of the opening or penetration by the tension development length for that bar size.

### 3.03 SPLICING OF REINFORCEMENT

- A. Provide splices as shown on the Drawings and as specified herein.
- B. Splices Indicated as Compression Splices: Provide lap splice of 30 bar diameters, but not less than 12-in unless indicated otherwise on the Drawings. Base the lap splice length for column vertical bars on the bar size in the column above.
- C. All Other Splices: Provide tension lap splices in compliance with ACI 318/350. Stagger splices in adjacent bars where possible. Provide Class B tension lap splices at all locations unless otherwise indicated.
- D. Tension Members: Avoid splicing of reinforcing steel in concrete elements indicated as "tension members." However, if splices are required for constructability, splices in the reinforcement subject to direct tension shall be butted and joined with complete penetration welds or mechanical splices as indicated in 2.01.H to develop, in tension, at least 125 percent of the specified yield strength of the bar. Offset splices in adjacent bars the distance of a Class B splice or 30-in, whichever is greater.
- E. Lap splices in welded wire fabric in accordance with the requirements of ACI 318/350 but not less than 12-in. Tie the spliced fabrics together with wire ties spaced not more than 24-in on center and lace with wire of the same diameter as the welded wire fabric. Offset splices in adjacent widths to prevent continuous splices.
- F. Mechanical reinforcing steel coupling system shall be used only where shown on the Drawings. Offset splices in adjacent bars by at least 30 bar diameters. Mechanical reinforcing steel coupling system is only to be used for special splice and dowel conditions approved by the Engineer.

### 3.04 ACCESSORIES

- A. Determine, provide and install accessories such as chairs, chair bars and the like to support the reinforcement providing the spacing and clearances indicated on the Drawings and prevent its displacement during the erection of the reinforcement and the placement of concrete.
- B. Use precast concrete blocks where the reinforcing steel is to be supported over soil.
- C. Use plastic protected bar supports or steel supports with plastic tips where the reinforcing steel is to be supported on forms for a concrete surface that will be exposed to weather, high humidity, or liquid (including bottom of slabs over liquid containing areas). Use stainless steel protected bar supports in walls, beams and elevated slabs. Use stainless steel supports or plastic tipped metal supports in all other locations unless otherwise noted on the Drawings or specified herein.
- D. Provide #5 minimum size support bars. Do not reposition upper bars in a bar mat for use as support bars.
- E. Alternate methods of supporting top steel in slabs, such as steel channels supported on the bottom steel or vertical reinforcing steel fastened to the bottom and top mats, may be used if approved by the Engineer.

### 3.05 INSPECTION

- A. The UTILITY or the registered design professional in responsible charge acting as the UTILITY's agent shall employ one or more special inspectors to provide inspections during construction.
- B. Special inspection shall be performed in accordance with Section 1704.4 and table 1704.4 of the IBC.
- C. The Engineer shall be notified when the forms are complete and ready for inspection at least 6 hours prior to the proposed concrete placement.
- D. In no case shall any reinforcing steel be covered with concrete until the installation of the reinforcement, including the size, quantity, spacing and position of the reinforcement has been observed by the Engineer and the Engineer's release to proceed with the concreting has been obtained. The Engineer shall be given ample prior notice of the readiness of placed reinforcement for observation. The forms shall be kept open until the Engineer has finished his/her observations of the reinforcing steel.

END OF SECTION

## SECTION 03 3300

### CAST-IN-PLACE CONCRETE

#### PART 1 GENERAL

##### 1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required and install cast-in-place concrete complete as shown on the Drawings and as specified herein.
- B. Furnish, as required to establish concrete mixes, all sampling and laboratory testing of products and materials performed by an independent testing laboratory engaged by and at the expense of the CONTRACTOR. Any field sampling, testing, inspection and related tests will be provided by the CONTRACTOR.

##### 1.02 RELATED WORK

- A. Concrete formwork is included in Section 03\_3100.
- B. Concrete reinforcement is included in Section 03\_3200.
- C. Miscellaneous metals are included in Section 05\_5000.

##### 1.03 SUBMITTALS

- A. Submit, in accordance with Section 01\_3000, product data and information for:
  - 1. Sources of cement, fly ash, aggregates, and batched concrete.
  - 2. Air-entraining admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM standards.
  - 3. Water reducing admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM standards.
  - 4. Sheet curing material. Product data including catalogue cut, technical data and conformity to ASTM standard.
  - 5. Material Safety Data Sheets (MSDS) for all concrete components and admixtures.
  - 6. High-range water-reducing admixture (plasticizer). Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, retarding effect, slump range and conformity to ASTM standards. Identify proposed locations of use.
  - 7. Liquid curing compound. Product data including catalogue cut, technical data, storage requirements, product life, application rate and conformity to ASTM standards. Identify proposed locations of use.

8. Procedures for mass concrete placement as defined in Section 3.06.9.
9. Cold and hot weather concrete placement procedures in accordance with Section 3.07.D and 3.07.E, respectively.

B. Samples

1. Fine and coarse aggregates if requested for examination by the Engineer.

C. Test Reports

1. Aggregates: Conformance to ASTM standards, including sieve analysis, mechanical properties, deleterious substance content, and mortar bar expansion test results.
2. Cement and fly ash: Conformance to ASTM standards, including chemical analysis and physical tests.
3. Concrete mixes: For each formulation of concrete proposed for use, submit constituent quantities per cubic yard, water cementitious ratio, air content, concrete slump, type and manufacturer of cement and type and manufacturer of fly ash. Provide either Paragraph a. or b., below, for each mix proposed.
  - a. Standard deviation data for each proposed concrete mix based on statistical records.

Provide the following for each strength data point used in the calculation of the standard deviation for determination of the minimum required average strength:

- i. Date of sampling and name of testing laboratory.
- ii. Name of concrete batch plant.
- iii. Water cementitious ratio.
- iv. Slump of batch.
- v. Air content of batch.
- vi. Compressive strengths of all cylinders tested at that age in that batch.
- vii. If available, temperature and unit weight of batch.

Provide data from projects not more strictly controlled than outlined in these specifications. Provide summary sheet showing all pertinent data and the computation of the standard deviation. Test results shall be within the previous 12-months.

- b. Water cementitious ratio curve for concrete mixes based on laboratory tests. Provide average cylinder strength test results at 7 and 28 days for laboratory concrete mix designs. Provide results of 14 day tests if available. Test results shall be within the previous 12-months.
4. Mix Water: Submit test reports verifying conformance with ASTM C1602 for all non-potable water used as mixing water in concrete mix designs specified herein. This requirement can be neglected if potable water sources are used as mixing water.

D. Certifications

1. Certify that admixtures used in the same concrete mix are compatible with each other and the aggregates.



2. Certify that the CONTRACTOR is not associated with the independent testing laboratory proposed for use by the CONTRACTOR nor does the CONTRACTOR or officers of the CONTRACTOR's organization have a beneficial interest in the laboratory.
3. Certificate of conformance for concrete production facilities from the NRMCA.

E. Qualifications

1. Independent Testing Laboratory
  - a. Name and address
  - b. Names and positions of principal officers and the name, position, and qualifications of the responsible registered professional engineer in charge.
  - c. Listing of technical services to be provided. Indicate external technical services to be provided by other organizations.
  - d. Names and qualifications of the supervising laboratory technicians.
  - e. Statement of conformance provided by evaluation authority defined in ASTM C1077. Provide report prepared by evaluation authority when requested by the Engineer.
  - f. Submit as required above for other organizations that will provide external technical services.

1.04 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
1. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
  2. ASTM C33 - Standard Specification for Concrete Aggregates.
  3. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
  4. ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
  5. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
  6. ASTM C138 – Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
  7. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.
  8. ASTM C150 - Standard Specification for Portland Cement.

9. ASTM C156 - Standard Test Method for Water Retention by Liquid Membrane-Forming Curing Compound for Concrete.
10. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete.
11. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
12. ASTM C192 – Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
13. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
14. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
15. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
16. ASTM C311 - Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for use in Portland Cement Concrete.
17. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
18. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
19. ASTM C1077 - Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.
20. ASTM C1260 - Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
21. ASTM C1602 - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
22. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.

B. American Concrete Institute (ACI).

1. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.
2. ACI 232.2R - Use of Fly Ash in Concrete.
3. ACI 304R - Guide for Measuring, Mixing, Transporting and Placing Concrete.
4. ACI 304.2R - Placing Concrete by Pumping Methods.
5. ACI 305R - Hot Weather Concreting.

6. ACI 306R - Cold Weather Concreting.
  7. ACI 318 - Building Code Requirements for Structural Concrete and Commentary.
  8. ACI 350 - Code Requirements for Environmental Engineering Concrete Structures and Commentary.
- C. National Ready Mixed Concrete Association (NRMCA)
1. Quality Control Manual, Section 3 - Certification of Ready Mixed Concrete Production Facilities.
- D. 2006 International Building Code (IBC).
- E. Truck Mixer Manufacturers Bureau (TMMB)
1. TMMB 100 - Truck Mixer, Agitator and Front Discharge Concrete Carrier Standards.
- F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

#### 1.05 QUALITY ASSURANCE

- A. Comply with ACI 318/ACI 350, as applicable, and other stated specifications, codes and standards. Apply the most stringent requirements of other stated specifications, codes, standards, and this Section when conflicts exist.
- B. Independent testing laboratory shall meet the requirements of ASTM E329 and ASTM C1077 and be acceptable to the Engineer. Laboratories affiliated with the CONTRACTOR or in which the CONTRACTOR or officers of the CONTRACTOR's organization have a beneficial interest are not acceptable.
- C. Use only one source of cement and aggregates for the project. Provide concrete uniform in color and appearance.
- D. If, during the progress of the work, it is impossible to secure concrete of the specified workability and strength with the materials being furnished, the Engineer may order such changes in proportions or materials, or both, as may be necessary to secure the specified properties. Make all changes so ordered at no additional cost to the UTILITY.
- E. If, during the progress of the work, the materials from the sources originally accepted change in characteristics, make, at no additional cost to the UTILITY, new acceptance tests of materials and establish new concrete mixes with the assistance of an independent testing laboratory.
- F. All field testing and inspection services and related laboratory tests required will be provided by the CONTRACTOR. The cost of such work will be paid for by the CONTRACTOR. Methods of testing will comply with the latest applicable ASTM methods. The following items will be tested by the CONTRACTOR to verify conformity with this Section.
- G. Provide field testing and inspection services and related laboratory tests. Methods of testing shall comply with the latest applicable ASTM methods. The following items shall be tested to verify conformity with this Section.

1. Concrete placements - compressive strength (cylinders), compressive strength (cores), slump, and air content.
2. Other materials that may require field testing.

#### 1.06 DELIVERY, STORAGE AND HANDLING

- A. Cement: Store in weathertight buildings, bins or silos to provide protection from dampness and contamination and to prevent warehouse set.
- B. Aggregate: Arrange and use stockpiles to prevent segregation or contamination with other materials or with other sizes of like aggregates. Build stockpiles in successive horizontal layers not exceeding three feet in thickness. Complete each layer before the next is started. Do not use frozen or partially frozen aggregate.
- C. Sand: Arrange and use stockpiles to prevent contamination. Allow sand to drain to a uniform moisture content before using. Do not use frozen or partially frozen sand.
- D. Admixtures: Store in closed containers to prevent contamination, evaporation or damage. Provide agitating equipment to uniformly disperse ingredients in admixture solutions which tend to separate. Protect liquid admixtures from freezing and other temperature changes which could adversely affect their characteristics.
- E. Fly Ash: Store in weathertight buildings, bins or silos to provide protection from dampness and contamination.
- F. Sheet Curing Materials: Store in weathertight buildings or off the ground and under cover.
- G. Liquid Curing Compounds: Store in closed containers.

### PART 2 PRODUCTS

#### 2.01 GENERAL

- A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. Like items of materials shall be the end products of one manufacturer in order to provide standardization for appearance, maintenance and manufacturer's service.

#### 2.02 MATERIALS

- A. Materials shall comply with this Section and any applicable State or local requirements.
- B. Cement: Domestic portland cement conforming to ASTM C150. Cement shall be low alkali cement. Do not use air entraining cements. Cement brand must be approved by the Engineer and one brand shall be used throughout the work. Provide the following type(s) of cement:
  1. Class A, and B Concrete - Type I/II; or Type II

2. Class A, and B Concrete - Type I, I/II or Type II with the addition of fly ash resulting in C<sub>3</sub>A being below 8 percent of total cementitious content.
  3. Type III cement, limited to 8 percent C<sub>3</sub>A, may be used for Class A and/or Class B concrete, subject to approval by the Engineer, where high-early strength concrete is deemed necessary.
- C. Aggregates:
1. Fine Aggregate: Washed inert natural sand conforming to ASTM C33.
  2. Coarse Aggregate: Well-graded crushed stone or washed gravel conforming to ASTM C33. Grading requirements as listed in ASTM C33, Table 2 for the specified coarse aggregate size number listed in Table 1 herein. Limits of deleterious substances and physical property requirements as listed in ASTM C33, Table 3 for severe weathering regions. Do not use coarse aggregates known to be deleteriously reactive with alkalis in cement.
  3. The fine and coarse aggregates used shall not cause expansion of mortar bars greater than 0.1 percent in 16 days when tested in accordance with ASTM C1260 and using the cement proposed for the project. If aggregates proposed for use do not meet this requirement, then satisfy either a. or b. below.
    - a. Total equivalent alkali content of the cement used shall not exceed 0.60 percent as provided in the Optional Chemical Requirements of ASTM C150.
    - b. The fine and coarse aggregates used shall not cause expansion of mortar bars greater than 0.1 percent in 16 days when tested in accordance with ASTM C1260 and using the cement and fly ash proposed for the project. The proportions of the cement-fly ash mix shall be the same as those proposed for the project.
- D. Water: Potable water free of oil, acid, alkali, salts, chlorides (except those attributable to drinking water), organic matter, or other deleterious substances. Non-potable water may be used where compliance with the requirements ASTM C1602 are shown to be satisfied. See also Item 1.03.C.4 above.
- E. Admixtures: Use admixtures free of chlorides and alkalis (except for those attributable to drinking water). The admixtures shall be from the same manufacturer when it is required to use more than one admixture in the same concrete mix. Use admixtures compatible with the concrete mix including other admixtures and made for use in concrete in contact with potable water after 30 days of concrete curing.
1. Air Entraining Admixture: Conforming to ASTM C260. Proportion and mix in accordance with manufacturer's recommendations.
  2. Water Reducing Admixture: Conforming to ASTM C494, Type A. Proportion and mix in accordance with manufacturer's recommendations.
  3. High-Range Water-Reducing Admixtures (Plasticizer): Conforming to ASTM C494, Type F resulting in non-segregating plasticized concrete with little bleeding and with the physical properties of low water/cementitious ratio concrete. The treated concrete shall be capable of maintaining its plastic state in excess of 2 hours. Proportion and mix in accordance with manufacturer's recommendations.

4. Do not use admixtures causing retarded or accelerated setting of concrete without written approval from the Engineer. Use retarding or accelerating water reducing admixtures when so approved.
- F. Fly Ash: Class F fly ash complying with ASTM C618, including the requirements of Table 1 but with the Loss of Ignition (LOI) limited to 3 percent maximum. Test in compliance with ASTM C311 with a minimum of one sample weighing four pounds taken from each 200 tons of fly ash supplied for the project.
- G. Sheet Curing Materials: Waterproof paper, polyethylene film or white burlap-polyethylene sheeting, all conforming to ASTM C171.
- H. Liquid Curing Compound. Liquid membrane-forming curing compound conforming to ASTM C309, Type 1-D (clear or translucent with fugitive dye) and containing no wax, paraffin, or oil. Curing compound shall comply with Federal, State and local VOC limits. Liquid curing compounds shall not impair the bond of any specified coatings or sealants to be applied to the concrete following curing.
  1. Curing compounds to be used for liquid containing structures shall be NSF 61 approved, be non-yellowing, and have a unit moisture loss no greater than  $0.055 \text{ gm/cm}^2$  at 72 hours, as measured by ASTM C156.
    - a. Liquid curing compound shall be E-Cure by SpecChem LLC, or approved equal.
  2. Liquid curing compounds for non liquid containing structures shall have a minimum of 18 percent solids, be non-yellowing, and have a unit moisture loss no greater than  $0.055 \text{ gm/cm}^2$  at 72 hours, as measured by ASTM C156.
    - a. Liquid curing compound shall be Super Aqua-Cure Vox by Euclid Chemical Company, or approved equal.

### 2.03 MIXES

- A. An independent testing laboratory engaged by and at the expense of the CONTRACTOR shall establish concrete mixes and perform all sampling and laboratory testing of products and materials.
- B. Select proportions of ingredients to meet the design strength and materials limits specified in Table 1 and to produce workable, durable concrete conforming to these specifications. Proportion ingredients to produce a homogenous mixture which will readily work into corners and angles of forms and around reinforcement without permitting materials to segregate or allowing free water to collect on the surface.
- C. Base concrete mixes on standard deviation data of prior mixes with essentially the same proportions of the same constituents or, if not available, develop concrete mixes by laboratory tests using the materials proposed for the work.
  1. For concrete mixes based on standard deviation data of prior mixes, submit standard deviation data of prior mixes with essentially the same proportions of the same constituents in accordance with ACI 318/350 and based on the modification factors for standard deviation tests contained in ACI 318/350.

2. For concrete mixes developed by laboratory testing, base cementitious content of the concrete on curves showing the relation between water cementitious ratio and 7 and 28 day compressive strengths of concrete made using the proposed materials. Determine curves by four or more points, each representing an average value of at least three test specimens and one water-cementitious ratio at each age. Provide curves with a range of values sufficient to yield the desired data, including the compressive strengths specified, without extrapolation. The cementitious content of the concrete mixes to be used, as determined from the curve, shall correspond to the required average compressive strength in Table 5.3.2.2 of ACI 318/350 as applicable. The resulting mix shall not conflict with the limiting values for maximum water cementitious ratio and net minimum cementitious content specified in Table 1.
- D. Test the fly ash and concrete mixture to provide test data confirming that the fly ash in combination with the cement to be used meets all strength requirements and is compatible with the other concrete additives.
  - E. Compression Tests: Provide testing of the proposed concrete mixes to demonstrate compliance with the compression strength requirements in conformity with the provisions of ACI 318/350.
  - F. Entrained air, as measured by ASTM C231, shall be as shown in Table 1.
    1. If the air entraining agent proposed for use in the mix requires testing methods other than ASTM C231 to accurately determine air content, make special note of this requirement in the admixture submittal specified under Paragraph 1.03.
  - G. Slump of the concrete as measured by ASTM C143, shall be as shown in Table 1. If a high-range water-reducing admixture (plasticizer) is used, the slump indicated shall be that measured before plasticizer is added. Plasticized concrete shall have a slump ranging from 7 to 10-in.
  - H. Proportion admixtures according to the manufacturer's recommendations. Two or more admixtures specified may be used in the same mix provided that the admixtures in combination retain full efficiency and have no deleterious effect on the concrete or on the properties of the other admixture(s).

TABLE 1  
CONCRETE MIX REQUIREMENTS

Class	Design Strength <sup>(1)</sup>		Coarse Aggregate	Cementitious Content <sup>(4)</sup>		
	Cement <sup>(2)</sup>					
A	4500	C150	67	535 min.		
B	3000	C150	67	560 min.		
Class	W/C Ratio <sup>(5)</sup>	Fly Ash <sup>(6)</sup>	AE Range <sup>(7)</sup>	WR <sup>(8)</sup>	HRWR <sup>(9)</sup>	Slump Range (in)
A	0.42 max.	-	3.5 to 5	Yes	Yes	3-5
B	0.54 max.	-	3.5 to 5	Yes	Yes	4-6

Notes:

- (1) Minimum compressive strength in psi at 28 days.
- (2) ASTM Designation; Type as specified in Section 2.02.B
- (3) Size Number in ASTM C33
- (4) Cementitious content in lb/yd<sup>3</sup>, (where fly ash is used cementitious content is defined as cement content plus fly ash content)
- (5) W/C is Water-Cementitious ratio by weight

TABLE 1  
CONCRETE MIX REQUIREMENTS

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- (6) Fly ash not allowed for this mix
- (7) AE is percent air-entrainment
- (8) WR is water-reducer admixture
- (9) HRWR is high-range water-reducer admixture; adjust W/C ratio accordingly

### PART 3 EXECUTION

#### 3.01 MEASURING MATERIALS

- A. Provide concrete composed of portland cement, fly ash, fine aggregate, coarse aggregate, water and admixtures as specified and produced by a plant complying with ACI 318/350 and ASTM C94. Batch all constituents, including admixtures, at the plant. High-range water reducing admixtures may be added in the field.
- B. Measure materials for batching concrete by weighing in conformity with and within the tolerances given in ASTM C94 except as otherwise specified. Use scales last certified by the local Sealer of Weights and Measures within one year of use.
- C. Weigh cement and fly ash in individual weigh batchers that are separate and distinct from the weigh batchers used for other materials. When cement and fly ash are weighed in a cumulative weigh batcher, the cement shall be weighed first.
- D. Measure the amount of free water in fine aggregates within 0.5 percent with a moisture meter. Compensate for varying moisture contents of fine aggregates. Record the number of gallons of water as-batched on printed batch tickets.
- E. Dispense admixtures either manually using calibrated containers or measuring tanks, or by means of an automatic dispenser approved by the manufacturer of the specific admixture.
  - 1. Charge air-entraining and chemical admixtures into the mixer as a solution using an automatic dispenser or similar metering device.
  - 2. Inject multiple admixtures separately during the batching sequence.

#### 3.02 MIXING AND TRANSPORTING

- A. Provide ready-mixed concrete produced by equipment complying with ACI 318/350 and ASTM C94 and produced by a plant certified by the NRMCA. Do not hand-mix. All truck mixers shall carry a rating plate conforming to TMMB 100. Clean each transit mix truck drum and reverse drum rotation before the truck proceeds under the batching plant. Equip each transit-mix truck with a continuous, nonreversible, revolution counter showing the number of revolutions at mixing speeds.
- B. Transport ready-mix concrete to the site in watertight agitator or mixer trucks loaded not in excess of their rated capacities as stated on the name plate.
- C. Keep the water tank valve on each transit truck locked at all times. Any addition of water must be directed by the Engineer. Incorporate water directed to be added by additional mixing of at least 50 revolutions at mixing speed after the addition of all water. Meter all added water and show the amount of water added on each delivery ticket.



- D. Comply with ACI 318/350 and ASTM C94 for all central plant and rolling stock equipment and methods.
- E. Select equipment of size and design to provide continuous flow of concrete at the delivery end. Use metal or metal-lined non-aluminum discharge chutes with slopes not exceeding one vertical to two horizontal and not less than one vertical to three horizontal. Chutes more than 20-ft long and chutes not meeting slope requirements may be used if concrete is discharged into a hopper before distribution.
- F. Do not re-temper (mix with or without additional cement, aggregate, or water) concrete or mortar which has partially hardened.
- G. Handle concrete from mixer to placement providing concrete of specified quality in the placement area and not exceeding the maximum time interval specified in Paragraph 3.02 I.4. Dispatch trucks from the batching plant so they arrive at the work site just before the concrete is required to avoid excessive mixing of concrete while waiting or delays in placing successive layers of concrete in the forms. Remix for a minimum of 5 minutes prior to discharge or testing.
- H. Furnish a delivery ticket for ready mixed concrete to the Engineer as each truck arrives. Provide a printed record of the weight of cement and each aggregate as batched individually on each ticket. Use the type of indicator that returns for zero punch or returns to zero after a batch is discharged. Indicate for each batch the weight of fine and coarse aggregate, cement, fly ash, and water, moisture content of fine and coarse aggregate at time of batching, and types, brand and quantity of each admixture, the quantity of concrete delivered, the time any water is added and the amount, and the numerical sequence of the delivery. Show the time of day batched and time of discharge from the truck. Indicate the number of revolutions of transit mix truck.
- I. Temperature and Mixing Time Control
  - 1. In cold weather (see Paragraph 3.07D) maintain the as-mixed temperature of the concrete and concrete temperatures at the time of placement in the forms as indicated in Table 3.
  - 2. If water or aggregate has been heated, combine water with aggregate in the mixer before cement is added. Do not add cement to mixtures of water and aggregate when the temperature of the mixture is greater than 90 degrees F.
  - 3. In hot weather (see Paragraph 3.07E), cool ingredients before mixing to maintain temperature of the concrete below the maximum placing temperature of 90 degrees F. Well-crushed ice may be substituted for all or part of the mixing water.
  - 4. The maximum time interval between the addition of mixing water and/or cement to the batch and the final placing of concrete in the forms shall not exceed the following:

TABLE 2

<u>CONCRETE TEMPERATURE</u>	<u>MAXIMUM TIME</u>
(27 Degree C) 80 Degree F to 90 Degree F (32 Degree C)	45 minutes
(21 Degree C) 70 Degree F to 79 Degree F (26 Degree C)	60 minutes
(5 Degree C) 40 Degree F to 69 Degree F (20 Degree C)	90 minutes

If an approved high-range water-reducing admixture (plasticizer) is used to produce plasticized concrete, the maximum time interval shall not exceed 90 minutes.

### 3.03 INSPECTION AND COORDINATION

- A. Batching, mixing, transporting, placing, and curing of concrete shall be subject to the inspection of the Engineer at all times. Advise the Engineer of readiness to proceed at least six working hours prior to each concrete placement. The Engineer will inspect the preparations for concreting including the preparation of previously placed concrete, the reinforcing and the alignment, cleanliness, and tightness of formwork. Do not place concrete without the inspection and acceptance of the Engineer.
- B. See also the requirements in Section 3.11 below.

### 3.04 EMBEDDED ITEMS

- A. Secure to forms as required or set for embedment as required, all miscellaneous metal items, sleeves, reglets, anchor bolts, anchors, inserts and other items furnished under other Sections and required to be embedded into concrete. Set and secure such items in the locations and alignments needed so they are not displaced by concrete placement.
- B. Clean embedded items free of rust, mud, dirt, grease, oil, ice, or other injurious contaminants.
- C. Coat or isolate all aluminum embedments to prevent aluminum-concrete reaction or electrolytic action between aluminum and steel.
- D. Do not embed piping in concrete unless shown on the Drawings.
- E. Do not embed electrical conduits in concrete unless shown on the Drawings.
- F. Pipes and conduits embedded within a slab or wall (other than those merely passing through) shall satisfy the following, unless otherwise shown on the Drawings or approved:
  - a. Maximum outside dimension of pipe or conduit shall not be greater than one third the overall thickness of the slab or wall.
  - b. Spacing of pipes or conduits shall be greater than or equal to three diameters or widths on center.
  - c. Fabricate piping and conduit such that the cutting, bending, or relocation of reinforcing steel is not required.
- G. Close open ends of piping, conduits, and sleeves embedded in concrete with caps or plugs prior to placing concrete.
- H. Ensure specified tests on embedded piping are completed and satisfactory before starting concrete placement. Ensure all mechanical or electrical tests and inspections are completed and satisfactory prior to starting concrete placement.
- I. Check location, alignment, and support of piping, electrical conduits, and other items fully or partially embedded before depositing concrete. Correct mis located and misaligned items and secure items which have become loose.

- J. Position embedded anchor bolts using templates.
- K. Correct all embedded items not installed in the location or alignment needed or displaced by concrete placement at no additional cost to the UTILITY.

### 3.05 CONCRETE APPEARANCE

- A. Remix concrete showing either poor cohesion or poor coating of the coarse aggregate with paste. Reject remixed concrete showing either poor cohesion or poor coating of the coarse aggregate with paste. Make, at no additional cost to the UTILITY, changes in the concrete mix design for future deliveries only by adjusting one or more of the following if the slump is within the allowable limit, but excessive bleeding, poor workability, or poor finishing quality are observed:
  - 1. The gradation of aggregate.
  - 2. The proportion of fine and coarse aggregate.
  - 3. The percentage of entrained air, within the allowable limits.
- B. Provide concrete having a homogeneous structure which, when hardened, will have the specified strength, durability and appearance. Provide mixtures and workmanship such that concrete surfaces, when exposed, will require no finishing except as specified in Section 03350.

### 3.06 PLACING AND COMPACTING

- A. Placing
  - 1. Verify that all formwork completely encloses concrete to be placed and is securely braced prior to concrete placement. Remove ice, standing water, dirt, debris, and other foreign materials from forms and exposed joint surfaces. Confirm that reinforcement and other embedded items are securely in place. Have a worker at the location of the placement who can check that reinforcement and embedded items remain in designated locations and alignments while concrete is being placed. Sprinkle semi-porous subgrades or forms to eliminate suction of water from the mix. Do not place concrete on frozen subgrade, snow, or ice.
  - 2. Deposit concrete as near its final position as possible to prevent segregation due to rehandling or flowing. Place concrete continuously at a rate that allows the concrete previously placed to be integrated with fresh plastic concrete. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials or on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If the section cannot be placed continuously, place construction joints as specified or as approved.
  - 3. Pumping of concrete will be permitted. Use a mix design and aggregate sizes chosen for pumping and submit for approval. Do not use pipelines made of aluminum or aluminum alloy. When concrete is pumped, slump will be determined at point of truck discharge and air content will be determined at point of placement.

4. Remove temporary spreaders from forms when the spreader is no longer needed. Temporary spreaders may remain embedded in concrete only when made of galvanized steel or concrete and if prior approval has been obtained.
5. Do not place concrete for supported elements until concrete previously placed in the supporting element has attained design strength.
6. Where surface mortar is to form the base of a finish, especially surfaces designated to be painted, work coarse aggregate back from forms to bring the full surface of the mortar against the form. Prevent the formation of surface voids.
7. Slabs
  - a. After bulkheads, screeds and jointing materials have been positioned, place concrete continuously between joints beginning at a bulkhead, edge form, or corner. Place each batch into the edge of the previously placed concrete to avoid stone pockets and segregation.
  - b. Avoid delays in placement. If there is a delay in placement, spade and consolidate the concrete placed after the delay at the edge of the previously placed concrete to avoid cold joints. Bring concrete to correct level and strike off with a straightedge. Use bull- floats or darbies to smooth the surface, leaving it free of humps or hollows.
  - c. Where slabs are to be placed integrally with the walls below them, place the walls and compact as specified. Allow one hour to pass between placement of the wall and the overlying slab to permit consolidation of the wall concrete. Keep the top surface of the wall moist to prevent cold joints.
8. Formed Concrete
  - a. Place concrete in forms using tremie tubes taking care to prevent segregation. Maintain bottom of tremie tubes in contact with the concrete already placed. Do not permit concrete to drop freely more than 4-ft. Place concrete for walls in 12-in to 24-in lifts, keeping the surface horizontal. If a high-range water-reducing admixture is used do not permit concrete to drop freely more than 15-ft; maximum lift thickness not to exceed 7-ft.
9. Pads (Mass Concrete Placement)
  - a. Care shall be taken during placement of concrete pads that exceed two (2) feet in thickness to ensure that internal temperatures are controlled to minimize internal stresses due to a high heat of hydration. CONTRACTOR shall attempt to pour such slabs/pads on cool days and follow applicable hot weather placing and curing procedures to keep the placed concrete cool. CONTRACTOR shall submit to the Engineer a work plan describing the methods and procedures proposed to use for mass concrete placement and curing. Mass concrete placement shall not begin until the work plan is acceptable to the Engineer.
10. Bollards
  - a. Conform to requirements specified above for formed concrete and completely fill pipe with concrete as indicated.

## 11. Thrust Blocking and Anchor Collars

- a. Concrete for thrust blocks and anchor collars shall be placed against undisturbed soil. The excavation shall be hand shaped and free of loose material. Forms shall be used to confine the concrete in areas other than that part that is in contact with undisturbed soil in the direction of thrust.

## B. Compacting

1. Consolidate concrete by vibration and puddling, spading, rodding or forking so that concrete is completely worked around reinforcement, embedded items and openings and into corners of forms. Continuously perform puddling, spading, rodding and forking along with vibration of the placement to eliminate air or stone pockets which may cause honeycombing, pitting or planes of weakness.
2. Compact all concrete with mechanical vibrators. Do not order concrete until vibrators (including standby units in working order) are on the job.
3. Use mechanical vibrators having a minimum frequency of 8000 vibrations per minute. Insert vibrators and withdraw at points from 18-in to 30-in apart. Vibrate sufficiently at each insertion to consolidate concrete, generally from 5 to 15 seconds. Do not over vibrate so as to segregate. Keep standby vibrators on the site during concrete placing operations.
4. Concrete Slabs: Vibration for concrete slabs less than 8-in thick shall be by vibrating screeds. Vibration for concrete slabs 8-in and thicker shall be by internal vibrators and (optionally) with vibrating screeds. Place vibrators into concrete vertically. Do not lay vibrators horizontally or lay over.
5. Walls and Columns: Use internal vibrators (rather than form vibrators) unless otherwise approved by the Engineer. In general, for each vibrator needed to melt down (level) the batch at the point of discharge, one or more additional vibrators must be used to densify, homogenize and perfect the surface. Insert vibrators vertically at regular intervals, through the fresh concrete and slightly into the previous lift, if any.
6. Amount of Vibration: Use vibrators to consolidate properly placed concrete. Do not use vibrators to move or transport concrete in the forms. Continue vibration until:
  - a. Frequency of vibrator returns to normal.
  - b. Surface appears liquefied, flattened and glistening.
  - c. Trapped air ceases to rise.
  - d. Coarse aggregate has blended into surface, but has not disappeared.

## 3.07 CURING AND PROTECTION

- A. Protect all concrete work against injury from the elements and defacements of any nature during construction operations.
- B. Curing Methods

1. Curing Methods for Concrete Surfaces: Cure concrete to retain moisture and maintain a temperature of at least 50 Degrees F at the concrete surface for a minimum of seven days after placement. Use the following curing methods as specified:
  - a. Water Curing: Keep entire concrete surface wet by ponding, continuous sprinkling or covered with saturated burlap. Begin water curing as soon as concrete attains an initial set and maintain water curing 24 hours a day. Do not permit the surface of the concrete to dry out at any time during the curing period. Temperature of curing water shall be within 20 Degrees F of the concrete temperature.
  - b. Sheet Material Curing: Cover entire surface with sheet material. Anchor sheeting to prevent wind and air from lifting the sheeting or entrapping air under the sheet. Place and secure sheet as soon as initial concrete set occurs.
  - c. Liquid Membrane Curing: Apply over the entire concrete surface except as follows. Curing compound shall NOT be placed on any concrete surface where additional concrete or grout is to be placed, where concrete sealers or surface coatings are to be used, or where the concrete finish requires an integral floor product. Apply curing compound as soon as the free water on the surface has disappeared and no water sheen is visible, but not after the concrete is dry or when the curing compound can be absorbed into the concrete. Apply in compliance with the manufacturer's recommendations.
2. Specified applications of curing methods:
  - a. Slabs for Liquid Retaining Structures: Water curing only.
  - b. Slabs on Grade and Footings (not used to retain liquids): Water curing, sheet material curing, or liquid membrane curing.
  - c. Structural Slabs (other than Liquid Retaining Structures): Water curing or liquid membrane curing.
  - d. Horizontal Surfaces which will Receive Additional Concrete, Coatings, Grout or Other Material that Requires Bond to the substrate: Water curing.
  - e. Formed Surfaces: None if nonabsorbent forms are left in place seven days. Water curing if absorbent forms are used. Water curing if forms are removed prior to seven days. Sheet cure or liquid membrane cure if forms are removed prior to seven days. Exposed horizontal surfaces of formed walls or columns shall be water cured for seven days or until next placement of concrete is made.
  - f. Surfaces of Concrete Joints: Water curing or sheet material curing.
  - g. Mass placements: Water curing or sheet material curing.
- C. Protect finished surfaces and slabs from the direct rays of the sun to prevent plastic cracking, checking and crazing. Do not apply additional water to the surface of concrete to facilitate finishing.
- D. Cold Weather Concreting

1. For this Specification, "cold weather" is defined as a period when for more than three successive days, the average daily outdoor temperature drops below 40 degrees F. Calculate average daily temperature as the average of the highest and the lowest temperature during the period from midnight to midnight.
2. Batch, deliver, place, cure and protect concrete during cold weather in compliance with the recommendations of ACI 306R and the additional requirements of this Section.
3. Review the cold weather concreting plan at the preconstruction meeting. Include the methods and procedures for use during cold weather including the production, transportation, placement, protection, curing and temperature monitoring of the concrete and the procedures to be implemented upon abrupt changes in weather conditions or equipment failures.
4. The minimum temperature of concrete immediately after placement and during the protection period shall be as indicated in Table 3. The temperature of the concrete in place and during the protection period shall not exceed these values by more than 20 degrees F. Prevent overheating and non-uniform heating of the concrete.

TABLE 3

Concrete Temperatures  
Minimum Dimension of Section

	<u>&lt; 12-in</u>	<u>12 to 36-in</u>
Min. concrete temperature:	55 Degree F	50 Degree F

5. Protect concrete during periods of cold weather to provide continuous warm, moist curing (with supplementary heat when required by weather conditions) for a total of at least 350 degree-days of curing.
    - a. Degree-days are defined as the total number of 24 hour periods multiplied by the weighted average daily air temperature at the surface of the concrete (e.g., 7 days at an average 50 degrees F = 350 degree-days).
    - b. To calculate the weighted average daily air temperature, sum hourly measurements of the air temperature in the shade at the surface of the concrete taking any measurement less than 50 degrees F as 0 degrees F. Divide the sum thus calculated by 24 to obtain the weighted average temperature for that day.
  6. Do not use salt, manure or other chemicals for protection.
  7. At the end of the protection period, allow the concrete to cool gradually to the ambient temperature. If water curing has been used, do not expose concrete to temperatures below those shown in Table 3 until at least 24 hours after water curing has been terminated and air dry concrete for at least 3 days prior to first exposure to freezing temperatures.
  8. During periods not defined as cold weather, but when freezing temperatures are expected or occur, protect concrete surfaces from freezing for the first 24 hours after placing.
- E. Hot Weather Concreting

1. For this Specification, "hot weather" is defined as any combination of high air temperatures, low relative humidity and wind velocity which produces a rate of evaporation as estimated in ACI 305R, approaching or exceeding 0.2 pounds per square foot per hour (lb/sq ft/hr).
2. Batch, deliver, place, cure and protect concrete during hot weather in compliance with the recommendations of ACI 305R and the additional requirements of this Section.
  - a. Temperature of concrete being placed shall not exceed 90 degrees F. Maintain a uniform concrete mix temperature below this level. The temperature of the concrete shall not cause loss of slump, flash set or cold joints.
  - b. Promptly deliver concrete to the site and promptly place the concrete upon its arrival at the site, not exceeding the maximum time interval specified in Paragraph 3.02.I.4. Provide vibration immediately after placement.
  - c. The Engineer may direct the CONTRACTOR to immediately cover concrete with sheet curing material.
3. Review the hot weather concreting plan at the preconstruction meeting. Include the methods and procedures for use during hot weather including production, placement, and curing.

### 3.08 REMOVAL OF FORMS

- A. Do not remove forms before the concrete has attained a strength of at least 70 percent of its specified design strength for beams and slabs and at least 30 percent of its specified design strength for walls and vertical surfaces, nor before reaching the following number of day-degrees of curing (whichever is the longer):

TABLE 4

<u>Forms for</u>	<u>Degree Days</u>
Beams and slabs	500
Walls and vertical surfaces	100

(See definition of degree-days in Paragraph 3.07D).

- B. Do not remove shores until the concrete has attained at least 70 percent of its specified design strength and also sufficient strength to support safely its own weight and the construction live loads upon it.
- C. In cold weather, when temperature of concrete exceeds ambient air temperature by 20 Degrees F at the end of the protection period, loosen forms and leave in place for at least 24 hours to allow concrete to cool gradually to ambient air temperature.

### 3.09 FIELD AND LABORATORY TESTS

- A. Sets of field control cylinder specimens will be taken by the CONTRACTOR's testing laboratory during the progress of the work, in compliance with ASTM C31. Take field control cylinder specimens during the progress of the work, in compliance with ASTM C31, at the point



of concrete placement. The number of sets of concrete test cylinders taken of each class of concrete placed each day shall not be less than one set per day, nor less than one set for each 100 cu yds of concrete nor less than one set for each 5,000 sq ft of surface area for slabs or walls. Specimens shall be formed in 6-in diameter by 12-in long non-absorbent cylindrical molds.

1. A "set" of test cylinders shall consist of four cylinders: one to be tested at seven days and two to be tested and their strengths averaged at 28 days. The fourth may be used for a special test at 3 days or to verify strength after 28 days if 28-day test results are low.
  2. When the average 28 day compressive strength of the cylinders in any set falls below the required compressive strength or below proportional minimum seven-day strengths (where proper relation between seven and 28 day strengths have been established by tests), change proportions, cementitious content, or temperature conditions to achieve the required strengths at no additional cost to the UTILITY.
  3. In the event that a set of field control cylinders are not collected on the day of concrete placement, a minimum of 3 cores shall be obtained and cured, per ASTM C42, 28 days after the concrete was placed and tested in accordance with ASTM C39 sampling standard, at no additional cost to the UTILITY. The location of the cores shall be specified by the engineer. Cores shall be of sufficient length to allow the upper 2" from each side of the cylinder to be removed and have an overall length to core diameter ratio of 2 to 1. Concrete core locations shall be repaired in accordance with Specification Section 03740.
- B. Cooperate in the making of tests by allowing free access to the work for the selection of samples. Provide four firmly braced, insulated, heated, closed wooden curing boxes, each sized to hold eight specimens, complete with cold weather temperature and hot weather temperature control thermostat for initial curing and storage from time of fabrication until shipment to the testing lab. Protect the specimens against injury or loss through construction operations. Furnish material and labor required for the purpose of taking concrete cylinder samples.
- C. Slump tests will be made in the field by the CONTRACTOR's testing laboratory inspector immediately prior to placing the concrete. Such tests will be made in accordance with ASTM C143. Test slump immediately prior to placing the concrete. Test shall be made in accordance with ASTM C143. When concrete is pumped, slump will be determined at point of truck discharge. If the slump is outside the specified range, the concrete will be rejected. Slump tests shall be performed for every 30 cubic yards of each type of concrete placed each day including when test cylinders are made.
- D. Air Content: Test for air content will be made by the CONTRACTOR's testing laboratory inspector on a fresh concrete sample, at the point of concrete placement. Air content for concrete made of ordinary aggregates having low absorption shall be made in compliance with either the pressure method complying with ASTM C231 or by the volumetric method complying with ASTM C173. If aggregates with high absorptions are used, the latter test method shall be used. When concrete is pumped, air content will be determined at point of placement. Air content tests shall be performed for every 30 cubic yards of each type of concrete placed each day including when test cylinders are made.

### 3.10 FIELD QUALITY CONTROL

- A. The Engineer may have cores taken from any questionable area in the concrete work such as construction joints and other locations as required for determination of concrete quality. The results of tests on such cores shall be the basis for acceptance, rejection or determining the

continuation of concrete work. The right of the Engineer to take such cores shall not be construed as creating any obligation to take such cores, and not exercising this right to do so shall not relieve the CONTRACTOR from meeting the requirements of these Specifications.

- B. Cooperate in obtaining cores by allowing free access to the work and permitting the use of ladders, scaffolding and such incidental equipment as may be required. Repair all core holes with non-shrink grout as specified in Section 03600. The work of cutting, testing and repairing the cores will be at the expense of the CONTRACTOR if defective work is uncovered. If no defective work is found, such cost will be at the expense of the UTILITY.

### 3.11 SPECIAL INSPECTION

- A. The UTILITY or the registered design professional in responsible charge acting as the UTILITY's agent shall employ one or more special inspectors to provide inspections during construction.
- B. Special inspection shall be performed in accordance with Section 1704.4 and table 1704.4 of the IBC.
- C. The Engineer shall be notified when the forms are complete and ready for inspection at least 12 hours prior to the proposed concrete placement.

### 3.12 FAILURE TO MEET REQUIREMENTS

- A. Should the strengths shown by the test specimens made and tested in compliance with the previous provisions fall below the values given in Table 1, the Engineer may require changes in proportions or materials, or both, to apply to the remainder of the work in accordance with Paragraph 1.05E. Furthermore, the Engineer may require additional curing on those portions of the structure represented by the test specimens which fall below the values given in Table 1. The cost of such additional curing shall be at no additional cost to the UTILITY. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, the Engineer may require strengthening or replacement of those portions of the structure which fail to develop the required strength. Coring and testing and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be at no additional cost to the UTILITY. In such cases of failure to meet strength requirements the CONTRACTOR and UTILITY shall confer to determine what adjustment, if any, can be made in compliance with Sections titled "Strength" and "Failure to Meet Strength Requirements" of ASTM C94. The "purchaser" referred to in C94 is the CONTRACTOR.
- B. When the tests on control specimens of concrete fall below the required strength, the Engineer will permit check tests for strengths to be made by obtaining a minimum of 3 cores drilled from the structure and cured, per ASTM C42, and tested in accordance with ASTM C39 sampling standard. In cases where tests of cores fall below the values given in Table 1, the Engineer, in addition to other recourses, may require load tests on any one of the slabs, walls, beams, and columns in which such concrete was used. Test need not be made until concrete has aged 60 days. The Engineer may require strengthening or replacement of those portions of the structure which fail to develop the required strength. All coring and testing and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be at no additional cost to the UTILITY.

- C. Should the strength of test cylinders fall below 60 percent of the required minimum 28 day strength, the concrete shall be rejected and shall be removed and replaced at no additional cost to the UTILITY.

### 3.13 PATCHING AND REPAIRS

- A. It is the intent of these Specifications to require quality work including forming, mixture and placement of concrete and curing so completed concrete surfaces will require no patching or repairs.
- B. As soon as the forms have been stripped and the concrete surfaces exposed: remove fins and other projections; fill recesses left by the removal of form ties; and repair surface defects which do not impair structural strength. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete.
- C. Immediately after removal of forms remove tie cones and metal portions of ties as specified in Section 03100. Fill holes promptly upon stripping as follows: Moisten the hole with water, followed by a 1/16-in brush coat of neat cement slurry mixed to the consistency of a heavy paste. Immediately plug the hole with a 1 to 1.5 mixture of cement and concrete sand mixed slightly damp to the touch (just short of "balling"). Hammer the grout into the hole until dense, and an excess of paste appears on the surface in the form of a spider web. Trowel smooth with heavy pressure. Avoid burnishing.
- D. When filling tie cone holes and patching or repairing exposed surfaces use the same source of cement and sand as used in the parent concrete. Adjust color to match by addition of white cement. Rub lightly with a fine carborundum stone at an age of one to five days if necessary to bring the surface down with the parent concrete. Do not damage or stain the virgin skin of the surrounding parent concrete. Wash thoroughly to remove all rubbed matter.
- E. Defective concrete and honeycombed areas: Chip down square and at least 1-in deep to sound concrete with hand chisels or pneumatic chipping hammers. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly embedded in the parent concrete. If honeycomb exists around reinforcement, chip to provide a clear space at least 3/8-in wide all around the steel. For areas less than 1-1/2-in deep, the patch may be made in the same manner as described above for filling form tie holes, care being exercised to use adequately dry (non-trowelable) mixtures and to avoid sagging. Thicker repairs will require build-up in successive 1-1/2-in layers on successive days, each layer being applied (with slurry, etc.) as described above.
- F. For very heavy (generally formed) patches, the Engineer may order the addition of pea gravel to the mixture and the proportions modified as follows:

<u>Material</u>	<u>Volumes</u>	<u>Weights</u>
Cement	1.0	1.0
Sand	1.0	1.0
Pea Gravel	1.5	1.5

- G. The CONTRACTOR may use a packaged patching compound, such as: Poly-Patch by Euclid Chemical Company; Emaco R310 by BASF Chemical Company; Sikatop 122 Plus by Sika Chemical Corporation or equal only if approved by the Engineer for use and for color match.
- H. See also the requirements of Specification Section 03\_3750.

3.14 SCHEDULE

- A. The following (Table 5) are the general applications for the various concrete classes and design strengths:

TABLE 5  
CONCRETE SCHEDULE

Class	Design Strength (psi)	Description
A	4,500	Walls, slabs on grade, equipment pads, pavement, repair areas, thrust collars, and all other structural concrete
B	3,000	Concrete duct and pipe encasement, sidewalks, thrust blocking

END OF SECTION

SECTION 05 5000

MISCELLANEOUS METALS AND MATERIALS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required to complete and install fabricated metal items and furnish all supplementary items necessary for their proper installation. Miscellaneous metal items include, but are not limited to, the following:
  - 1. Embedded steel plates and miscellaneous embedded metal assemblies.
  - 2. Anchors and anchor bolts, except those specified to be furnished under equipment specifications.
  - 3. Metal pipe supports per the Drawings
- B. Check Drawings carefully and furnish all anchors, sleeves, bolts, brackets, clips, inserts, angles, loose lintels, tubing, bar stock, plates, and other miscellaneous metal and materials not distinctly specified under other Sections but necessary to complete the work.

1.02 RELATED WORK

- A. Concrete reinforcement and concrete accessories are included in Division 3.

1.03 SUBMITTALS

- A. Submit shop drawings and product data, in accordance with Section 01\_3000, showing materials of construction and details of installation. Submittals shall include at least the following:
  - 1. Shop drawings, erection drawings, product data, etc., showing methods of assembly, anchorage, and connection to other members. Shop drawings will be required for all items included under this Section, unless otherwise noted.
- B. Samples
  - 1. Samples of products prior to construction, if requested by the Engineer.
- C. Submit product information for specific items indicated below and as selected for use in construction including, but not limited to:
  - 1. Post-installed concrete anchors
  - 2. Cast-in-place concrete anchors
  - 3. Dowel adhesive for post-installed anchors and reinforcing bars

D. Certifications

1. Certified material test reports for materials supplied and certification that materials meet the specified standards: for all shop fabrications, excluding prefabricated components.
2. Welder's certifications, if requested by the Engineer.

1.04 REFERENCE STANDARDS

A. Aluminum Association

1. Aluminum Design Manual
2. Specifications for Aluminum Structures
3. Engineering Data for Aluminum Structures
4. AA M31C22A41
  - a. M31: Mechanical Finish, Fine Satin
  - b. C22: Finish, Medium Matte
  - c. A41: Clear Anodic Coating, Class I

B. American Institute of Steel Construction (AISC)

1. Manual of Steel Construction, 13<sup>th</sup> Edition

C. American National Standards Institute (ANSI)

1. ANSI A14.3 - Standard for Ladders-Fixed-Safety Requirements

D. American Society for Testing and Materials (ASTM)

1. ASTM A36 - Standard Specification for Carbon Structural Steel
2. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
3. ASTM A108 - Standard Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality
4. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
5. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
6. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

7. ASTM A240 - Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Plate, Sheet, and Strip Pressure Vessels.
  8. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes
  9. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 Psi Tensile Strength.
  10. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
  11. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
  12. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts
  13. ASTM A992 - Standard Specification for Structural Shapes
  14. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
  15. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.
  16. ASTM B429 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
  17. ASTM F436 - Standard Specification for Hardened Steel Washers
  18. ASTM F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
  19. ASTM F594- Standard Specification for Stainless Steel Nuts
  20. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
  21. ASTM E94 - Standard Guide for Radiographic Examination
  22. ASTM E164 - Standard Practice for Contact Ultrasonic Testing of Weldments
  23. ASTM E165 - Standard Test Method for Liquid Penetrant Examination
  24. ASTM E709 - Standard Guide for magnetic Particle Testing
- E. American Welding Society (AWS)
1. AWS A2.0 - Standard Welding Symbols
  2. AWS D1.1 - Structural Welding Code - Steel
  3. AWS D1.2 - Structural Welding Code – Aluminum
- F. Occupational Safety and Health Administration (OSHA)

- G. 2006 International Building Code (IBC).
- H. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply or the edition as specified in the International Building Code shall be used.

1.05 COORDINATION

- A. Coordinate completely the work of this Section with the work of other Sections. Verify at the site both the dimensions and work for other trades adjoining items of work in this Section before fabrication and installation of the items specified.
- B. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other Sections.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver items to be incorporated into the work of other trades in sufficient time to be checked prior to installation.
- B. Deliver anchorage devices with setting drawings, templates, and instructions for installation.
- C. Store delivered items off the ground and protected from dirt and weather.
- D. Protect items to be incorporated into the work against scratching, splashes, mortar, paint, and other damage during transportation, storage, installation, and until adjacent work by other trades is complete.
- E. Repair items that have become damaged or corroded to the satisfaction of the Engineer prior to incorporating them into the work.

1.07 QUALITY ASSURANCE

- A. See additional inspection and testing requirements as provided in Section 3.02.

PART 2 PRODUCTS

2.01 STEEL AND IRON FABRICATIONS

- A. Steel and Iron
  - 1. Structural Steel ASTM A36
  - 2. Structural Steel Tubing ASTM A500, Grade B
  - 3. Welded and Seamless Steel Pipe ASTM A501 or ASTM A53, Type E or S, Grade B Schedule 40. Use standard malleable iron fittings, galvanized for exterior work
  - 4. Steel Sheets ASTM A1008



- |                          |   |
|--------------------------|---|
| 5. Gray Iron Castings    | ASTM A48, Class 35                      |
| 6. Ductile Iron Castings | ASTM A536, Grade 65-45-12               |
| 7. Galvanizing           | ASTM A123, Zn w/0.05 percent minimum Ni |
| 8. Galvanizing, hardware | ASTM A153, Zn w/0.05 percent minimum Ni |

B. Fabrication

1. See general fabrication requirements in Article 2.11.
2. Steel construction shall conform to the AISC Manual of Steel Construction, unless otherwise noted.
3. Welding and welding electrodes shall be in accordance with AWS D1.1, unless otherwise noted. Provide Type E70XX low-hydrogen electrodes, unless otherwise specified. Minimum fillet weld size shall be 1/4-in unless otherwise noted.
4. Connection bolts for structural framing shall be 3/4-in diameter A325 bolts, two bolts minimum, unless otherwise noted.
5. Fabricate miscellaneous steel shapes and plates as shown, including: beams, angles, support brackets, anchor bolts, and any other miscellaneous steel called for on the Drawings and not otherwise specified.
6. Finishes
  - a. All embedded steel items and all steel elements supporting masonry or veneer shall be hot-dip galvanized, unless otherwise noted.
  - b. Galvanizing shall be done after fabrication.
  - c. Thoroughly clean steel fabrications of all loose mill scale, rust, grease or oil, moisture, dirt, or other foreign matter and finish in compliance with Division 9 or.

2.02 STAINLESS STEEL FABRICATIONS

A. Materials

1. Stainless Steel Plates, Sheets, and Structural Shapes
  - a. Exterior, Submerged or Industrial Use      ASTM A276, Type 316 (Type 316L for welded)
  - b. Interior and Architectural Use      ASTM A276, Type 304
2. Stainless Steel Bolts, Screws and Studs      ASTM F593 CW (Type 316)
3. Stainless Steel Nuts      ASTM F594 (Type 316)

4. Stainless Steel Washers ASTM A240 (Type 316)

B. Fabrication

1. See general fabrication requirements in Article 2.11.

2.03 ALUMINUM FABRICATIONS

A. General

1. Aluminum alloy designations shall be in accordance with the designations of the Aluminum Association.

B. Materials

1. Aluminum Extruded Pipe ASTM B429, Alloy 6063 T6
2. Aluminum Extruded Shapes ASTM B221, Alloy 6061 T6
3. Aluminum Sheet and Plate ASTM B209, Alloy 6061 T6

C. Fabrication

1. See general fabrication requirements in Section 2.11.
2. Aluminum construction shall conform to the standards and specifications of the Aluminum Association, unless otherwise noted.
3. Fabricate miscellaneous aluminum shapes and plates as shown. Furnish all miscellaneous aluminum shown but not otherwise detailed. Structural shapes and extruded items shall comply with the dimensions on the Drawings within the tolerances published by the Aluminum Association.
4. Weld aluminum work on the unexposed side when possible in order to prevent pitting or discoloration of exposed aluminum surfaces.
5. Use appropriate weld filler material as required by the Aluminum Design Manual for respective aluminum alloys.
6. Finishes
  - a. All exposed aluminum surfaces shall have fabricator's standard mill finish unless otherwise specified.

2.04 ANCHORS, BOLTS, AND FASTENING DEVICES

- A. Furnish anchors, bolts, fasteners, etc., as necessary for installation for the work of this Section or as specified for securing the work of other Sections.

B. Materials

1. Carbon Steel Bolts and Studs ASTM A307, Grade A (hot dip)

- galvanized nuts and washers where noted), ASTM A108, or ASTM F1554, Grade 36 - Standard headed anchor bolts
2. Carbon Steel Nuts ASTM A563
  3. Carbon Steel Washers (Grade A, Hex, UNO) ASTM F436
  4. High Strength Steel Bolts, Nuts and washers ASTM A325 (mechanically galvanized per ASTM B695, Class 50, where noted)
    - a. Elevated Temperature Exposure Type I
    - b. General Application Type I or Type II
- C. Fasten aluminum and stainless-steel members utilizing Type 316 stainless steel machine bolts. Fasten iron or steel members utilizing steel machine bolts, unless otherwise noted. Galvanized steel members shall be fastened utilizing galvanized steel or zinc-plated fasteners, unless otherwise noted.
- D. Unless otherwise noted, drilled concrete anchors shall be adhesive type or expansion type anchor bolts as specified below:
1. Adhesive anchors shall consist of a metal stud assembly and a two-component resin anchoring system. Chemical resins shall be polyester or vinylester resin, combined with a hardener and aggregates, as applicable. Stud assemblies shall consist of an all-thread anchor rod with nut and washer, unless otherwise noted on the Drawings. Provide manufacturer's recommended installation tools for installing anchor components. Install anchors in full compliance with the manufacturer's recommendations.
    - a. Adhesive anchors shall be: HIT RE 500 SD or HIT HY 150 MAX SD (seismic applications) as manufactured by Hilti, Inc., or approved equal. Anchor rods shall be of the size and type designated on the Drawings. Where specifically indicated on the Drawings, the adhesive anchoring system noted shall be used; no substitutions.
  2. Expansion anchors shall be wedge type anchors of the sizes and minimum embedment as noted on the Drawings, complete with nuts and washers. Embedment depth, side over, and spacing shall be in accordance with the manufacturer's recommendations and as shown on the Drawings.
    - a. Expansion anchors shall be: "Kwik Bolt TZ Expansion Anchors" as manufactured by Hilti, Inc., or approved equal. These anchors shall be used when anchoring into new or existing concrete construction.
    - b. Expansion anchors shall be: "Kwik Bolt III Expansion Anchors" as manufactured by Hilti, Inc., or approved equal. These anchors shall be used when anchoring into new or existing grouted masonry construction.
  3. Anchors used in masonry construction shall be as indicated in Section 2.04.E.2.b above where anchors are installed into grouted cells. Additionally, Hilti HY 150 adhesive

anchoring system, or approved equal, may also be used in grouted masonry construction. Where anchors are installed in hollow cells, adhesive anchors shall be a three-part stud, screen and chemical dispenser anchoring system. Adhesive cartridges shall contain premeasured amounts of resin and hardener which are mixed and deposited in a screen tube by a dispenser. Stud assemblies shall consist of an all-thread anchor rod with nut and washer. Anchors shall be Hilti, HIT C-20 System or equal.

- E. Headed anchor studs shall be Nelson Type H4L or S3L, unless otherwise noted, by Nelson Stud Welding Company, or equal. Studs shall be welded per the manufacturer's recommendations and in accordance with AWS D1.1.
- F. Compound masonry anchors shall be of the "two unit" type and shall be Star Slugin anchors as manufactured by Star Expansion Industries; equal by Phillips Drill Co.; or The Rawlplug Co.; or equal.
- G. Machine bolts and nuts shall conform to Federal Specification FF-B-575C. Bolts and nuts shall be hexagon type. Bolts, nuts, screws, washers and related appurtenances shall be Type 316 stainless steel.
- H. Toggle bolts shall be by Diamond; Keystone; Star; or equal.
- I. Embedded anchor bolts shall be 5/8-in diameter (minimum), unless otherwise noted. Protect the exposed portions of embedded anchor bolts during concrete placement.

2.05 NOT USED

2.06 NOT USED

2.07 NOT USED

2.08 NOT USED

2.09 MISCELLANEOUS STEEL

- A. Miscellaneous steel items shall include: beams, angles, lintels, metal stairs, support brackets, base plates for other than structural steel or equipment, closure angles, holddown straps and lugs, door frames, splice plates, subframing at roof openings and any other miscellaneous steel called for on the Drawings and not otherwise specified.
- B. Steel pipe pieces for sleeves, lifting attachments and other functions shall be Schedule 40 pipe unless otherwise shown on the Drawings. Wall and floor sleeves, of steel pipe, shall have welded circumferential steel waterstops at mid-length.
- C. Lintels, relief angles or other steel supporting masonry or embedded in masonry shall be galvanized.
- D. All steel finish work shall be thoroughly cleaned, by effective means, of all loose mill scale, rust and foreign matter and shall be given one shop coat of primer compatible with the finish coat after fabrication but before shipment. Paint shall be omitted within 3-in of proposed field welds. Paint shall be applied to dry surfaces and shall be thoroughly and evenly spread and well worked into joints and other open spaces.

- F. Galvanizing, where required, shall be the hot-dip zinc process after fabrication. Coating shall be not less than 2 oz/sq ft of surface. See Specification Section 05910 for additional information regarding galvanizing.

## 2.10 MISCELLANEOUS STAINLESS STEEL

- A. Miscellaneous stainless-steel items shall include: beams, angles, bar racks and any other miscellaneous stainless steel called for on the Drawings and not otherwise specified.

## 2.11 FABRICATION - GENERAL

- A. Form all miscellaneous metal work true to detail, with clean, straight, sharply defined profiles, tight joints, and smooth surfaces of uniform color and texture. Provide fabrications free from defects impairing strength or durability. Drill or punch holes and smooth edges. Ease exposed edges to a small, uniform radius. Fabricate supplementary pieces necessary to complete each item even though such pieces are not specifically shown or specified.
- B. Supply components required for anchorage of fabrications. Connections and accessories shall be of sufficient strength to safely withstand stresses and strains to which they will be subjected. Steel accessories and connections to steel or cast iron shall be steel, unless otherwise specified. Threaded connections shall be made so that the threads are concealed by fittings.
- C. Welded joints shall be rigid and continuously welded unless otherwise specified or shown. Dress the face of welds flush and smooth. Continuously weld and grind smooth welds that will be exposed. Exposed joints shall be close fitting and jointed where least conspicuous. Conceal fastenings where practical. Punch or drill for temporary field connections and for attachment of the work of other trades.
- D. Welding of parts shall be in compliance with the latest edition of AWS D1.1 or AWS D1.2 as applicable, and shall only be done where shown, specified, or permitted by the Engineer. Welding shall be performed only by welders certified to perform the required welding in compliance with the requirements of the AWS Code. Component parts of built-up members to be welded shall be adequately supported and clamped or held by other adequate means to hold the parts in proper relation for welding.
- E. Where indicated, pipe penetrations in existing construction shall be core drilled and sealed with mechanical seals (Link Seals) or equivalent.

## PART 3 EXECUTION

### 3.01 INSTALLATION - GENERAL

- A. Install all items furnished in accordance with this Section, except items to be embedded in concrete that shall be installed under Division 3. Items to be attached to concrete after such work is completed shall be installed in compliance with the details shown. Furnish to appropriate trades all anchors, sockets, or fastenings required for securing work to other construction.
- B. Set metal work level, true to line, and plumb, as indicated.
- C. Weld field connections and grind smooth where practical. Clean and strip primed steel items to bare metal where field welding is required. Conceal fastenings where practical.

- D. Touch-up abrasions to finish or primer coatings immediately after erection and prior to both final coating and final acceptance.
- E. Specialty products shall be installed in accordance with the manufacturer's recommendations.
- F. Expansion bolts shall be checked for tightness a minimum of 24 hours after initial installation.
- G. Install adhesive capsule anchors using manufacturer's recommended drive units and adapters and in compliance with the manufacturer's recommendations.
- H. Headed anchor studs shall be welded in accordance with manufacturer's recommendations.
- I. All railings shall be erected to line and plumb.
- J. All steel surfaces that come into contact with exposed concrete or masonry shall receive a protective coating of an approved heavy bitumastic troweling mastic applied in accordance with the manufacturer's instructions prior to installation.
- K. Break contact between dissimilar metals as shown on the Drawings or as specified in paragraph 3.01L and M.
- L. Field or shop apply coatings for installation of metal fabrications according to the following schedule. For embedded items, coat the embed.
  - 1. All unbonded steel surfaces in contact with exposed concrete or masonry shall receive a protective coating of an approved epoxy paint as specified in Division 9, applied in compliance with the manufacturer's instructions prior to installation.
  - 2. Where aluminum contacts a dissimilar metal, apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal. Alternately, where approved, provide neoprene isolator pads, 1/4-in thick, 85 durometer plus or minus 5 durometers, Shore A hardness, sized for full width and length of connection.
  - 3. Where aluminum contacts masonry or concrete, apply a heavy coat of approved alkali resistant paint to the masonry or concrete.
  - 4. Where aluminum contacts wood, apply two coats of aluminum metal and masonry paint to the wood.
  - 5. Steel, equipment & piping subject to wastewater immersion or splash above wastewater stream shall be prepared according to SSPC-SP5 White Metal Blast Cleaning, with one coat of Tnemec Series N69/N69F HB Epoxoline at 4 to 6 mils DFT.
  - 5. Field paint exposed metal surfaces as specified in Division 9, Painting.
- M. Between aluminum gratings, aluminum stair treads, or aluminum handrail brackets and steel supports, insert 1/4-in thick neoprene isolator pads, 85 durometer plus or minus 5 durometer, Shore A hardness, sized for full width and length of bracket or support.

### 3.02 FIELD INSPECTION/QUALITY CONTROL

- A. The UTILITY or the registered design professional in responsible charge acting as the UTILITY's agent shall employ one or more special inspectors to provide inspections during construction.
- B. After arrival on-site and prior to installation, inspect all received materials including bolts, structural steel, aluminum grating, aluminum structural shapes, ladders, stairs, and all other items referenced in the specification to ensure that materials received are as specified herein, on the drawings, and that they comply with all referenced standards.
- C. Structural Inspections (Fabricators):
  - 1. Special inspection of fabricators shall be performed in accordance with Section 1704.2 of the IBC.
- D. Structural Inspections (Construction):
  - 1. Special inspection of steel construction shall be performed in accordance with Section 1704.3 and table 1704.3 of the IBC.
- E. Structural Inspections (Welding):
  - 1. All field welding will be inspected visually by AWS certified welding inspectors provided by the UTILITY. Additional non-destructive testing may be required at the discretion of the welding inspector and based upon observations made during visual inspection in which weld adequacy or strength is in question. Follow AWS standards/guidelines for non-destructive testing procedures at the discretion of the welding inspector. Comply with all requests of inspectors to correct deficiencies. The following non-destructive tests are allowed and shall be used at the discretion of the welding inspector:
    - 2. Liquid Penetrant Inspection: ASTM E165.
    - 3. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
    - 4. Ultrasonic Inspection: ASTM E164.
    - 5. Radiographic Inspection: ASTM E94.
- F. All post-installed concrete anchors shall be inspected to ensure compliance with the manufacturer's recommended installation instructions, indicated bolt size, and embedment as shown on the Contract Drawings. Inspection services shall be provided by an independent inspector employed by the UTILITY.
  - 1. Test a minimum of 5%, or as directed by the UTILITY under consultation of the employed independent inspector, of each type and size of drilled-in anchor in each substrate they are installed. Drilled-in anchors shall be proof loaded by the independent testing laboratory

employed by the UTILITY. Adhesive anchors and capsule anchors, if applicable, shall not be torque tested unless otherwise directed by the Engineer. If any of the tested anchors fail to achieve 1.5 times the expected allowable design loads per the manufacturer, all anchors of the same diameter, embedment, and type as the failed anchor shall be tested unless otherwise directed by the UTILITY/Engineer. The testing agency shall verify that test loads will not overstress the embedded anchors.

- a. Proof loads (tension only) shall be applied with a calibrated hydraulic ram. Displacement of adhesive and capsule anchors at the specified load shall not exceed  $D/10$ , where  $D$  is the nominal anchor diameter.
  - b. Field testing and subsequent reports shall be performed in accordance with ASTM E488. Field testing shall be of tension capacity of the installed anchor only.
- G. Special inspections for seismic resistance shall be performed as outlined in Section 1707 of the IBC.

END OF SECTION



## SECTION 09 9100

### PAINTING

#### PART 1 GENERAL

##### 1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install all painting complete as shown on the Drawings and as specified herein.
- B. It is the intent of this Section to paint all exposed structural and miscellaneous steel; tanks and systems; mechanical and electrical equipment; conveying systems, pipe, fittings and valves; electrical conduit and appurtenances; all as specified in the attached painting schedules and all other work obviously required to be painted unless otherwise specified. The pump station floor and valve vault floor shall be painted as scheduled, herein. Minor items not mentioned in the schedule of work shall be included in the work of this Section where they come within the general intent of this Section as stated herein.
- C. The following items will not be painted:
  - 1. Concrete except where specified above and scheduled to be painted
  - 2. Stainless steel louvers, doors and frames.
  - 3. Finish hardware.
  - 5. Non-ferrous metals and stainless steel, unless specifically noted otherwise.
  - 6. Factory pre-finished architectural components.
  - 7. Packing glands and other adjustable parts and name plates of mechanical equipment.
  - 8. Parts of buildings not exposed to sight, unless specifically noted otherwise.
  - 9. Maintenance equipment
  - 10. Plumbing fixtures.
  - 11. Mechanical, HVAC, Plumbing, Process, and Electrical equipment which has been finish painted in the factory.
  - 12. Stainless Steel or Aluminum hardware, ladders, stairs, rails, and equipment, unless specifically identified elsewhere.

##### 1.02 RELATED WORK

- A. Shop priming and surface preparation of equipment and piping are specified and included in the respective Section with the item to be primed.

##### 1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01 3000.

- B. Product Data: For each type of product indicated.
- C. Samples: Submit the following for each type of coating system and in each color and gloss of finish coat indicated.
  - 1. Color cards for initial color selections.
  - 2. Three sets of 8-in by 8-in samples, on 1/4-in hardboard, of all colors required for all types of paint. Resubmit until approved.
- D. Product List: For each product indicated. Cross-reference products to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules.

#### 1.04 REFERENCE STANDARDS

- A. Steel Structures Painting Council (SSPC)
  - 1. SSPC SP-1 - Surface Preparation Specification No. 1 Solvent Cleaning.
  - 2. SSPC SP-2 - Surface Preparation Specification No. 2 Hand Tool Cleaning.
  - 3. SSPC-SP7 – Surface Preparation Specification No. 7 Brush-Off Blast Cleaning.
  - 4. SSPC-SP6 – Surface Preparation Specification No. 6 Commercial Blast Cleaning.
  - 5. SSPC-SP10 – Surface Preparation Specification No. 10 Near-White Blast Cleaning.
  - 6. SSPC-SP5 – Surface Preparation Specification No. 5 White-Metal Blast Cleaning.
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

#### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
  - 1. Maintain containers in clean condition, free of foreign materials and residue.
  - 2. Remove rags and waste from storage areas daily.

#### 1.06 PROJECT CONDITIONS

- A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 50 and 95 deg F.
- B. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1.07 EXTRA MATERIALS

- A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
  - 1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. of each material and color applied.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Provide products by one of the following:
  - 1. Tnemec, Inc.(TN);
  - 2. The Sherwin Williams Company (SW)
  - 3. Induron Protective Coatings (ID)
  - 5. Or equal.

2.02 MATERIALS

- A. Material Compatibility:
  - 1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
  - 2. Provide products of same manufacturer for each coat in a coating system.
- B. All painting materials shall be delivered to the work site in unbroken packages, bearing the manufacturer's brand and name. They shall be used without adulteration and mixed, thinned and applied in strict accordance with manufacturer's directions for the applicable materials and surface and with the Engineer's approval before using.
- C. Shop priming shall be done with primers that are guaranteed by the manufacturer to be compatible with the finish paints to be used. Refer to Section 09901 for special primers.
- D. Work areas will be designated by the Engineer for storage and mixing of all painting materials. Materials shall be in full compliance with the requirements of pertinent codes and fire regulations. Proper containers outside of the buildings shall be provided and used for painting wastes and no plumbing fixture shall be used for this purpose.
- E. Colors: As selected by Engineer from manufacturer's full range.

2.03 COLOR CODING FOR PIPES AND EQUIPMENT

- A. All pipes and equipment shall be painted with final coat color selected by the Engineer and shall be treated as an integral part of the Contract.

- B. All hanger saddles and pipe support floor stands shall be painted the same color and with the same paint as the pipe it supports. Hanger rods and hanger rod connections to building structure shall be painted to match the color of the wall or ceiling to which it is attached.

## 2.04 TESTING EQUIPMENT

- A. Furnish to the Engineer for use on the Project for paint inspection, wet and dry film thickness gauges and all other equipment required by the Engineer for inspection.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
  - 1. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
    - a. Concrete: 12 percent.
    - b. Masonry (Clay and CMU): 12 percent.
    - c. Wood: 15 percent.
    - d. Gypsum Board: 12 percent.
  - 2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
  - 3. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
  - 4. Coating application indicates acceptance of surfaces and conditions.

### 3.02 PREPARATION

- A. All surfaces to be painted shall be prepared as specified herein and shall be dry and clean before painting. Special care shall be given to thoroughly clean interior concrete and CMU surfaces to receive polyamide cured epoxy paint of all marks before application of finish.
- B. All metal welds, blisters, etc, shall be ground and sanded smooth. All pits and dents shall be filled and all imperfections shall be corrected so as to provide a smooth surface for painting. All rust, loose scale, oil, tar and asphalt bearing coatings, grease and dirt shall be removed by use of approved solvents, wire brushing, grinding or sanding.
- C. Concrete surfaces shall have been finished as specified in Section 033300. Report unsatisfactory surfaces to the Engineer. Concrete shall be left for one month minimum before painting and shall be free of dust, oil, curing compounds and other foreign matter.

- D. Concrete masonry unit surfaces shall be smooth and cleaned of all dust, loose mortar and other foreign matter.
- E. All PVC pipe and other plastic matrix surfaces to be painted shall be lightly sanded and cleaned of residue before painting.
- F. Galvanized, aluminum, and copper surfaces identified for coating shall have all oxidation and foreign material removed before painting by SSPC SP-1, using an approved V.O.C. compliant method. Galvanized and, when ordered, the other metal surfaces specified above shall be hand tool cleaned to SSPC SP-2 standards to provide a uniform 1 mil surface profile.
- G. Existing Surfaces to be Repainted
  - 1. Existing concrete, masonry, steel and other previously field painted surfaces so noted or as provided in Paragraph 1.01B shall be repainted.
  - 2. Preparation shall be in general as specified above for new surfaces except that all loose paint shall be removed and all edges of existing paint shall be feathered to ensure a smooth surface.
  - 3. Paint removal, capture of its residue, and its disposal shall be handled in accordance with all laws and regulations concerning disposal of hazardous materials.
  - 4. Primer (spot) and paint used for a particular surface shall, in general, be as scheduled for that type of new surface. Confirm with the paint manufacturer that the paint proposed for a particular repaint condition will be compatible with the existing painted surface and environment the coating is being placed in. Perform adhesion and compatibility tests on existing substrates as ordered and required. Repainted areas shall be covered by the same guaranty specified for remainder of Project.

### 3.03 WORKMANSHIP

#### A. General

- 1. At the request of the Engineer, sample areas of the finished work prepared in strict accordance with this Section shall be furnished and all painting shall be equal in quality to the approved sample areas. Finished areas shall be adequate for the purpose of determining the quality of workmanship. Experimentation with factory or paint manufacturer's warehouse mixed colors shall be furnished to the satisfaction of the Engineer where standard chart colors are not satisfactory.
- 2. Protection of furniture and other movable objects, equipment, fittings and accessories shall be provided throughout the painting operation. Canopies of lighting fixtures shall be loosened and removed from contact with surface, covered and protected and reset upon completion. Remove all electric plates, surface hardware, etc, before painting, protect and replace when completed. Mask all machinery name plates and all machined parts not receiving a paint finish. Dripped or spattered paint shall be promptly removed. Lay drop cloths in all areas where painting is being done to adequately protect flooring and other work from all damage during the operation and until the finished job is accepted.
- 3. On metal surfaces apply each coat of paint at the rate specified by the manufacturer to achieve the minimum dry mil thickness required. If material has thickened or must be diluted for application by spray gun, the coating shall be built up to the same film thickness

achieved with undiluted material. One gallon of paint as originally furnished by the manufacturer shall not cover a greater area when applied by spray gun than when applied unthinned by brush. Deficiencies in film thickness shall be corrected by the application of an additional coat(s). On masonry, application rates will vary according to surface texture; however, in no case shall the manufacturer's stated coverage rate be exceeded. On porous surfaces, it shall be the painter's responsibility to achieve a protective and decorative finish either by decreasing the coverage rate or by applying additional coats of paint.

#### B. Field Priming

1. Steel members, metal castings, mechanical and electrical equipment and other metals which are shop primed before delivery at the site will not require a prime coat on the job. All piping and other bare metals to be painted shall receive one coat of primer before exposure to the weather, and this prime coat shall be the first coat as specified in the painting schedule. Surface preparation of bare metal shall be the responsibility of the Contractor.
2. Equipment which is specified to receive a baked-on enamel finish or other factory finish shall not be field painted unless the finish has been damaged in transit or during installation. Surfaces that have been shop painted and have been damaged, or where the shop coat or coats of paint have deteriorated, shall be properly cleaned and retouched before any successive painting is done on them in the field. All such field painting shall match as nearly as possible the original finish. Preparation and painting shall be provided by the Contractor.
3. Equipment shipped with a protective shop painting coat or coats shall be touched up to the satisfaction of the Engineer with primers as recommended by the manufacturer of the finish paint. Preparation and painting shall be provided by the Contractor.

#### C. Field Painting

1. All painting at the site shall be under the strict inspection of the Engineer. Only skilled painters and, where dictated by special conditions or systems and so ordered, specialist painters shall be used on the work.
2. All paint shall be at room temperature before applying, and no painting shall be done when the temperature is below 60 degrees F, in dust-laden air, when rain or snow is falling, or until all traces of moisture have completely disappeared from the surface to be painted.
3. Successive coats of paint shall be different shades (from paint manufacturer's stock or shop mixed paint) of the required colors so as to make each coat easily distinguishable from each other with the final undercoat the approximate shade of the finished coat to ensure no show-through as approved.
4. Finish surfaces shall not show brush marks or other irregularities. Undercoats shall be thoroughly and uniformly sanded with the type paper appropriate for the undercoats to remove defects and provide a smooth even surface. Top and bottom edges of doors shall be painted.
5. Painting shall be continuous and shall be accomplished in an orderly manner so as to facilitate inspection. Materials subject to weather shall be primed coated as quickly as

possible. Surfaces of exposed members that will be inaccessible after erection shall be cleaned and painted before erection.

6. All painting shall be performed by approved methods with number of coats modified as required to obtain the total dry film thickness specified. Spray painting shall be performed specifically by methods submitted and as approved by the Engineer.
7. All surfaces to be painted as well as the atmosphere in which painting is to be done shall be kept warm and dry by heating and ventilation, if necessary, until each coat of paint has hardened. Any defective paint shall be scraped off and repainted in accordance with the Engineer's directions.
8. Before final acceptance of the work, all damaged surfaces of paint shall be cleaned and repainted as directed by the Engineer.
9. Only the aluminum work noted on the Drawings or in the Painting Schedule shall be field painted.

#### 3.04 FIELD QUALITY CONTROL

- A. Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when coatings are being applied:
  1. Owner will engage the services of a qualified testing agency to sample coating material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
  2. Testing agency will perform tests for compliance with specified requirements.
  3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with specified requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

#### 3.05 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Engineer, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.06 PAINTING SCHEDULE

- A. All colors will be selected by the Engineer.
- B. Severe Exposure is defined as areas exposed to:
  - 1) Chemical liquid, vapor, or fumes
  - 2) H<sub>2</sub>S (includes all untreated wastewater wet-wells)
  - 3) Salt spray or other extreme weathering condition
- C. If not classified as Severe the exposure is to be considered Moderate Exposure
- D. The following surfaces shall have the types of paint scheduled below applied at the dry film thickness (DFT) in mils per coat noted:
  - 1. Exterior non-submerged ferrous metals, including ductile iron pipe (exterior or in vaults).
    - a. First and Second Coat: On properly prepared unprimed metal or for touch-up
      - 1) TN: Series N69 (3.0-4.0 DFT)
      - 2) Or equal.
    - b. Third Coat:
      - 1) TN: Series 73 (3.0 DFT).
      - 2) Or equal.
  - 2. Interior non-submerged ferrous metals, including ductile iron pipe (except first coat of previously painted metal work), on properly prepared unprimed metal or for touch-up.
    - a. First and Second Coats:
      - 1) TN: Series N69 (3.0-4.0 DFT)
      - 2) Or equal.
  - 3. Submerged ferrous metals and ferrous metals subject to submersion or splashing, including ductile iron pipe. Surface shall be lightly sanded or abraded before application of first field coat.
    - a. First Coat:
      - 1) TN: Series N69 (4.0 - 6.0 DFT)
      - 2) Or equal.
    - b. Finish Coat for Moderate Exposure:
      - 1) TN: Series 142 Epoxoline (12 – 16 mils DFT)



- c. Finish Coat for Severe Exposure (H2S & Chemical):
  - 1) TN: Series G435 Perma-Shield Glaze (15 – 20 mils DFT)
  
- 4. UV exposed plastic piping and plastic components, or where scheduled
  - a. First and Second Coats:
    - 1) TN: Series 1026 (2.0 – 3.0 DFT)
    - 2) Or equal.
  
- 5. Previously painted existing concrete/CMU scheduled for painting:
  - a. First and Second Coats:
    - 1) TN: Series 1026 (2.0-3.0 DFT)
    - 2) Or equal.
  
- 6. Previously painted metal surfaces - First coat on substrates prepared as approved and replacing first coat of above-specified systems. Complete painting with remainder of specified system for each type of substrate.
  - a. First Coat:
    - 1) TN: FC Typoxy Series 27 (4.0 - 5.0 DFT)
    - 2) Or equal.
  
- 7. Galvanized surfaces where scheduled to be painted. (Mechanically abrade surfaces to a uniform profile of 1 to 2 mils and clean completely.)
  - a. First Coat:
    - 1) TN: N69/N69F HB Epoxoline II (2.0 to 3.0 DFT)
    - 2) Or equal.
  
  - b. Second Coat:
    - 1) TN: Series 73 (2.5 to 3.5 DFT)
    - 2) Or equal.

8. Concrete Repair Moderate Exposure:

a. Surface Preparation:

SSPC-SP13/NACE No. 6 ICRI – CSP5

b. First Coat:

- 1) TN: Series 218 Mortarclad (1/16”-1/4” per lift; maximum 1/2” thickness)
- 2) Or Equal

c. Second Coat:

- 1) TN: Series G435 Perma-Shield Glaze (30.0 to 40.0 DFT)
- 2) Or Equal

Concrete Repair Severe Exposure H2S & Chemical:

a. Surface Preparation:

SSPC-SP13/NACE No. 6 ICRI – CSP5

b. First Coat:

- 1) TN: Series 217 MortarCrete as needed to patch repair concrete (1/4” to 4” DFT)
- 2) TN: Series 218 MortarClad (1/16” to 1/4” thickness)
- 3) Or Equal

c. Second Coat:

- 1) TN: Series G435 Perma-Shield Glaze (60.0 to 80.0 DFT)
- 2) Or Equal

d. Finish Coat:

- 1) TN: Series G435 Perma-Shield Glaze (15.0 to 20.0 mils DFT)
- 2) Or Equal

9. New Concrete for Severe Exposure:

a. Surface Preparation:

SSPC-SP13/NACE No. 6 - Allow new cast-in-place concrete to cure a minimum of 28 days at 75°F (24°C). Verify concrete dryness in accordance with ASTM F 1869 “Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride” (moisture vapor transmission should not exceed three pounds per 1,000 square feet in a 24 hour period), F 2170 “Standard Test

Method for Determining Relative Humidity in Concrete using in situ Probes” (relative humidity should not exceed 80%), or D 4263 “Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method” (no moisture present). Prepare concrete surfaces in accordance with NACE No. 6/SSPC-SP13 Joint Surface Preparation Standards and ICRI Technical Guidelines. Abrasive blast, shot-blast, water jet or mechanically abrade concrete surfaces to remove laitance, curing compounds, hardeners, sealers and other contaminants and to provide a minimum ICRI-CSP 5 surface profile. Large cracks, voids and other surface imperfections should be filled with a recommended filler or surfacer.

b. First Coat:

- 3) TN: Series 218 MortarClad (1/16” min DFT)
- 4) Or Equal

c. Second Coat:

- 3) TN: Series G435 Perma-Shield Glaze (60.0 to 80.0 DFT)
- 4) Or Equal

d. Finish Coat:

- 1) TN: Series G435 Perma-Shield Glaze (15.0 to 20.0 mils DFT)
- 2) Or Equal

END OF SECTION



## SECTION 16000

### ELECTRICAL - GENERAL PROVISIONS

#### PART 1 GENERAL

##### 1.01 SCOPE OF WORK

- A. Furnish all labor, materials and equipment required and install complete and make operational, electrical system as shown on the Drawings and as specified herein.
- B. The work shall include the following:
  - 1. Coordinate the electrical service requirements with the power company and provide the electrical service(s) from the Power Company at the locations indicated.
  - 2. Provide conduit, wire and field connections for all motors, motor controllers, control devices, control panels and electrical equipment furnished under Divisions 1, 11, 13 and 15.
  - 3. Provide conduit, wiring and terminations for variable frequency drives, reactors, harmonic filters, transformers and power factor correction capacitors furnished and mounted under other related Divisions.
- C. Each bidder or their authorized representatives shall, before preparing their proposal, visit all areas of the existing buildings and structures in which work under this sub-bid is to be performed and inspect carefully the present installation. The submission of the proposal by this bidder shall be considered evidence that their representative has visited the buildings and structures and noted the locations and conditions under which the work will be performed and that he/she takes full responsibility for a complete knowledge of all factors governing his/her work.

##### 1.02 SUBMITTALS

- A. As a minimum all equipment specified in each Section of Division 16 shall be submitted at one time. As an example all lighting fixtures shall be submitted together, all motor control centers shall be submitted together, etc. Submittals that do not comply will be returned disapproved.
- B. Mark submittals to clearly identify proposed equipment including accessories, options, and features and to exclude parts not applicable to the project. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submittal piece of literature and each submittal drawing shall clearly reference the Project Specification and/or Contract Drawing that the submittal is to cover. General catalogs will not be accepted as cut sheets to fulfill submittal requirements.
- C. Check shop drawings for accuracy prior to submittal. Shop drawings shall be stamped with the date checked and a statement indicating that the shop drawings conform to this Section and the Drawings. This statement shall also list all exceptions to this Section and the Drawings. Mark submittals to identify proposed equipment including accessories, options and features being

proposed for approval and exclude parts not to be used. Shop drawings not so checked and noted shall be returned marked NOT APPROVED.

- D. The Engineer's check shall be for conformance with the design concept of the project and compliance with this Section and the Drawings. Errors and omissions on approved shop drawings shall not relieve the Contractor from the responsibility of providing materials and workmanship required by this Section and the Drawings.
- E. All dimensions shall be field verified at the job site and coordinated with the work of all other trades.
- F. Material shall not be ordered or shipped until the shop drawings have been approved. No material shall be ordered or shop work started if shop drawings are marked "APPROVED AS NOTED - CONFIRM," "APPROVED AS NOTED - RESUBMIT" or "NOT APPROVED."
- G. Operation and Maintenance Data
  - 1. Submit operations and maintenance data for equipment furnished under this Division, in accordance with Section 01730. The manuals shall be prepared specifically for this installation and shall include catalog data sheets, drawings, equipment lists, descriptions, parts lists including replacement part numbers, to instruct operating and maintenance personnel unfamiliar with such equipment.
  - 2. Manuals shall include the following as a minimum:
    - a. A complete "As-Built" set of approved shop drawings.
    - b. A complete list of the equipment supplied, including serial numbers, ranges and pertinent data.
    - c. Detailed service, maintenance and operation instructions for each item supplied.
- H. Exceptions for Submittals
  - 1. Exceptions to the Specifications or Drawings shall be clearly defined by the Electrical Subcontractor in a separate section of each submittal package. The submittal shall contain the reason for the exception, the exact nature of the exception and the proposed substitution so that a proper evaluation may be made by the Engineer. The acceptability of any device or methodology submitted as an "or equal" or "exception" to the Specifications shall be at the sole discretion of the Engineer.
  - 2. Submittals for certain major items such as generators, automatic transfer switches, and Variable Frequency Drives (100 hp and up ) shall include a complete copy of their specification section with each paragraph and sub-paragraph noted with the comment "compliance" , "deviation" , or "alternate".
    - a. By noting the term "compliance", it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
    - b. By noting the term "deviation", it shall be understood that the manufacturer

prefers to provide a different component in lieu of the one specified and in so doing, takes full responsibility for making the equipment work as specified and will provide any and all ancillary components to make the equipment work at no extra cost to the Owner.

- c. By noting the term "alternate", it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner and in so doing, takes full responsibility for making the equipment work as specified and will provide any and all ancillary components to make the equipment work at no extra cost to the Owner. The alternate method shall be fully described with schematic diagrams and one-line diagrams as applicable.

I. Submittals will be returned to the Contractor under one of the following codes.

Code 1 -"APPROVED" is assigned when there are no notations or comments on the submittal. When returned under this code the Contractor may release the equipment and/or material for manufacture.

Code 2 -"APPROVED AS NOTED" - This code is assigned when a confirmation of the notations and comments IS NOT required by the Contractor. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product.

Code 3 -"APPROVED AS NOTED/CONFIRM" - This combination of codes is assigned when a confirmation of the notations and comments IS required by the Contractor. The Contractor may, at his own risk, release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product. This confirmation shall specifically address each omission and nonconforming item that was noted. Confirmation is to be received by the Engineer within 10 calendar days of the date of the Engineer's transmittal requiring the confirmation.

Code 4 -"APPROVED AS NOTED/RESUBMIT" - This combination of codes is assigned when notations and comments are extensive enough to require a resubmittal of the package. This resubmittal is to address all comments, omissions and non-conforming items that were noted. Resubmittal is to be received by the Engineer within 15 calendar days of the date of the Engineer's transmittal requiring the resubmittal.

Code 5 -"NOT APPROVED" is assigned when the submittal does not meet the intent of the Contract Documents. The Contractor must resubmit the entire package revised to bring the submittal into conformance. It may be necessary to resubmit using a different manufacturer/vendor to meet the Contract Documents.

Code 6 -"COMMENTS ATTACHED" is assigned where there are comments attached to the returned submittal which provide additional data to aid the Contractor.

Code 7 -"RECEIPT ACKNOWLEDGED" - This code is assigned to acknowledge receipt of a submittal that is not subject to the Engineer's review and approval; and, is being filed for informational purposes only. This code is generally used in acknowledging receipt of *means*

*and methods of construction* work plan, field conformance test reports, and Health and Safety plans.

Codes 1 through 5 designate the status of the reviewed submittal with Code 6 showing there has been an attachment of additional data.

### 1.03 REFERENCE STANDARDS

- A. Electric equipment, materials and installation shall comply with the National Electrical Code (NEC).
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

### 1.04 PRIORITY OF THE CONTRACT DOCUMENTS

- A. If, during the performance of the work, the Contractor finds a conflict, error or discrepancy between or among one or more of the Sections or between or among one or more Sections and the Drawings, furnish the higher performance requirements. The higher performance requirement shall be considered the equipment, material, device or installation method which represents the most stringent option, the highest quality or the largest quantity.
- B. In all cases, figured dimensions shall govern over scaled dimensions, but work not dimensioned shall be as directed by the Engineer and work not particularly shown, identified, sized, or located shall be the same as similar work that is shown or specified.
- C. Detailed Drawings shall govern over general drawings, larger scale Drawings take precedence over smaller scale Drawings, Change Order Drawings shall govern over Contract Drawings and Contract Drawings shall govern over Shop Drawings.
- D. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract Documents and any referenced standard, or code of any technical society, organization or association, the provisions of the Contract Documents will take precedence if they are more stringent or presumptively cause a higher level of performance. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization or association, or between Laws and Regulations, the higher performance requirement shall be binding on the Contractor, unless otherwise directed by the Engineer.
- E. In accordance with the intent of the Contract Documents, the Contractor accepts the fact that compliance with the priority order specified shall not justify an increase in Contract Price or an extension in Contract Time nor limit in any way, the Contractor's responsibility to comply with all Laws and Regulations at all times

### 1.05 ENCLOSURE TYPES

- A. Unless otherwise required, electrical enclosures shall be NEMA Types as follows:
  - 1. NEMA 4 in outdoor locations, rooms below grade including basements and buried vaults and "WET" locations shown on the Drawings.



2. NEMA 4X in "CORROSIVE" locations shown on the Drawings.

#### 1.06 SERVICE AND METERING

- A. Service will be obtained at 480 Volts, 3Phase, 4Wire, 60 Hz.
- B. The Contractor shall be responsible for the following work:
  1. Obtain an estimate from the power company for the work described above and include the cost of the power company work in the Bid Price.
  2. Make all arrangements with the power company for obtaining electrical service, pay all power company charges.

#### 1.07 CODES, INSPECTION AND FEES

- A. Equipment, materials and installation shall comply with the requirements of the local authority having jurisdiction.
- B. Obtain all necessary permits and pay all fees required for permits and inspections.

#### 1.08 INTERPRETATION OF DRAWINGS

- A. Unless specifically stated to the contrary, the Drawings do not show exact locations of conduit runs. Coordinate the conduit installation with other trades and the actual supplied equipment.
- B. Install each 3 phase circuit in a separate conduit unless otherwise shown on the Drawings.
- C. Conduit shown exposed shall be installed exposed; conduit shown concealed shall be installed concealed. Unless otherwise indicated install branch circuit conduits exposed in process/ industrial type spaces and concealed in finished spaces.
- D. Where circuits are shown as "home-runs" all necessary fittings and boxes shall be provided for a complete raceway installation. Where home-runs indicate conduit is to be installed concealed or exposed the entire branch circuit shall be installed in the same manner.
- E. Verify the exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation.
- F. Except where dimensions are shown, the locations of equipment, fixtures, outlets and similar devices shown on the Drawings are approximate only. Exact locations shall be determined by the Contractor and approved by the Engineer during construction. Obtain information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.
- G. Circuit layouts are not intended to show the number of fittings, or other installation details. Furnish all labor and materials to install and place in satisfactory operation all power, lighting and other electrical systems shown.
- H. Redesign of electrical or mechanical work, which is required due to the Contractor's use of an alternate item, arrangement of equipment and/or layout other than specified herein, shall be

done by the Contractor at his/her own expense. Redesign and detailed plans shall be submitted to the Engineer for approval. No additional compensation will be provided for changes in the work, either his/her own or others, caused by such redesign.

- I. Raceways and conductors for low voltage (120 Volts) thermostats controlling HVAC unit heaters, exhaust fans and similar equipment are not shown on the Drawings. Provide raceways and conductors between the thermostats, the HVAC equipment and the motor starters for a complete and operating system. Raceways shall be installed concealed in all finished space and may be installed concealed or exposed in process spaces. Refer to the HVAC drawings for the locations of the thermostats.

#### 1.09 SIZE OF EQUIPMENT

- A. Investigate each space in the structure through which electrical equipment furnished under Division 16 must pass to reach its final location. Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the structure.
- B. The equipment shall be kept upright at all times during storage and handling. When equipment must be tilted for passage through restricted areas, brace the equipment to ensure that the tilting does not impair the functional integrity of the equipment.

#### 1.10 RECORD DRAWINGS

- A. As the work progresses, legibly record all field changes on a set of Project Contract Drawings, hereinafter called the "Record Drawings."

#### 1.11 MATERIALS AND EQUIPMENT

- A. Materials and equipment furnished under this contract shall be new.
- B. Material and equipment of the same type shall be the product of one manufacturer and shall be UL listed.

#### 1.12 EQUIPMENT IDENTIFICATION

- A. Identify equipment, disconnect switches, separately mounted motor starters, control stations, etc. furnished under Division 16 with the name of the equipment it serves. Motor control centers, control panels, panelboards, switchboards, switchgear, junction or terminal boxes, transfer switches, etc, shall have nameplate designations as shown on the Drawings.
- B. Nameplates shall be engraved, laminated plastic, not less than 1/16-in thick by 3/4-in by 2-1/2-in with 3/16-in high white letters on a black background.
- C. Nameplates shall be screw mounted to NEMA 1 enclosures. Nameplates shall be bonded to all other enclosure types using an epoxy or similar permanent waterproof adhesive. Two sided foam adhesive tape is not acceptable. Where the equipment size does not have space for mounting a nameplate the nameplate shall be permanently fastened to the adjacent mounting surface.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

### 3.01 LEEVES AND FORMS FOR OPENINGS

- A. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all slots for electrical work and form before concrete is poured.
- B. Exact locations are required for stubbing-up and terminating concealed conduit. Obtain shop drawings and templates from equipment vendors or other subcontractors and locate the concealed conduit before the floor slab is poured.
- C. Where setting drawings are not available in time to avoid delay in scheduled floor slab pours, the Engineer may allow the installations of such conduit to be exposed. Requests for this deviation must be submitted in writing. No additional compensation for such change will be allowed.

### 3.02 CUTTING AND PATCHING

- A. Cutting and patching shall be done in a thoroughly workmanlike manner and be in compliance with modifications and repair to concrete as specified. Saw cut concrete and masonry prior to breaking out sections.

### 3.03 INSTALLATION

- A. Work not installed according to the Drawings and Specification shall be subject to change as directed by the Engineer at Contractor's expense.
- B. Electrical equipment shall be protected against mechanical and water damage. Store all electrical equipment in dry permanent shelters. Do not install electrical equipment in place until structures are weather-tight.
- C. Damaged equipment shall be replaced or repaired by the equipment manufacturer, at the Engineer's discretion and at the Contractor's expense.
- D. Repaint any damage to factory applied paint finish using touch-up paint furnished by the equipment manufacturer.

### 3.04 WORK SUPERVISION

- A. The Contractor shall designate in writing the qualified electrical supervisor who shall provide supervision to all electrical work on this project. The minimum qualifications for the electrical supervisor shall be a master electrician as defined by the Arkansas Board of Electrical Examiners. The supervisor or his appointed alternate possessing at least a journeyman electrician license shall be on site whenever electrical work is being performed. The qualifications of the electrical supervisor shall be subject to approval of the Owner and the Engineer.
- B. All master and journeyman electricians shall be licensed in accordance with Arkansas Code Title 17 Chapter 28 - Electricians. The website located at <http://www.arkleg.state.ar.us> publishes the text of this statutory requirement. No unlicensed electrical workers shall perform work on this project. Apprentice electricians in a ratio of not more than one apprentice per

journeyman electrician will be allowed if the apprentices are licensed and actively participating in an apprenticeship program recognized and approved by the Arkansas Board of Electrical Examiners.

END OF SECTION

## SECTION 16110

### RACEWAYS, BOXES, FITTINGS AND SUPPORTS

#### PART 1 GENERAL

##### 1.01 SCOPE OF WORK

- A. Furnish and install complete raceway systems as shown on the Drawings and as specified herein.
- B. Home runs indicated are to assist the contractor in identifying raceways to be installed concealed or exposed. Raceways identified to be installed exposed on the Drawings shall be run near the ceilings or along the walls of the areas through which they pass and shall be routed to avoid conflicts with HVAC ducts, cranes and hoists, lighting fixtures, doors and hatches. Raceways indicated to be run concealed shall be run in the center of concrete floor slabs, in partitions, or above hung ceilings, as required.

#### PART 2 PRODUCTS

##### 2.01 RACEWAYS AND FITTINGS

- A. Steel Conduit and Fittings
  - 1. Rigid metal conduit (GRS), couplings, factory elbows and fittings shall be heavy wall steel tubing with a hot-dipped galvanized finish inside and out after threading and shall comply with ANSI C 80.1 and UL/6.
  - 2. Intermediate metal conduit (IMC), couplings, factory elbows and fittings shall be medium wall steel tubing with a hot-dipped galvanized finish inside and out after threading and shall comply with UL/1242.
  - 3. Electrical metallic tubing (EMT), factory elbows and fittings shall be thin wall steel tubing with an electrically galvanized finish after fabrication and comply with ANSI C80.3 and UL/797.
  - 4. Acceptable manufacturers:
    - a. Allied Tube & Conduit Corp.
    - b. LTV Steel Tubular Products Corp.
    - c. Triangular PWC Inc.
    - d. Or equal.
  - 5. Rigid metal and intermediate metal conduit fittings shall be of the threaded type, and shall be steel or malleable iron, with a hot-dipped galvanized finish. Threadless fittings and split couplings are not allowed except in specific applications as approved by the Engineer.

6. Electrical metallic tubing fittings shall be of the rain tight, concrete tight, compression type with malleable iron or pressure cast steel body, steel hex type compression nut and electrically galvanized finish.
7. Acceptable manufacturers:
  - a. Appleton Electric Co.
  - b. O-Z Gedney Co.
  - c. RACO Inc.
  - d. Gould/Efcor
  - e. Steel City
  - f. Or equal

B. PVC Coated Rigid Steel Conduit and Fittings

1. PVC coated rigid steel conduit shall be heavy wall steel tubing with a hot-dipped galvanized finish inside and out after threading with a minimum 0.040-in thick, polyvinyl chloride coating permanently bonded to it and an internal chemically cured urethane or enamel coating. The rigid steel conduit shall comply with ANSI C80.1 and UL/6 prior to coating.
2. PVC coated couplings, factory elbows and fitting shall be furnished with a PVC coating bonded to steel the same thickness as used on the PVC coated conduit. The ends of all couplings, fittings, etc. shall have a minimum of one pipe diameter in length of PVC overlap.
3. Acceptable manufacturers:
  - a. "OCAL" as manufactured by Thomas & Betts
  - b. "Plasti-Bond Red" as manufactured by Robroy Industries
  - c. Triangle PWC Inc
  - d. Or equal

C. Non Metallic Conduit and Fittings

1. PVC conduit shall be rigid polyvinyl chloride schedule 40. Rigid PVC conduit up to trade sizes 3-1/2-in shall comply with NEMA TC-2 and UL/651 and shall be sunlight resistant, rated for use with 90 degree C conductors in exposed, direct burial or concrete encased applications. Underground utility duct, 4-in trade size and above, shall be polyvinyl chloride (PVC).
2. Connectors, couplings, fittings and ancillary materials shall be supplied by the conduit manufacturer. Connectors, fittings and ancillary materials shall be rated for the environment for which they are installed.

3. Acceptable manufacturers:
  - a. Carlon Corp.
  - b. Certained Corp.
  - c. Conux Pipe Systems, Inc.
  - d. Or equal.

D. Liquid-tight Flexible Metal Conduit, Couplings and Fittings

1. Liquid-tight flexible metal conduit shall be square locked, galvanized steel flexible conduit with a moisture proof, flame resistant, polyvinyl chloride jacket, for use with rigid metal conduit systems. Sealtite, Type UA, manufactured by the Anaconda Metal Hose Div.; Anaconda American Brass Co.; American Flexible Conduit Co., Inc.; Universal Metal Hose Co. or equal.
2. Liquid-tight conduit fittings shall be hot-dipped mechanically galvanized, positive grounding, screw in type. Provide external bonding lugs on sizes 1-1/4-in and larger. Box connectors shall have insulated throats as manufactured by the Thomas & Betts Co.; Crouse-Hinds Co. or equal.
3. Acceptable Manufacturers:
  - a. American Flexible Conduit Co.
  - b. Anaconda Metal Hose/ANAMET Inc.
  - c. Electri-flex Co.
  - d. Thomas & Betts
  - e. O-Z Gedney
  - f. Or equal

2.02 BOXES AND FITTINGS

A. Dry and Damp Location Boxes and Fittings

1. Outlet boxes shall be zinc-galvanized, extra depth, pressed steel with knockouts and of size and type suitable for the intended application.
2. Boxes that are less than 100 cubic inches in size used for junction or pull boxes shall be zinc galvanized pressed steel not less than 14 USS gauge with appropriate blank covers, minimum size 4-11/16-in square by 2-1/8-in deep.
3. Boxes that are 100 cubic inches and larger shall be constructed of hot dip galvanized sheet steel without knockouts. Covers shall be secured with round head brass machine screws. All joints shall be welded and ground smooth.

4. Terminal cabinets shall be NEMA 12 sheet steel unless otherwise shown on the Drawings. Boxes shall be painted and have continuously welded seams. Welds shall be ground smooth and galvanized. Box bodies shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14 gauge metal and covers shall not be less than 12 gauge metal. Terminal boxes shall be furnished with latching hinged doors, terminal mounting straps and brackets. Terminal blocks shall be rated not less than 20A, 600V.
5. Acceptable Manufacturers:
  - a. Appleton
  - b. Raco
  - c. Steel City
  - d. Hoffman
  - e. Electromate Division of Robroy Ind.
  - f. Wiegmann

B. Wet Location Boxes and Fittings

1. NEMA 4 terminal boxes, junction boxes, pull boxes, etc, shall be sheet Type 316 stainless steel unless otherwise shown on the Drawings. Boxes shall have continuously welded seams and mounting feet. Welds shall be ground smooth. Boxes shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14 gauge metal and covers shall not be less than 12 gauge metal. Covers shall be gasketed and fastened with stainless steel clamps. Terminal boxes shall be furnished with hinged doors, terminal mounting straps and brackets. Terminal blocks shall be NEMA type, not less than 20 Amps, 600 Volt.
2. Cast or malleable iron device boxes shall be Type FD. Boxes and fittings shall have cadmium-zinc finish with cast covers and stainless steel screws.
3. Cast aluminum device boxes shall be Type FD. Boxes and fittings shall be copper free aluminum with cast aluminum covers and stainless steel screws
4. Acceptable Manufacturers:
  - a. Appleton
  - b. Crouse-Hinds
  - c. Steel City
  - d. Hoffman
  - e. Electromate - Division of Robroy Ind.
  - f. Or equal



## 2.03 HARDWARE

### A. Conduit Mounting Equipment

1. Stainless steel channel with stainless steel hardware shall be used in ALL indoor areas and in outdoor locations.
2. Furnish any and all necessary supports, brackets, conduit sleeves, racks and bracing as required. All boxes and hardware shall be stainless steel.

### B. Conduit Supports

1. Trapezes
  - a. In dry indoor areas, beams, channels, struts, hangers, bracing, rods, beam clamps, accessories and components shall be stainless steel.
  - b. Stainless steel beams, channels, struts or fiberglass beams, channels, struts with stainless steel hangers, bracing, rods, beam clamps, accessories and components shall be used in all areas.
2. Conduit Racks
  - a. In dry indoor areas, conduit racks, accessories and components shall be stainless steel.
  - b. Stainless steel conduit racks with stainless, accessories and components shall be used in all areas.

## PART 3 EXECUTION

### 3.01 RACEWAY APPLICATIONS

- A. Refer to Table 16110-1 for specific raceway application requirements.
- B. All conduit of a given type shall be the product of one manufacturer.

### 3.02 BOX APPLICATIONS

- A. Terminal boxes, junction boxes and pull boxes shall have NEMA ratings suitable for the location in which they are installed.
- B. All conduit bodies and pulling outlets shall comply with NEC wire bending space requirements. Mogul type fittings shall be used for sizes 2-1/2-in and larger.

**TABLE 16110-1**  
**Raceway Application Guidelines**

<b>Location/Circuit Type</b>	<b>Raceway Type</b>
<p><u>All locations</u></p> <ul style="list-style-type: none"> <li>▪ Class 2 and 3 signal wiring and 4-20 mA instrumentation cables, non-fiber (copper) data highway.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Exposed - Galvanized rigid steel (GRS) conduit. Use PVC coated rigid steel conduit in corrosive areas.</li> <li>▪ Concealed - Galvanized rigid steel (GRS) conduit.</li> <li>▪ Underground - PVC duct (as specified) in duct bank.</li> <li>▪ Use PVC coated steel conduit for single conduit direct burial applications.</li> </ul>
<p><u>Clean, dry finished areas</u> - offices, administrative areas, lobbies, control room, lunch room, toilets, and laboratories, etc.</p>	<ul style="list-style-type: none"> <li>▪ Conceal raceways in walls above hung ceilings in rooms and areas that have finished interiors. Surface raceway for multiple receptacle, voice, and data outlets in labs and control rooms or in offices where specified.</li> <li>▪ 3/4 or 1-in electrical metallic tubing (EMT) for lighting, switch, and receptacle circuits exposed above hung ceilings or concealed in partition walls. Galvanized rigid steel (GRS) above 1-in.</li> </ul>
<p><u>Clean, dry non-finished areas</u> - electrical rooms, generator rooms, mechanical rooms, shops, dry storage, etc.</p>	<ul style="list-style-type: none"> <li>▪ Exposed conduit for power wiring, lighting, switch, and receptacle circuits - Galvanized rigid steel (GRS).</li> <li>▪ Concealed conduit for power wiring, lighting, switch, and receptacle circuits - Schedule 40 PVC conduit when embedded within concrete floor slabs. GRS when embedded within masonry block walls.</li> </ul>
<p><u>Process areas</u> - non-corrosive, non-hazardous locations designated as DAMP or WET on the Drawings.</p>	<ul style="list-style-type: none"> <li>▪ Exposed conduit for power wiring, lighting, switch, and receptacle circuits - Galvanized rigid steel (GRS).</li> <li>▪ Concealed conduit for power wiring, lighting, switch, and receptacle circuits - Schedule 40 PVC conduit when embedded within concrete floor slabs. GRS when embedded within masonry block walls.</li> </ul>

**TABLE 16110-1**  
**Raceway Application Guidelines**

<b>Location/Circuit Type</b>	<b>Raceway Type</b>
<u>Outdoor areas</u> - all locations.	<ul style="list-style-type: none"> <li>▪ Exposed conduit for power wiring, lighting, switch, and receptacle circuits - Galvanized rigid steel (GRS). PVC conduit shall not be used exposed.</li> <li>▪ Concealed conduit for power wiring, lighting, switch, and receptacle circuits - Schedule 40 PVC conduit when embedded within concrete structures.</li> </ul>

3.03 FITTINGS APPLICATIONS

- A. Combination expansion-deflection fittings shall be used where exposed conduits cross structure expansion joints or in straight runs where expansion is anticipated. Combination expansion-deflection fittings shall be installed where embedded conduits cross structural expansion joints. Refer to Structural Drawings for expansion joint locations. Provide bonding jumpers around fittings.
- B. All underground conduit penetrations at walls or other structures shall be sealed watertight. Conduit wall seals and sleeves shall be used in accordance with the manufacturer's installation instructions and the details shown on the Drawings.
- C. Conduit sealing bushings shall be used to seal conduit ends exposed to the weather and at other locations shown on the Drawings.
- D. Insulated throat grounding bushings shall be used where specified herein and where conduits stub up into electrical equipment such as MCC's, switchgear, etc.

3.04 INSTALLATION

- A. No conduit smaller than 3/4-in electrical trade size shall be used, nor shall any have more than the equivalent of three 90 degree bends in any one run. Pull boxes shall be provided as required by the NEC after every 270 degrees of bends and for straight run not to exceed 200 feet or as directed.
- B. All conduit which may under any circumstance contain liquids such as water, condensation, liquid chemicals, etc, shall be arranged to drain away from the equipment served. If conduit drainage is not possible, conduit seals shall be used to plug the conduits. The ends of all conduits shall be temporarily plugged to exclude dust, moisture and debris from entering during construction.
- C. Conduit ends exposed to the weather shall be sealed with conduit sealing bushings.
- D. Conduits noted as spare shall be capped or plugged at both ends with easily removable fittings.
- E. Conduit terminating in NEMA 3R, 4, 4X enclosures shall be terminated with Myers type conduit hubs.

- F. Conduit terminating in pressed steel boxes shall have double locknuts and insulated bushings.
- G. Conduits containing equipment grounding conductors and terminating in sheet steel boxes shall have insulated throat grounding bushings.
- H. Conduits shall be installed using threaded fittings except for PVC or EMT.
- I. The use of running threads is prohibited. Where such threads are necessary, a 3-piece union shall be used.
- J. All conduits entering or leaving a motor control center, switchboard or other multiple compartment enclosure shall be stubbed up into the bottom horizontal wireway or other manufacturer's designated area, directly below the vertical section in which the conductors are to be terminated. The 3-in extension of conduit above the floor slab or concrete equipment pad may be reduced to a dimension that suits the equipment manufacturer's installation requirements if the 3-in stub-up interferes with the equipment being provided.
- K. Rigid galvanized steel conduits buried in earth shall be completely painted with bitumastic.
- L. Rigid galvanized steel conduits which have been field cut and threaded shall be painted with cold galvanizing compounds.
- M. PVC coated rigid galvanized steel conduit shall be used for elbows at risers at the utility pole for electrical and telephone service conduits. Rigid galvanized steel conduit shall be used at utility pole for electrical and telephone service and fire alarm conduits to a height of 10-ft above finished grade. Furnish and install weather heads at service pole riser if required by utility company.
- N. Liquid-tight flexible metal conduit shall be used for all motor terminations, the primary and secondary of transformers, generator terminations and other equipment where vibration is present or may require removal. Non-metallic flexible conduit can be used with rigid PVC conduit systems.
- O. Flexible couplings shall be used in hazardous locations for all motor terminations and other equipment where vibration is present.
- P. PVC coated rigid steel conduit shall be used as a transition section where concrete embedded conduit stubs out of floor slabs or through below grade walls or where conduit installed under building slabs on grade stub out of floors. The PVC coated rigid steel conduit shall extend a minimum of 3-in into and out of the floor slab, concrete pad, or wall to allow for proper threading of the conduit.
- Q. Expansion fittings shall be used on exposed runs of PVC conduit where required for thermal expansion. Installation and number of fittings shall be as recommended by manufacturer.
- R. Conduit supports, other than for underground raceways, shall be spaced at intervals not exceeding the distance required by the NEC to obtain rigid construction.
- S. Single conduits shall be supported by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the surface. Multiple runs of conduits shall be supported on fabricated channel trapeze type racks with steel horizontal members and threaded

hanger rods. The rods shall be not less than 3/8-in diameter. Surface mounted panel boxes, junction boxes, conduit, etc, shall be supported by spacers to provide a minimum of 1/2-in clearance between wall and equipment.

T. Conduit Supports (Other than Underground Raceways)

1. Trapezes

- a. Conduit support trapezes shall be vertically supported every 10-ft or less, as required to obtain rigid conduit construction.
- b. Lateral seismic restraints (Sway Bracing) shall be spaced 30-ft or less.
- c. Horizontal seismic restraints shall be spaced at 40-ft or less. There shall be at least one horizontal restraint per horizontal run.
- d. Attachment to structural steel shall be by beam clamps or welded beam attachment. C-clamps will not be allowed for vertical hangers. Side beam clamps with beam hooks shall be used for seismic restraint only.
- e. Attachment to concrete shall be cast-in-place inserts, cast-in place welded plates with welded studs or stainless steel adhesive anchors.

2. Flush Mounted Supports

- a. Support shall be spaced 10-ft or less, as required to obtain rigid conduit construction.
- b. Attachment to concrete shall be with cast-in-place inserts, cast-in place welded plates with welded studs or stainless adhesive anchors.

3. Conduit Racks

- a. Support shall be spaced 10-ft or less, as required to obtain rigid conduit construction.
- b. Horizontal seismic restraints shall be spaced at 30-ft or less, with welded studs or stainless adhesive anchors.

4. Conduit Hangers

- a. Conduit hangers shall be vertical supported 10-ft or less, as required to obtain rigid conduit construction.
- b. Lateral seismic restraints (Sway Bracing) shall be spaced 20-ft or less.
- c. Horizontal seismic restraints shall be spaced at 30-ft or less. There shall be at least one horizontal restraint per horizontal run.
- d. Attachment to structural steel shall be by beam clamps or welded beam attachment. C-clamps will not be allowed for vertical hangers. Side beam clamps with beam hooks shall be used for seismic restraint only.

- e. Attachment to concrete shall be cast-in-place inserts, cast-in place welded plates with welded studs or stainless steel adhesive anchors.
- 5. All reinforcing bars shall be located by the Electrical Subcontractor with the use of a rebar locator prior to installing adhesive capsule type anchors. Mark the location of all reinforcing bars in an area bounded by a line drawn at least 18-in from the edge of the support bearing/weld plates on all four sides of the bearing/weld plates prior to fabricating and installing bearing/weld plates.
- 6. Where interference occurs, adjust anchor locations to clear reinforcing bars and alter support configuration at no additional cost to the Authority.
- U. Miscellaneous steel for the support of fixtures, boxes, transformers, starters, contactors, panels and conduit shall be furnished and installed. Channel supports shall be ground smooth and fitted with plastic end caps.
- V. Steel channels, flat iron and channel iron shall be furnished and installed for the support of all electrical equipment and devices, where required, including all anchors, inserts, bolts, nuts, washers, etc, for a rigid installation. Channel supports shall be ground smooth and fitted with plastic end caps.
- W. 3/16-in polypropylene pull lines shall be installed in all new conduits noted as spares or designated for future equipment. Conduit noted as spare shall be capped or plugged at both ends with easily removable fittings
- X. Where no type or size is indicated for junction boxes, pull boxes or terminal cabinets, they shall be sized in accordance with the requirements of NEC Article 314. Enclosure type and material shall be as specified herein.
- Y. Pull or junction boxes shall be furnished and installed where shown on the Drawings, in every 200 feet of straight conduit runs or in runs where more than the equivalent of four 90 degree bends occur or at any point necessary for wire pulling and splicing. Splices shall not be made in pulling elbows.

END OF SECTION

## SECTION 16120

### WIRES AND CABLES (600 VOLT MAXIMUM)

#### PART 1 GENERAL

##### 1.01. SCOPE OF WORK

- A. Furnish, install and test all wire, cable and appurtenances as shown on the Drawings and as specified herein.

##### 1.02. DELIVERY, STORAGE AND HANDLING

- A. Carefully handle all conductors to avoid kinks and damage to insulation.

#### PART 2 PRODUCTS

##### 2.01. GENERAL

- A. Wires and cables shall be of annealed, 98 percent conductivity, soft drawn copper.
- B. All conductors shall be stranded, except that lighting and receptacle wiring may be solid.
- C. Except for control, signal and instrumentation circuits, wire smaller than No. 12 AWG shall not be used.
- D. Wire shall have 600 Volt insulation except where indicated otherwise.

##### 2.02. BUILDING WIRE

- A. Wire for lighting, receptacles and other circuits not exceeding 150 Volts to ground shall be NEC type THHN/THWN as manufactured by General Cable.; American Insulated Wire Corp.; Southwire Co.; or equal.
- B. Wire for circuits over 150 Volts to ground within buildings and structures shall be NEC type THHN/THWN as manufactured by General Cable.; American Insulated Wire Corp.; Southwire Co.; or equal.
- C. Wire for circuits over 150 Volts to ground used underground or for service entrance shall be NEC type THHN/THWN as manufactured by General Cable.; American Insulated Wire Corp.; Southwire Co.; or equal.
- D. Bare copper ground wire shall be stranded, annealed copper wire ASTM-B3 alloy coated soft copper electrical wire ASTM B189.
- E. Equipment grounding conductors shall be NEC Type THW green and sized in accordance with NEC Table 250-122. Ground grid conductors shall be insulated unless shown otherwise on the Drawings.

2.03. CONTROL, STATUS AND ALARM WIRE

- A. Wire shall be No.14 AWG NEC type THHN/THWN stranded as manufactured by The Okonite Co.; General Cable.; American Insulated Wire Corp.; Southwire Co.; or equal.

2.04. INSTRUMENTATION WIRE

- A. Wire for process instrumentation signals (i.e. 1-5 VDC, 4-20 mADC), R.T.D., potentiometer and similar signals shall be:

- 1. Single pair cable:

- a. Conductors: 2 No. 16 stranded and twisted on 2-in lay
- b. Insulation: XLP with 600 Volt, 105 degrees C rating
- c. Shield: 100% Aluminum/polyester foil with drain wire
- d. Jacket: PVC with UL Subject 13, UL 1581 and manufacturers' identification
- e. Max overall diameter: 0.262-in
- f. Miscellaneous: UL Listed as Instrument Tray Cable for use in accordance with Article 727 and Article 725 of the NEC.
- g. Manufacturers: Belden; Manhattan; General Cable; The Okonite Co.; or equal

2.05. SPLICES (POWER CONDUCTORS)

- A. Unless otherwise indicated on the Drawings, splices shall not be made in the cables without prior written approval of the Engineer. Where splicing is approved by the Engineer, splicing materials for all 600 Volt splices shall be made with long barrel, tin plated copper compression (hydraulically pressed) connectors and insulated with heavy wall heat shrinkable tubing. The conductivity of all completed connections shall be not less than that of the uncut conductor. The insulation resistance of all completed connections of insulated conductors shall be not less than that of the uncut conductor.
- B. Wire lugs shall be tin plated copper, long barrel compression type (hydraulically pressed) for wire sizes No. 8 AWG and larger. Lugs for No. 10 AWG and smaller wire shall be locking spade type with insulated sleeve. Lugs shall be as manufactured by the Thomas and Betts Co.; Burndy; Amp; or equal.
- C. Compression type connectors shall be insulated with a heat shrink boot or outer covering and epoxy filling. Splice kits shall be as manufactured by Raychem (Tyco); Ideal Industries; 3M Co. or equal.
- D. Solderless pressure connectors shall be self-contained, waterproof and corrosion-proof units incorporating prefilled silicone grease to block out moisture and air. Connectors shall be sized according to manufacturer's recommendations. The connectors shall be UL listed and CSA approved, as manufactured by King Innovation; Ideal Industries, Inc., or equal.



## 2.06. MOTOR CONNECTIONS

- A. Motor connections shall be ring type mechanical compression terminations installed on the branch circuit wires and the motor leads and secured with bolt, nut and springwasher. Connections shall be insulated with a Raychem Type RVC, roll-on stub insulator; Thomas & Betts, Shrink-Kon MSCV20; or equal. For wire sizes N0. 8 and larger, long barrel, tin plated copper compression (hydraulically pressed) type connections Burndy Co., or equal) shall be installed on the branch circuit wires and the motor leads. Connections shall be insulated with heavy duty heat shrinkable material (Raychem Corp., or equal).

## 2.07. TERMINATION AND SPLICES (CONTROL, STATUS AND ALARM CONDUCTORS)

- A. Termination connectors shall be of the locking fork-end (upturned leg ends) type as manufactured by Ideal Industries; 3M Co.; Panduit Corp. or equal.
- B. Insulated compression type connectors shall be of the expanded vinyl insulated parallel or pigtail type as manufactured by Ideal Industries; 3M Co.; Panduit Corp. or equal.
- C. Solderless pressure connectors shall be self-contained, waterproof and corrosion-proof units incorporating prefilled silicone grease to block out moisture and air. Connectors shall be sized according to manufacturer's recommendations. The connectors shall be UL listed and CSA approved, as manufactured by King Innovation; Ideal Industries, Inc or equal.

## 2.08. TERMINATIONS (INSTRUMENTATION CABLES)

- A. Termination connectors shall be of the locking fork-end (upturned leg ends) type as manufactured by Ideal Industries; 3M Co.; Panduit Corp. or equal.

## 2.09. WIRE AND CABLE MARKERS

- A. Wire and cable markers shall be "Omni-Grip" as manufactured by the W.H. Brady Co.; Thomas & Betts Co., SMS; 3M Co., STD-TAG; or equal.
- B. Wire and cables with diameters exceeding the capacity of the "Omni-Grip" shall be marked with pre-printed, self-adhesive vinyl tapes as manufactured by the W.H. Brady Co.; Panduit Corp.; 3M Co.; or equal.

## PART 3 EXECUTION

### 3.01. INSTALLATION

- A. Uniquely identify all wires, cables and each conductor of multi-conductor cables (except lighting and receptacle wiring) at each end and in all manholes, hand holes and pull boxes with wire and cable markers.
- B. Use lubrications to facilitate wire pulling. Lubricants shall be UL approved for use with the insulation specified.
- C. Provide multi-conductor control and signal cables within the underground system. Cables shall be installed continuous from building to building without splices. Individual control conductors and twisted shielded pairs signal cables will not be allowed in underground systems.

- D. The crimping tools used in securing the conductor in the compression type connectors or terminal lugs shall be those made for that purpose and for the conductor sizes involved. The crimping tool shall be the ratchet type which prevents the tool from opening until the crimp action is completed. Such tools shall be a product of the connector manufacturer.
- E. Install an equipment grounding conductor in all raceways.
- F. Seal openings in slabs and walls through which wires and cables pass.
- G. Pull cables from the direction that requires the least tension. Use a feed-in tube and sheave designed for cable installation. Use sheaves with radii that exceed the cable manufacturer's recommended minimum bending radius. Use a dynamometer and constant velocity power puller. Velocity should not be less than 15-ft./min. or more than 50-ft./min. Do not exceed the cable manufacturer's maximum recommended tension.
- H. If cable can not be terminated immediately after installation, install heat shrinkable end caps.
- I. Fireproof exposed cables in manholes, vaults, pullboxes, switchgear and other areas not protected by conduit where medium voltage cables are present. Use fire-proofing tape and glass tape in accordance with the manufacturer's instructions. Fire-proofing tape shall be installed with one half-lapped layer of Scotch Brand 77 Electric Arc and Fireproofing Tape (3M Corp., or equal). Tape shall be secured with a two-layer band of Scotch Brand 69 Glass Electrical Tape (3M Corp., or equal) over the last wrap.

3.02. WIRE COLOR CODE

- A. All wire shall be color coded or coded using electrical tape in sizes where colored insulation is not available. Where tape is used as the identification system, it shall be applied in all junction boxes, manholes and other accessible intermediate locations as well as at each termination.
- B. The following coding shall be used:

System	Wire	Color
240/120 Volts Single-Phase, 3 Wire	Neutral	White
	Line 1	Black
	Line 2	Red
208Y/120, Volts 3 Phase, 4 Wire	Neutral	White
	Phase A	Black
	Phase B	Red
	Phase C	Blue
240/120 Volts 3 Phase, 4 Wire delta, center tap ground on phase coil A-C	Neutral	White
	Phase A	Black
	Phase B (High)	Orange
	Phase C	Blue
480Y/277 Volts 3 Phase, 4 Wire	Neutral	White
	Phase A	Brown

Phase B	Orange
Phase C	Yellow

- C. Neutral or ground wires that terminate in a Panelboard and require color tape shall have the color tape extend at least 6-in from the termination point.

### 3.03. TERMINATIONS AND SPLICES

- A. Power conductors: Unless otherwise indicated on the Drawings, no splices may be made in the cables without prior written approval of the Engineer. Where splicing is approved, terminations shall be die type or set screw type pressure connectors as specified. Splices (where allowed) shall be die type compression connector and waterproof with heat shrink boot or epoxy filling for copper conductors # 4 AWG and larger. Splices shall be solderless pressure connectors with insulating covers for copper conductors # 6 AWG and smaller. Aluminum conductors (where specified) shall employ terminations and splices specifically designed for aluminum conductors.
- B. Control Conductors: Termination on saddle-type terminals shall be wired directly with a maximum of two conductors. Termination on screw type terminals shall be made with a maximum of two spade connectors. Splices (where allowed) shall be made with insulated compression type connectors.
- C. Instrumentation Signal Conductors (including graphic panel, alarm, low and high level signals): terminations same as for control conductors. Splices allowed at instrumentation terminal boxes only.
- D. Except where permitted by the Engineer no splices will be allowed in manholes, handholes or other below grade located boxes.
- E. Splices shall not be made in push button control stations, control devices (i.e., pressure switches, flow switches, etc), conduit bodies, etc.

### 3.04. INSTRUMENTATION CABLES

- A. Instrumentation cables shall be installed in rigid steel raceways as specified. All circuits shall be installed as twisted pairs or triads. In no case shall a circuit be made up using conductors from different pairs or triads. Triads shall be used wherever three wire circuits are required.
- B. Terminal blocks shall be provided at all instrument cable junction and all circuits shall be identified at such junctions.
- C. Shielded instrumentation wire, coaxial, data highway, I/O and fiber optic cables shall be run without splices between instruments, terminal boxes, or panels.
- D. Ground shielding on instrumentation wires at one end only as recommended by the instrument manufacturer and isolated at all other locations. Terminal blocks shall be provided for inter-connecting shield drain wires at all junction boxes. Where individual circuit shielding is required, each shield circuit shall be provided with its own block.
- E. Install shielded instrumentation wire in conduit and pull boxes that contain only shielded instrumentation wire. Instrumentation cables shall be separated from all other (i.e. power,

control, etc.) cables in manholes by enclosing them within rigid steel raceways and boxes.

- F. Shielded cable terminations at each end shall be provided with heat shrinkable tubing placed over the exposed shield and conductors. The tubing shall extend 1-in minimum over the jacket end and extend 0.5-in minimum from the jacket end over the exposed conductors.

3.05. FIELD TESTING

- A. Test all 600 Volt wire insulation with a megohm meter after installation and prior to termination. Make tests at not less than 1000 Volts DC. Test duration shall be one minute. Submit a written test report of the results to the Engineer. Notify the Engineer in writing 48 hours prior to testing.
- B. Field testing and commissioning shall be done in accordance with the latest revision of the “Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems” published by the International Electrical Testing Association (NETA Standard ATS-1999) unless otherwise modified by this Section. Minimum wire insulation resistance shall not be less than 250 Megohms.

END OF SECTION

## SECTION 16191

### MISCELLANEOUS EQUIPMENT

#### PART 1 GENERAL

##### 1.01 SCOPE OF WORK

- A. Furnish and install all miscellaneous equipment as shown on the Drawings and as specified herein.

##### 1.02 EQUIPMENT LIST

- A. This Section provides the requirements for miscellaneous equipment typically employed in a facility, however, not all components specified in this Section are necessarily utilized on this project.

#### PART 2 PRODUCTS

##### 2.01. MATERIALS

###### A. Disconnect Switches

1. Disconnect switches shall be heavy-duty, quick-make, quick-break, visible blades, 600 Volt, 3 Pole with full cover interlock, interlock defeat and flange mounted operating handle. All current carrying parts shall be copper
2. NEMA 4 enclosures shall be stainless steel.
3. NEMA 4X enclosures shall be stainless steel.
4. Switches shall be as manufactured by the Square D Co.; General Electric; Cutler-Hammer, or equal.

###### B. Horsepower Rated, Toggle Switch Type Disconnect Switch

1. Toggle type disconnect switches shall be manufactured of thermoplastic materials with screw-type terminals. The switches shall be rated 600 VAC and 20A at 600 VAC.
2. Toggle type disconnect switches shall be similar to a manual non-reversing starter without overloads and shall be 3 Pole, capable of "on-off" control of a 10 horsepower motor at 460 VAC.
3. Enclosure shall be provided with lock off provisions.
4. NEMA 4 enclosures shall be die-cast zinc.
5. Switches shall be as manufactured by the Square D Co.; Siemens Electrical Products; Cutler-Hammer or equal.

C. Combination Magnetic Motor Starters

1. Motor starters shall be a combination motor circuit protector and contactor, 2 or 3 Pole, single or 3 Phase as required, 60 Hz, 600 Volt, magnetically operated, full voltage non-reversing unless otherwise shown on the Drawings. NEMA sizes shall be as required for the horsepower shown on the Drawings. Minimum size shall be NEMA size 1. Motor circuit protectors shall be molded case with adjustable magnetic trip only. They shall be specifically designed for use with magnetic motor starters. Motor circuit protectors shall be current limiting type, with additional current limiters if required.
2. Multi-speed and reversing starters shall include two motor rated contactors mechanically and electrically interlocked so that only one device may be energized at any time.
3. Reduced voltage starters: Auto-transformer type with closed circuit transition. Auto-transformers shall be dry type with 50, 65 and 80 percent voltage taps and over-temperature protection. Timing relays shall be pneumatic, adjustable. Relay settings shall be approximately 75 percent of relay range.
4. Reduced voltage starters: Solid state, six SCR, full wave type with adjustable current limit and voltage ramp to control starting torque, automatic load sensing circuit to minimize energy consumption, line and load side surge protection and noise suppression and controlled deceleration adjustment to reduce the effects of surges caused by centrifugal pump loads. Provide heat sinks and ventilation to remove heat from the structure. Each starter shall include a motor horsepower rated isolation contactor to positively disconnect the line voltage when the SCR control is off.
5. Each motor starter shall have a 120 Volt operating coil and control power transformer. Transformer primaries and secondaries shall be equipped with time-delay fuses. Three phase starters shall have three overload relays. One normally open and one normally closed auxiliary contact shall be provided as spares in addition to contacts shown on the Drawings.
6. Overload relays shall be adjustable, ambient compensated and manually reset.
7. NEMA 4 enclosures shall be stainless steel.
8. NEMA 4X enclosures shall be stainless steel.
9. Combination magnetic motor starters shall be as manufactured by the Square D Co.; General Electric; Cutler-Hammer, or equal.

D. General Purpose Dry Type Transformers

1. Transformers shall be dry type, two-winding with kVA and voltage ratings as shown on the Drawings. Transformer shall incorporate a 220 degree C insulation system and be designed not to exceed 150 degrees C temperature rise above a 40 degree C ambient full load
2. Four full capacity taps shall be furnished, two 2-1/2 percent above and two 2-1/2 percent below rated primary voltage.

3. Windings shall be copper.
4. Transformers shall be built in accordance with ANSI C89.2 and NEMA ST-20 shall be UL listed and suitable for non-sinusoidal current loads with a K-factor of 4.
5. Transformers, other than K-rated units, shall meet the efficiency levels contained in Tables 4.1 and 4.2 of NEMA Standard TP1-1996 and shall contain an EPA "Energy Star" label. Efficiency shall be tested in accordance with TP1-1996.
6. Transformers shall have common core construction with low hysteresis and eddy current losses. The core flux density shall be below the saturation point to prevent overheating caused by harmonic distortion.
7. Transformer impedance shall be a minimum of 3 percent and a maximum of 5 percent.
8. Provide vibration isolators for transformers rated 112.5 kVA and higher.
9. Provide ground lug on frame and strap ground core assembly to frame of enclosure.
10. The neutral bus shall be sized and configured for 200 percent of secondary full load current.
11. Transformers shall be manufactured by Square D Co.; General Electric Co.; Cutler-Hammer, or equal.

E. Wireway

1. NEMA 1 wireway shall be painted steel with screw covers.
2. NEMA 4 and 4X wireway shall be stainless steel with gasketed screw covers and stainless steel screws.
3. NEMA 1 wireway shall be Square-Duct as manufactured by the Square D Co.; NEMA 4 and 4X shall be Bulletin F-22 as manufactured by the Hoffman Engineering Co.; Appleton; Killark, or equal.

F. Control Relays

1. Control relays shall be heavy duty machine tool type, with 10 Amp, 300 Volt convertible contacts. Number of contacts and coil voltage shall be as shown on the Drawings. General use relays shall be General Electric Co., Catalog No. CR120B; similar by Square D Co.; Allen-Bradley Co., or equal. Latching relays shall be General Electric Co., Catalog No. CR120BL; similar by Square D Co.; Allen-Bradley Co. or equal.
2. Time delay relays shall be pneumatic, 600 Volt, 20 Amp contacts, with calibrated knob operated adjustment. On delay and off delay types and timing ranges shall be as shown on the Drawings. Relays shall be Agastat Model 7012 or 7022; similar by Square D Co.; Cutler-Hammer, or equal.

G. Detectable Warning Tape

1. Each duckbank section shall be marked by means of a detectable warning tape (tracer tape) as shown on the Drawings. The detectable warning tape shall be capable of being detected or located by either conductive or inductive location techniques.
2. The detectable warning tape shall consist of 5 mil (.005-in) overall thickness; five-ply composition; ultra-high molecular weight; virgin polyethylene; acid; alkaline and corrosion resistant; with 150 pounds of tensile break strength minimum per 6-in width.
3. The top side of the tracer tape shall be color banded red for electrical and high voltage lines, and orange for signal, communication, telephone and fire alarm lines. Tracer tape shall be 4-in wide with four color bands. The tape shall be inscribed with the warning message for the utility such as "CAUTION – ELECTRICAL LINED BURIED BELOW". Tape shall be as manufactured by Mutual Industries, Inc.; Terra Tape, Div. of Reef Industries Inc. or equal.

#### H. Terminal Blocks

1. Terminal blocks shall be NEMA type rated at 20 amperes minimum, 600 Volt, channel mounted, with tubular screw and pressure plate.
2. Terminal blocks shall be Bulletin 1492 as manufactured by the Allen-Bradley Co.; ABB; Kukla, or equal.

#### I. Equipment Identification Nameplates

1. All field mounted electrical equipment such as disconnects, push button stations, etc, shall be provided with a weather resistant engraved laminoid equipment identification nameplate screwed or bolted adjacent to the device. Nameplate shall identify the mechanical equipment controlled exactly as shown on the electrical singleline drawings (i.e, P-95 Cooling Water Pump No. 1).

#### J. Arc Flash Protection Warning Signs

1. Provide field-affixed arc flash warning labels on all switchboards, panelboards, industrial control panels, and motor control centers in accordance with National Electrical Code Article 110.16.
2. As a minimum, warning signs shall state "WARNING: Arc Flash and Shock Hazard, Appropriate PPE required", and shall be designed in accordance with ANSI Z535.4-1998. Where available from the equipment manufacturer, additional information including Flash Hazard boundary, incident energy, voltage shock hazard, PPE required, etc. shall be provided.

### PART 3 EXECUTION

#### 3.01. INSTALLATION

##### A. A. Mounting Stands

1. Field mounted disconnects, pushbutton control stations, alarm panels, enclosed starters and circuit breakers, transformers, automatic transfer switches, wireways, contactors,



terminal boxes, junction and pull boxes shall be mounted on galvanized or stainless steel stands as specified. Where clearance requirements for stands may not be maintained, the Engineer may direct electric control equipment to be wall-mounted adjacent to the driven equipment, but in no case shall the distance from the drive motor to the control station exceed 3-ft, all at no additional cost to the Owner.

2. Channel supports shall be ground smooth and fitted with plastic end caps.

B. All panelboards located in pedestal cabinets or outdoors and panelboards that have branch circuits feeding exterior to the building shall be equipped with lightning arresters and surge capacitors.

### 3.02. FIELD TESTING

A. Before supplying power to the alarm panels, the following tests shall be done: Verify that all wiring connection interfaces that are required are present. Check for secure connections. Using a continuity device, verify that all discrete inputs and output to and from the control panel are wired in correct polarity and are operating in the correct state of operation (normally open or closed state). Check for any direct short circuits across all voltage supply sources. As each of the above tests are performed, the Electrical Contractor shall highlight and initial each circuit that is tested. This set of prints shall be signed and left inside the enclosure.

B. Check mechanical interlocks for intended operation. Make any adjustments required.

C. In the event of an equipment fault in the panel, notify the Engineer immediately. After the cause of the fault has been identified and corrected, a joint inspection of the equipment shall be conducted by the Contractor and Engineer. Repair or replace the equipment as directed by the Engineer prior to placing the equipment back into service at no additional cost to the Owner.

END OF SECTION



## SECTION 16289

### SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. Section includes both field-mounted SPDs and integrated SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

##### 1.2 DEFINITIONS

- A.  $I_{(n)}$ : Nominal discharge current rating.
- B. MCOV: Maximum continuous operating voltage.
- C. Protection Modes: The pair of electrical connections where the VPR applies.
- D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short-circuit current rating.
- G. SPD: Surge protective device.
- H. VPR: Voltage protection rating.

##### 1.3 SUBMITTALS

- A. Product Data:
  - 1. For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
  - 2. Provide verification the SPD is listed or recognized through Underwriters Laboratories to the latest Safety Standard, ANSI/UL 1449 3<sup>rd</sup> Edition.
  - 3. Operations and Maintenance Data: SPDs to include operation, and maintenance manuals.
  - 4. Warranties: Sample of special warranties.

##### 1.4 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to replace or repair SPDs that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Ten years.

## PART 2 - PRODUCTS

### 2.1 GENERAL SPD REQUIREMENTS

- A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by Underwriters Laboratories, and marked for intended location and application.
- B. Comply with Underwriters Laboratories ANSI/UL 1449 3<sup>rd</sup> Edition – Surge Protective Devices.
- C. Comply with Underwriters Laboratories ANSI/UL 1283 5<sup>th</sup> Edition – Electromagnetic Interference Filters. (Applies to Type 2 SPDs)
- D. Designed in accordance with ANSI/IEEE C62.41.1-2002, C62.41.2-2002 and C62.45-2002
- E. SPDs manufacturer shall be ISO-9001 certified.
- F. MCOV of the SPD shall not be less than 115% for 480Y/277V and 125% for 208Y/120V nominal RMS system voltages.
- G. SPDs shall be installed internal to the distribution equipment and shall be of the same manufacturer as the equipment. The equipment shall be fully tested and certified to the following UL standards:

- UL 67 = Panelboards
- UL 845 = Motor Control Centers
- UL 857 = Busway
- UL 891 = Switchboards
- UL 1558 = Low Voltage Switchgear

### 2.2 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide SquareD Surgeloc branded Surge Protection, or comparable product by one of the following:
  - 1. Square D by Schneider Electric
  - 2. Cutler-Hammer
  - 3. Siemens
  - 4. GE

### 2.3 SERVICE ENTRANCE SUPPRESSOR

- A. SPDs: Comply with UL 1449 3<sup>rd</sup> Edition.
  - 1. SPD Type – All SPDs installed on the line side of the service entrance OCPD shall be Type 1 SPDs. SPDs installed on the load side of the service entrance OCPD shall be either Type 1 or Type 2 SPDs.
  - 2. Type 2 SPDs shall also comply with ANSI/UL 1283.
- B. SPDs shall be provided with the following features and accessories:
  - 1. Integral disconnect switch.

2. Internal fusing design capable of disconnecting the SPD before any damaging external effects to the suppressor or surroundings occur.
3. Indicator light(s) display for power and protection status.
4. Audible Alarm with silencing switch.
5. Form-C contacts- One normally open and one normally closed for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
6. Surge counter with reset switch.

C. Surge Current Rating: The surge current rating of the SPD shall be dependent of its Category/Location:

Category/Location	Application	Per Phase	Per Mode
C	Service Entrance	240 kA	120 kA
B	Distribution	160 kA	80 kA

Protection modes: UL 1449 **VPR** for grounded WYE configured circuits shall not exceed the following:

Modes	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	800 V	1200 V	1500 V
L-L	1200 V	2000 V	2500 V

Protection modes: UL 1449 **VPR** for Delta configured circuits shall not exceed the following:

Modes	240D	480D	600D
L-G; N-G	1200 V	2000 V	2500 V

- D. SCCR: Per NEC 285.6, the short circuit current rating of the SPD shall be equal to or greater than the available short circuit current at the point on the system where installed.
- E. Nominal Discharge Current Rating: 20 kA  $I_{(n)}$

Note: Surge Protective Devices must carry a minimum Nominal Discharge Current Rating of 20kA to meet the requirements for UL96A – Installation Requirements for Lightning Protection Systems.

## 2.4 PANELBOARD SUPPRESSORS

- A. SPDs: Comply with UL 1449 3<sup>rd</sup> Edition.
  1. Type 1 or Type 2 SPD

2. Type 2 SPDs shall also comply with UL 1283.
- B. SPDs shall be provided with the following features and accessories:
1. Indicator light(s) for power and protection status.
  2. Internal fusing design capable of disconnecting the SPD before any damaging external effects to the suppressor or surroundings occur.
  3. Audible Alarm with silencing switch.
  4. Form-C contacts - One normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
  5. Surge counter with reset switch.
- C. Surge Current Rating: The surge current rating of the SPD shall be dependent of its Category/Location:

Category/Location	Application	Per Phase	Per Mode
B	Distribution	160 kA	80 kA
B	Branch	120 kA	60 kA

Protection modes: UL 1449 **VPR** for grounded WYE configured circuits shall not exceed the following:

Modes	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	800 V	1200 V	1500 V
L-L	1200 V	2000 V	2500 V

Protection modes: UL 1449 **VPR** for Delta configured circuits shall not exceed the following:

Modes	240D	480D	600D
L-G; N-G	1200 V	2000 V	2500 V

- D. SCCR: Per NEC 285.6, the short circuit current rating of the SPD shall be equal to or greater than the available short circuit current at the point on the system where installed.
- E. Nominal Discharge Current Rating: Minimum of 10 kA  $I_{(n)}$
- 2.5 ENCLOSURES
- A. Enclosure shall meet or exceed the ratings for the environment to be installed as indicated on drawings.

1. Indoor Enclosures: NEMA 250, Type 3R
2. Outdoor Enclosures: NEMA 250, Type 3R, 4X

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. SPD devices at distribution panels or switchboards shall be mounted integral to the equipment with leads as short as possible (not to exceed 24-in) and the lead size shall be a minimum of 6 AWG or larger. The SPD shall include an integral disconnect switch which has been tested to the surge current rating of the SPD and shall match or exceed the fault current rating of the board. The disconnect switch shall switch the phases and neutral.
- B. SPD devices at branch panels shall be direct bus-to-bus connected with leads as short as possible (not to exceed 24-in) and lead size shall be a minimum of 6 AWG or larger.
- C. Install SPD devices at the service entrance in accordance to NFPA 70. All SPDs installed on the line side of the service entrance OCPD shall be Type 1 SPDs. All SPDs installed on the load side of the OCPD shall be either Type 1 or Type 2 SPDs.
- D. Follow manufacturers recommended installation practices.
  1. Provide a minimum 30 Amp circuit breaker as a dedicated disconnecting means for the SPD unless otherwise indicated.
  2. Install SPDs with properly rated conductors between suppressor and points of attachment as short and straight as possible; adjust circuit-breaker positions to achieve shortest and straightest leads.
  3. Do not splice and extend SPD leads unless specifically permitted by manufacturer.
  4. Twist input conductors together to reduce the input inductance.

### 3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections.
  1. Compare equipment nameplate data for compliance with Drawings and Specifications.
  2. Inspect anchorage, alignment, grounding, and clearances.
  3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. An SPD will be considered defective if it does not pass inspections.
- C. Prepare inspection reports.

### 3.3 STARTUP SERVICE

- A. Complete startup checks according to manufacturer's written instructions.

- B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect all wires, including neutral of the SPD before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.
- C. Energize SPDs after power system has been energized, stabilized, and tested.

END OF SECTION



## SECTION 16470

### PANELBOARDS

#### PART 1 GENERAL

##### 1.01. SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install all panelboards as shown on the Drawings and as specified herein.

##### 1.02. REFERENCE STANDARDS

- A. Panelboards shall be in accordance with the Underwriter Laboratories (UL) "Standard for Panelboards" and "Standard for Cabinets and Boxes" and shall be so labeled where procedures exist. Panelboards shall also comply with NEMA Standard for Panelboards and the National Electrical Code (NEC).
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

##### 1.03. MANUFACTURERS

- A. 120/240 Volt, single phase, 3 Wire and 120/208 Volt, 3 Phase, 4 Wire panelboards shall be Sentron Type P1 as manufactured by Siemens; Type NQOD by Square D Co.; Type Pow-R-Line C by Cutler-Hammer; or Type AQ as manufactured by the General Electric Co.
- B. 277/480 Volt, 3 Phase, 4 Wire panelboards shall be Sentron Type P1 or P2 as manufactured by Siemens; Type NF by Square D Co.; Type Pow-R-Line C by Cutler-Hammer or Type AE as manufactured by the General Electric Co.
- C. 480 Volt, 3 Phase, 3 Wire Power panelboards shall be Sentron Type P3 as manufactured by Siemens; Type NF by Square D Co.; Type Pow-R-Line C by Cutler-Hammer; or Type AD by General Electric Co.
- D. 480 Volt, 3 Phase, 3 Wire Distribution panelboards shall be Sentron Type P4 or P5 as manufactured by Siemens; I-Line series by Square D Co. or Spectra Series by General Electric Co.; Type Pow-R-Line C by Cutler-Hammer, or equal.
- E. NEMA 3, 4 and 12 panelboards shall be similar to those specified above with appropriate enclosure modifications as required by voltage application. Panel enclosures shall be provided as specified in Section 16000 and 16110.

#### PART 2 PRODUCTS

##### 2.01. GENERAL

- A. Rating

1. Panelboard ratings shall be as shown on the Drawings. All panelboards shall be rated for the intended voltage.
2. Circuit breaker panelboards shall be fully rated for the specified circuit breaker fault current interrupting capacity. Series connected short circuit ratings will not be acceptable.

## 2.02. MATERIALS

### A. Interiors

1. All interiors shall be completely factory assembled with circuit breakers, wire connectors, etc. All wire connectors, except screw terminals, shall be of the anti-turn solderless type and all shall be suitable for copper or aluminum wire of the sizes indicated.
2. Interiors shall be so designed that circuit breakers can be replaced without disturbing adjacent units and without removing the main bus connectors and shall be so designed that circuits may be changed without machining, drilling or tapping.
3. Branch circuits shall be arranged using double row construction except when narrow column panels are indicated. Branch circuits shall be numbered by the manufacturer.
4. A nameplate shall be provided listing manufacturer's name, panel type and rating.

### B. Buses

1. Bus bars for the mains shall be of copper. Full size neutral bars shall be included. Phase bussing shall be full height without reduction. Cross connectors shall be copper.
2. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection.
3. Spaces, provision for future breakers, shall have bus straps bolted onto the bus so that future breakers can be bolted into the panel.
4. Equipment ground bars shall be furnished.

### C. Boxes

1. Recessed or flush mounted boxes shall be made from galvanized code gauge steel having multiple knockouts, unless otherwise noted. Boxes shall be of sufficient size to provide a minimum gutter space of 4-in on all sides.
2. Surface mounted boxes and trims shall have an internal and external finish as specified in Paragraph 2.04D4 below. Surface mounted boxes shall be field punched for conduit entrances.
3. At least four studs for mounting the panelboard interior shall be furnished.

### D. Trim

1. Hinged doors covering all circuit breaker handles shall be included in all panel trims.

2. Doors shall have semi flush type cylinder lock and catch, except that doors over 48-in in height shall have a vault handle and 3-point catch, complete with lock, arranged to fasten door at top, bottom and center. Door hinges shall be concealed. Furnish two keys for each lock. All locks shall be keyed alike; directory frame and card having a transparent cover shall be furnished on each door.
3. The trims shall be fabricated from code gauge sheet steel.
4. All exterior and interior steel surfaces of the panelboard shall be properly cleaned and finished with ANSI Z55.1, No. 61 light gray paint over a rust-inhibiting phosphatized coating. The finish paint shall be of a type to which field applied paint will adhere.
5. Trims for flush panels shall overlap the box by at least 3/4-in all around. Surface trims shall have the same width and height as the box. Trims shall be fastened with quarter turn clamps.
6. Door-in-door type construction shall be provided so that trim may be opened to access wire ways without removing the trim from the panel

#### 2.03. CIRCUIT BREAKERS

- A. Panelboards shall be equipped with circuit breakers with frame size and trip settings as shown on the Drawings.
- B. Circuit breakers shall be molded case, bolt-in type.
- C. Circuit breakers shall be as manufactured by the panelboard manufacturer.

### PART 3 EXECUTION

#### 3.01. INSTALLATION

- A. Mount boxes for surface mounted panelboards so there is at least 1/2-in air space between the box and the wall.
- B. Connect panelboard branch circuit loads so that the load is distributed as equally as possible between the phase busses.
- C. Type circuit directories giving location and nature of load served. Install circuit directories in each panelboard.
- D. Install markers on the front cover of all panelboards which identify the voltage rating. Markers shall be made of self sticking B-500 vinyl cloth printed with black characters on an Alert Orange background, 2-1/4-in high by 9-in wide, Style A as manufactured by W.H. Brady Co. or equal.
- E. Install a 1-in by 3-in laminated plastic nameplate with 1/4-in white letters on a black background on each panelboard. Nameplate lettering shall be as shown on the Drawings. Nameplates shall be stainless steel screw mounted.

END OF SECTION



## SECTION 16600

### UNDERGROUND SYSTEM

#### PART 1 GENERAL

##### 1.01. SCOPE OF WORK

- A. Furnish and install a complete underground system of raceways, manholes and handholes as shown on the Drawings and as specified herein.
- B. All underground systems shall be encased as shown on the drawings.
- C. The Contractor shall be responsible for setting manholes and handholes at the proper elevation such that the pitch of raceways will be towards manholes and handholes and away from structures, vaults and buildings.
- D. Where referred in this Section, raceways are underground conduits – Ductbanks are a collection of underground raceways. Underground system is the collection of underground raceways, manholes and handholes.
- E. Ductbanks shall be constructed as shown on the drawings up to the building, structure, vault, manhole and handhole.
  - 1. Ductbank, manhole and handhole depths vary. Coordinate with other utilities, yard piping, yard structures and field conditions to determine required depths and install raceways, manholes and handholes at that required depth at no additional cost to the Owner.
  - 2. Ductbank routing and manhole/handhole locations shown on the Drawings are diagrammatically depicted. Coordinate with other utilities, yard piping, yard structures and field conditions to determine required paths and depths at no additional cost to the Owner.

#### PART 2 PRODUCTS

##### 2.01. MATERIALS

- A. Raceways shall be polyvinyl chloride conduit.
- B. Cable racks, supports, pulling-in irons, manhole steps and hardware shall be galvanized steel as manufactured by Line Materials Co.; Underground Devices, Inc.; Chance or equal.
- C. Precast manholes and handholes shall be designed as specified below for precast concrete structures.
  - 1. Provide lifting lugs in each precast section for handling.
  - 2. All sections, flat slab tops and grade rings shall conform to ASTM C478.
  - 3. Base, riser and transition top sections shall have tongue and groove joints.

4. Compressive strength for shipping shall be 4000 psi.
  5. Design precast concrete base, riser, transition top, flat slab top and grade ring for a minimum H-20 loading plus earth load. Earth load shall be calculated from the future grade indicated as final grade with a unit weight of 130 pcf.
  6. The date of manufacture, name and trademark of manufacturer shall be marked on the inside of each precast section.
  7. Provide integrally cast knock-out panels in precast concrete manhole and handhole sections at locations indicated and with sizes indicated. Knock-out panels shall have no steel reinforcing.
  8. Seal tongue and groove joints of precast manhole and handhole sections with rubber O-ring gasket. O-ring gasket shall conform to ASTM C443. In lieu of the O-ring gasket, a flexible joint sealant may be used. Sealant shall be Kent Seal No. 2; Con Seal No. 2; Ram-Nek or equal. Completed joints shall withstand 15 psi internal water pressure without leakage or displacement of gasket or sealant.
  9. Dampproofing shall be Hydrocide 648 by Sonneborn Building Products; Dehydratine 4 by A.C. Horn, Inc.; RIW Marine Liquid by Toch Bothers, or equal.
- D. Handholes shall be precast concrete, heavy-duty type, designed for a Class H-20 wheel load and conform to ASTM C478. Precast units shall be as manufactured by Chase Precast Corp.; Rotondo; American Precast Co. or equal and constructed to dimensions as shown on the Drawings.
- E. Manhole and handhole frames and covers shall be cast iron, heavy duty type for Class H-20 wheel loading as manufactured by Neenah; LeBaron; Vulcan or equal. Covers shall be marked and sized as shown on the Drawings.
- F. Ground rods and other grounding materials and methods shall be as specified.
- G. Bell ends and plastic duct spacers shall be as manufactured by Carlon; Underground Devices Inc. or equal.
- H. Pull line for spare conduits shall be 1/8-in nylon rope.
- I. Detectable Warning Tape
1. Each duckbank section shall be marked by means of a detectable warning tape (tracer tape) as shown on the Drawings. The detectable warning tape shall be capable of being detected or located by either conductive or inductive location techniques.
  2. The detectable warning tape shall consist of 5 mil (.005-in) overall thickness; five-ply composition; ultra-high molecular weight; virgin polyethylene; acid; alkaline and corrosion resistant; with 150 pounds of tensile break strength minimum per 6-in width.
  3. The top side of the tracer tape shall be color banded red for electrical and high voltage lines, and orange for signal, communication, telephone and fire alarm lines. Tracer tape shall be 4-in wide with four color bands. The tape shall be inscribed with the warning

message for the utility such as “CAUTION – ELECTRICAL LINED BURIED BELOW”. Tape shall be as manufactured by Mutual Industries, Inc.; Terra Tape, Div. of Reef Industries Inc. or equal.

### PART 3 EXECUTION

#### 3.01. INSTALLATION

- A. Install raceways to drain away from buildings. Raceways between manholes or handholes shall drain toward the manholes or handholes. Raceway slopes shall not be less than 3-in per 100-ft.
- B. Use plastic spacers located not more than 4-ft apart to hold raceways in place. Spacers shall provide not less than 2-in clearance between raceways and edge of envelope.
- C. The minimum cover for raceway banks shall be 24-in unless otherwise permitted by the Engineer.
- D. Raceway terminations at manholes shall be with end bells for PVC conduit and insulated throat grounding bushings for steel conduit.
- E. Where bends in raceways are required, use long radius elbows, sweeps and offsets.
- F. Swab all raceways clean before installing cable.
- G. Plug and seal spare raceways watertight at all manholes, buildings and structures.
- H. Seal the ends of raceways and make watertight at all manholes, buildings and structures.
- I. Install pulling-in irons opposite all raceway entrances to manholes.
- J. Train cables in manholes and handholes and support and restrain them on racks and hooks. Furnish inserts on all manhole and handhole walls for mounting future racks as well as racks required for present installation.
- K. PVC Coated Rigid galvanized steel conduit shall be used for elbows and risers at the utility pole for electrical and telephone service conduits.
- L. PVC coated rigid galvanized steel elbows shall be used for pad-mounted transformer stub-ups and all stub-ups through concrete floors, walls and slabs.
- M. A pull line shall be installed and left in all spare raceways.
- N. Install detectable warning tape in all ductbanks as shown on the Drawings. Where trench exceeds 24-in width, provide additional detectable tape runs to mark each side of the ductbank in addition to the one in the center.
- O. Manhole and Handhole Installation
  - 1. Place bases on bed of 12-in screened gravel. Set base grade so that a minimum grade adjustment of 4-in of brickwork is required to bring the manhole and handhole frame and cover to final grade.

- a. Use precast concrete grade rings or brick and non-shrink mortar to adjust frame and cover to final grade.
  2. Set precast sections plumb with a 1/4-in maximum out-of-plumb tolerance. Seal joints of precast sections with either a rubber O-ring set in a recess or a flexible joint sealant used in sufficient quantity to fill 75 percent of the joint cavity. Fill the outside and inside joint with non-shrink grout and finished flush with the adjoining surfaces. Caulk the inside of leaking barrel section joints with lead wool or non-shrink grout. If leaks appear in the manholes or handholes the inside joints shall be cleaned out and remade in a manner that will result in a watertight joint.
  3. Allow joints to set for 24 hours before backfilling. Backfilling shall be performed by bringing the fill up evenly on all sides.
  4. Plug holes in concrete with non-shrink grout or non-shrink grout in combination with concrete plugs. Finish flush on the inside.
  5. Cut holes in precast sections to accommodate conduits prior to setting manhole and handhole sections in place.
- 3.02. CLEANING
- A. All new manholes and handholes shall be thoroughly cleaned of all silt, debris and foreign matter prior to final inspection.

END OF SECTION



## SECTION 16660

### GROUNDING SYSTEM

#### PART 1 GENERAL

##### 1.01. SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install a complete grounding system in strict accordance with Article 250 of the National Electrical Code NEC.
- B. All raceways, conduits, ducts and multi-conductor cables shall contain equipment grounding conductors sized in accordance with the NEC. Minimum sizes shall be No. 12 AWG.

1.02. A supplemental grounding conductor shall be provided from each switchgear, switchboard, motor control center, power panelboard, lighting panelboard, to the buried ground grid. Supplemental grounding conductors shall be installed in PVC Schedule 80 conduit.

#### PART 2 PRODUCTS

##### 2.01. MATERIALS

- A. Conduit shall be as specified under Section 16110.
- B. Wire shall be as specified under Section 16120.
- C. Ground rods shall be 3/4-in by 10-ft copper clad steel and constructed in accordance with UL 467. The minimum copper thickness shall be 0.25 mm. Ground rods shall be Copperweld; Blackburn; Erico, Inc. or equal.
- D. Grounding conduit hubs shall be malleable iron type, and of the correct size for the conduit, as manufactured by Thomas & Betts Co.; Catalog No. 3940 Series, similar by Burndy; O.Z. Gedney Co. or equal.
- E. Water pipe ground clamps shall be cast bronze saddle type, and of the correct size for the pipe, as manufactured by Thomas & Betts Co. Cat. No. 2 (1/2-in, 3/4-in, or 1-in size), similar by Burndy; O.Z. Gedney Co. or equal and of the correct size for the pipe.
- F. Buried grounding connections shall be by Cadweld process, or equal exothermic welding system.
  - 1. Molds, cartridge materials and accessories shall be provided in kit form and selected per the manufacturer's written instructions for specific types, sizes and combinations of conductors and connected items. Molds and powder shall be furnished by the same manufacturer.

#### PART 3 EXECUTION

##### 3.01. INSTALLATION

- A. Run grounding electrode conductors in rigid steel conduits. Bond the protecting conduits to the grounding electrode conductors at both ends. Do not allow water pipe connections to be painted. If the connections are painted, dis-assemble them and re-make them with new fittings.
- B. Install equipment grounding conductors with all feeders and branch circuits.
- C. Bond all steel building columns in new structures together with ground wire in rigid conduit and connect to the distribution equipment ground bus, as shown on the Drawings.
- D. Ground wire connections to structural steel columns shall be made with exothermic welds.
- E. Metal conduits stubbed into a motor control center or floor mounted electrical enclosure shall be terminated with insulated grounding bushings and connected to the motor control center or electrical enclosure ground bus. Bond boxes mounted below motor control centers to the motor control center ground bus. Size the grounding wire in accordance with NEC Table 250-122, except that a minimum No. 12 AWG shall be used.
- F. Liquid tight flexible metal conduit in sizes 1-1/2-in and larger shall have bonding jumpers. Bonding jumpers shall be external, run parallel (not spiraled) and fastened with plastic tie wraps.
- G. Ground transformer neutrals to the nearest available grounding electrode with a conductor sized in accordance with NEC Article 250-66.
- H. Drive grounding electrodes as shown on the Drawings.
- I. All equipment enclosures, motor and transformer frames, conduits systems, cable armor, exposed structural steel and all other equipment and materials required by the NEC to be grounded, shall be grounded and bonded in accordance with the NEC.
- J. Seal exposed connections between different metals with No-Oxide Paint Grade A or equal.
- K. Ground metal poles supporting outdoor lighting fixtures to a supplemental grounding electrode (rod) in addition to the separate equipment grounding conductor run with the supply branch circuit.
- L. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate in accordance with NEC Paragraph 250.52 using a minimum of 20-ft of bare copper conductor not smaller than No. 4 AWG. Where base of foundation is less than 20-ft in length, coil excess conductor within base of concrete foundation. Extend grounding conductor below grade and connect to building grounding grid, ground loop, or grounding electrode external to concrete.
- M. Install driven ground rods in manholes and handholes close to wall and set rod depth so 4-in will extend above finished floor. Protect ground rods with double wrapping of pressure-sensitive tape or heat shrunk insulating sleeve from 2-in above to 6-in below concrete floor. Seal floor opening with waterproof, non-shrink grout. Where ground rods are installed outside of manhole or handhole, provide a No. 4/0 AWG bare, tinned copper conductor from ground rod into manhole or handhole through a waterproof sleeve in the wall.

### 3.02. INSPECTION AND TESTING

- A. Inspect the grounding and bonding system conductors and connections for tightness and proper installation.
- B. Use Biddle Direct Reading Earth Resistance Tester or equivalent test instrument to measure resistance to ground of the system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method.
- C. Resistance to ground testing shall be performed during dry season. Submit test results in the form of a graph showing the number of points measured (12 minimum) and the numerical resistance to ground.
- D. Testing shall be performed before energizing the distribution system.
- E. Test all grounded cases and metal parts associated with the electrical equipment for continuity with the ground system.
- F. Notify the Engineer immediately if the resistance to ground for any building or system is greater than five ohms.

END OF SECTION



SECTION 31 1100

SITE PREPARATION

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials and equipment required and perform all site preparation, complete as shown on the Drawings and as specified herein.
- B. Obtain all permits required for site preparation work prior to proceeding with the work, including clearing, burning.

1.02 RELATED WORK

- A. Earthwork is included in Section 31\_2000.
- B. Topsoil and Seeding is included in Section 31\_2900.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01\_3000, copies of all permits required prior to clearing, grubbing, and stripping work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CLEARING

- A. Cut and remove all timber, trees, stumps, brush, shrubs, roots, grass, weeds, rubbish and any other objectionable material resting on or protruding through the surface of the ground.
- B. Preserve and protect trees and other vegetation designated on the Drawings or directed by the Engineer to remain as specified below.
- C. Unless otherwise specified in these specifications or in the Plans, the CONTRACTOR shall replace all sod, shrubs, bushes, trees, and flowers disturbed or removed, that are located upon improved or landscaped public and private property. The CONTRACTOR shall replant vegetation and re-landscape or cause such to be performed throughout the work area as soon as possible after the pipelines and appurtenances have been installed. All vegetation damaged during or after removal shall be replaced with healthy vegetation of the same kind or type. All plants shall be replanted as close as possible to the original location or approved by the property UTILITY and or the utility. The CONTRACTOR shall maintain all such replanted vegetation by the application of water, fertilizers, and topsoil. The vegetation shall be cultivated to prohibit the growth of foreign vegetation until a well-developed root system has been established and transplanted vegetation has overcome the "shock" resulting from transplanting. The CONTRACTOR shall replace all vegetation that dies or becomes unhealthy. The contour of the ground shall be left as near the original contour as possible.

### 3.02 GRUBBING

- A. Grub and remove all stumps, roots in excess of 1-1/2-in in diameter, matted roots, brush, timber, logs, concrete rubble and other debris encountered to a depth of 18-in below original grade or 18-in beneath the bottom of (foundations) (and) (roadway subbase) whichever is deeper.
- B. Refill all grubbing holes and depressions excavated below the original ground surface with suitable materials and compact to a density conforming to the surrounding ground surface in accordance with Section 02200.

### 3.03 STRIPPING

- A. Strip topsoil from all areas to be occupied by buildings, structures, and roadways and all areas to be excavated or filled.
- B. Topsoil shall be free from brush, trash, large stones and other extraneous material. Avoid mixing topsoil with subsoil.
- C. Stockpile and protect topsoil until it is used in landscaping, loaming and seeding operations. Dispose of surplus topsoil after all work is completed.

### 3.04 DISPOSAL

- A. Cut tree trunks and limbs exceeding 4-in in diameter shall be cut into 4-ft lengths and stockpiled on site in the area designated by the UTILITY.
- B. Dispose of material and debris from site preparation operations by hauling such materials and debris to an approved offsite disposal area. No rubbish or debris of any kind shall be buried on the site.
- C. On-site disposal of cleared and grubbed materials by open-air burning may be permitted only with the expressed written consent of the UTILITY. Burning operations and ash disposal shall be conducted in strict accordance with local and state requirements, subject to applicable permit requirements.

### 3.05 PROTECTION

- B. Trees and other vegetation designated on the Drawings or directed by the Engineer to remain shall be protected from damage by all construction operations by erecting suitable barriers, guards and enclosures, or by other approved means. Conduct clearing operations in a manner to prevent falling trees from damaging trees and vegetation designated to remain and to the work being constructed and so as to provide for the safety of employees and others.
- B. Maintain protection until all work in the vicinity of the work being protected has been completed.
- C. Do not operate heavy equipment or stockpile materials within the branch spread of existing trees.
- D. Immediately repair any damage to existing tree crowns, trunks, or root systems. Roots exposed and/or damaged during the work shall immediately be cut off cleanly inside the exposed or damaged area.

- E. When work is completed, remove all dead and downed trees. Live trees shall be trimmed of all dead and diseased limbs and branches. All cuts shall be cleanly made at their juncture with the trunk or preceding branch without injury to the trunk or remaining branches.
- F. Restrict construction activities to those areas within the limits of construction designated on the Drawings, within public rights-of-way, and within easements provided by the UTILITY. Adjacent properties and improvements thereon, public or private, which become damaged by construction operations, shall be promptly restored to their original condition, to the full satisfaction of the property UTILITY.

END OF SECTION

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## SECTION 31 2000

### EARTHWORK

#### PART 1 GENERAL

##### 1.00 STATUTORY REQUIREMENTS

- A. All excavation, trenching, sheeting, bracing, etc shall comply with the requirements of OSHA excavation safety standards (29 CFR Part 1926.650 Subpart P), and State and local requirements. Where conflict between OSHA, State and local regulations exists, the most stringent requirements shall apply.

##### 1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and perform all excavation work and grading; place and compact backfill and fill; and dispose of unsuitable, waste and surplus materials as shown on the Drawings and as specified herein.
- B. Provide the services of a licensed professional engineer registered in the State in which the work is located, to prepare temporary excavation support system designs and submittals.
- C. Furnish and install temporary excavation support systems, including sheeting, shoring and bracing, to insure the safety of personnel and protect adjacent structures, piping, etc, in accordance with Federal, State and local laws, regulations and requirements.

##### 1.02 RELATED WORK

- A. Site Preparation is included in Section 31\_1100.
- B. Trenching, Backfilling and Compaction is included in Section 31\_2300.
- C. Fill and Backfill Materials are included in Section 31\_2330.
- D. Erosion and Sedimentation Control are included in Section 31\_2500.
- E. Topsoil and Seeding are included in Section 31\_2900.

##### 1.03 SUBMITTALS

- A. Excavation support system designs shall be prepared by a licensed professional engineer, registered in the State in which the work is located, having a minimum of 5 years of professional experience in the design and construction of excavation support systems. Submit an original and three copies of the licensed professional engineer's certification, on the PE form specified in Section 01\_3000, stating that the excavation support systems designs have been prepared by the professional engineer and that the professional engineer will be responsible for their execution. Do not submit excavation support system designs unless requested in writing.

##### 1.04 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)

1. ASTM D1557 - Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

#### 1.05 QUALITY ASSURANCE

A. At all structures, prior to the placement of bedding material, concrete work mats, structural fill or structural concrete, coordinate with a soils testing laboratory to verify the suitability of the existing subgrade soil and to perform in-place soil density tests as required to verify that the bearing capacity of the subgrade is sufficient. Utilize Anderson Engineering Consultants, Inc. of Little Rock, AR. A min. of 1 nuclear density test per every 2,500 sf shall be performed.

B. Prior to and during the placement of backfill and fill coordinate with the soils testing laboratory to perform in-place soil density tests to verify that the backfill/fill material has been compacted in accordance with the compaction requirements specified elsewhere.

#### 1.06 DEFINITIONS

A. Where the phrase "in-the-dry" is used in this Section, it shall be defined to mean a soil condition such that the in-place moisture content of the soil at that time is no more than two percentage points above the optimum moisture content of that soil as determined by the laboratory test of the moisture-density relation appropriate to the specified level of compaction.

B. Where used in this Section "structures" refers to all buildings, wet wells, manholes and below grade vaults. Stormwater structures and duct banks are not considered structures in this context.

### PART 2 PRODUCTS

#### 2.01 GENERAL

A. Materials designated for use in this Section are specified in Section 31\_2330.

### PART 3 EXECUTION

#### 3.01 PREPARATION

A. Test Pits

1. Perform exploratory excavation work (test pits) for the purpose of verifying the location of underground utilities and structures and to check for unknown utilities and structures, prior to commencing excavation work.

2. Test pits shall be backfilled as soon as the desired information has been obtained. Backfilled surfaces shall be stabilized in accordance with approved erosion and sedimentation control plans.

B. Dewatering and Drainage Systems

1. Temporary dewatering and drainage systems shall be in place and operational prior to beginning excavation work. Groundwater levels must be maintained a minimum of 2 ft. below the excavation bottom, to allow construction in the dry.

3.02 EXCAVATION SUPPORT

- A. Furnish, install, monitor and maintain excavation support (e.g., shoring, sheeting, bracing, trench boxes, etc) as required by Federal, State or local laws, ordinances, regulations and safety requirements. Support the sides of excavation, to prevent any movement which could in any way reduce the width of the excavation below that necessary for proper construction and protect adjacent structures from undermining, settlement or other damage. Take care to prevent the formation of voids outside of sheeting. If voids occur behind sheeting, immediately backfill and compact the voids with common fill material. Voids in locations that cannot be properly compacted upon backfilling shall be filled with lean concrete.
- B. Install excavation supports outside the neat lines of foundations. Supports shall be plumb and securely braced and tied in position. Excavation support shall be adequate to withstand all pressures to which the supports will be subjected. Any movement or bulging of supports shall be corrected to provide the necessary clearances, dimensions and structural integrity.
- C. Excavation Supports Left in Place
1. Excavation supports that are required to remain in place, if applicable, are indicated on the Drawings.
  2. The UTILITY or Engineer may direct that certain excavation supports remain in place, or be cut off at any specific elevation. Supports directed by the UTILITY or Engineer to be left in place and not so designated on the Drawings or otherwise specified herein to remain in place, will be paid for in accordance with the Unit Price Schedule. If the CONTRACTOR believes that such a directive increases CONTRACTOR's cost and would thereby entitle CONTRACTOR to a change in contract cost, CONTRACTOR shall notify the Engineer in accordance with the applicable article(s) in the General Conditions pertaining to changes in the work.
  3. The right of the UTILITY or Engineer to direct that certain excavation supports remain in place shall not be construed as creating any obligation on the UTILITY or Engineer to give such direction, nor shall failure to give such direction relieve the CONTRACTOR from liability for damages to persons or property occurring from or upon the work occasioned by negligence or otherwise, growing out of a failure on the part of the CONTRACTOR to leave in place sufficient excavation supports to prevent any movement of the ground or damage to adjacent structures.
- D. Excavation supports shall be carefully removed in such manner so as not to endanger the Work or other adjacent structures, utilities, or property. All voids left or caused by withdrawal of supports shall be immediately filled with sand and compacted.

### 3.03 STRUCTURAL EXCAVATION PROCEDURES

- A. Excavations for structures shall be suitably wide for construction of the structures, including excavation supports, dewatering and drainage systems and working clearances.
- B. Excavation shall be performed in-the-dry and shall be accomplished by methods which preserve the undisturbed state of subgrade soils. Drainage and dewatering systems shall be in place and operational prior to beginning excavation work. In no case shall the earth be plowed, scraped or excavated by any means so near to the finished subgrade that would disturb the finished subgrade. Hand excavation of the final 3 to 6-in may be required to obtain a satisfactory, undisturbed subgrade. Subgrade soils which become soft, loose, "quick", or otherwise unsatisfactory for support of structures as a result of inadequate excavation, dewatering, or other construction methods shall be removed and replaced with lean concrete, compacted structural fill or suitable crushed rock, subject to prior approval by the Engineer, at no additional cost to the UTILITY.
- C. Subgrade Preparation
  - 1. All structures unless otherwise shown on the Drawings or otherwise specified herein:
    - a. Compact the top 12-in of subgrade to a minimum of 95 percent modified proctor (ASTM D1557).
    - b. Where structures are supported by piles, compact the top 12-in of subgrade to a minimum of 90 percent modified proctor (ASTM D1557).
  - 2. Where existing subgrade contains a significant amount of clay or cohesive soils, over-excavate sufficiently below the bottom of structure for placement of a lean concrete working mat. Prior to placing the lean concrete working mat, compact the top 12-in of existing subgrade to a minimum of 95 percent modified proctor (ASTM D1557).
- D. When excavations have reached the required subgrade, including any allowances for working mats or base materials, prior to the placement of working mats or base materials, notify the soils testing laboratory to verify the suitability of the existing subgrade soils for the anticipated foundation and structural loadings. If the existing subgrade soils are determined to be unsuitable, direction will be provided by the Engineer regarding removal and replacement with suitable materials. If CONTRACTOR believes that such direction would increase CONTRACTOR's cost and would thereby entitle CONTRACTOR to a change in Contract cost, CONTRACTOR shall notify the Engineer in accordance with the applicable article(s) in the General Conditions pertaining to changes in the work.
- E. Over-excavation beyond the limits and depths required by the Contract Documents shall be replaced at no additional cost to the UTILITY by low density cellular concrete or other approved material subject to the prior approval of the Engineer.

### 3.04 GENERAL FILLING AND BACKFILLING PROCEDURES

- A. Fill and backfill materials shall be placed in lifts to suit the specified compaction requirements to the lines and grades required, making allowances for settlement and placement of cover materials (i.e. topsoil, sod, etc). Soft spots or uncompacted areas shall be corrected.
- B. Fill and backfill materials shall not be placed on frozen surfaces, or surfaces covered by snow or ice. Fill and backfill material shall be free of snow, ice and frozen earth.
- C. Compaction in open areas may be accomplished by any of the following methods: compaction equipment, fully loaded ten-wheel trucks, tractor dozers weighing at least 30,000 lbs and operated at full speed, or heavy vibratory rollers. Compaction in confined areas (including areas within a 45-degree angle extending upward and outward from the base of a wall) and in areas where the use of large equipment is impractical, shall be accomplished by hand operated vibratory equipment or mechanical tampers. Lift thickness shall not exceed 6-in (measured before compaction) when hand operated equipment is used.
- D. Fill and backfill shall not be placed and compacted when the materials are too wet to properly compact (i.e. the in-place moisture content of the soil at that time is no more than three percentage points above the optimum moisture content of that soil as determined by the laboratory test of the moisture-density relation appropriate to the specified level of compaction).

### 3.05 FILL AND BACKFILL PROCEDURES

- A. Fill required beneath foundations or slabs on grade (except sidewalks) shall be structural fill (AHTD Class 7 Base Course). Place and compact structural fill in even lifts having a maximum thickness (measured before compaction) of 8-in.
- B. Fill and backfill material placed immediately adjacent to and within 5-ft of all structures shall be structural fill. All structure water-tightness tests and dampproofing/waterproofing shall be completed prior to placing fill or backfill around structures. Place and compact select fill in even lifts having a maximum thickness (measured before compaction) of 8-in uniformly around the structure.
- C. Common fill may be used in areas beyond those designated for structural fill unless shown or specified otherwise. Common fill shall be placed in even lifts having a maximum thickness (measured before compaction) of 12-in.

### 3.06 EMBANKMENT FILL PROCEDURES

- A. Prior to placing embankment fill materials, all organic materials (including peat and loam) and loose inorganic silt material (loess) shall be removed from areas beneath the embankments. If the subgrade slopes are excessive, the subgrade shall be stepped to produce a stable, horizontal surface for the placement of embankment materials. The existing subgrade shall then be scarified to a depth of at least 6-in.
- B. Embankment fill shall consist of common fill material and shall be placed and compacted in even lifts (measured before compaction) of 12-in.
- C. Rock may be used in embankment fill only with prior, written approval of the Engineer.

### 3.07 COMPACTION REQUIREMENTS

- A. Beneath foundations and slabs on grade (except sidewalks): Compact the top 12-in of existing subgrade and each layer of fill to a minimum of 95 percent modified proctor (ASTM D1557) at or near its optimum moisture content (minus 2 to plus 3 percent).
- B. 5-ft around structures: Compact the top 12-in of existing subgrade and each layer of fill or backfill to a minimum of 90 percent modified proctor (ASTM D1557) at or near its optimum moisture content (minus 2 to plus 3 percent).
- C. Fill beneath structures: Compact fill below structures to a minimum of 95 percent modified proctor (ASTM D1557) at or near its optimum moisture content (minus 2 to plus 3 percent).
- C. Embankments (except under roadways), lawn or unimproved areas: Compact the top 6-in of existing subgrade and each layer of fill or backfill to a minimum of 90 percent modified proctor (ASTM D1557) at or near its optimum moisture content (minus 1 to plus 4 percent).
- D. Sidewalks: Compact the top 6-in of existing subgrade (and each 6-in layer of fill if applicable) to a minimum of 90 percent modified proctor (ASTM D1557) at or near its optimum moisture content (minus 2 to plus 3 percent).
- E. Roads, paved areas and roadway embankments: Compact the top 12-in of existing subgrade and each layer of fill or backfill to a minimum of 95 percent modified proctor (ASTM D1557) at or near its optimum moisture content (minus 2 to plus 3 percent).

### 3.08 DISPOSAL OF UNSUITABLE, WASTE AND/OR SURPLUS EXCAVATED MATERIAL

- A. Unsuitable, waste and surplus excavated material shall be removed and disposed of on-site, in areas approved by the OWNER. Materials may be temporarily stockpiled in an area within the limits of construction that does not disrupt construction activities, create any nuisances or safety hazards, or otherwise restrict access to the work site.

### 3.10 GRADING

- A. Grading shall be performed to the lines and grades shown on the Drawings. All objectionable material encountered within the limits indicated shall be removed and disposed of. Subgrades shall be completely and continuously drained and dewatered throughout the grading process. Install temporary drains, drainage ditches, etc, to intercept or divert surface water which may affect the execution or condition of grading work.
- B. If at the time of grading it is not possible to place any material in its proper section of the Work, it shall be stockpiled in approved areas for later use. No extra payment will be made for the stockpiling or double handling of excavated material.
- C. Stones or rock fragments larger than 4-in in their greatest dimensions will not be permitted within the top 6-in of the finished grade of fills and embankments.
- D. In cut areas, all loose or protruding rocks in slopes shall be removed to line or finished grade of the slope. All cut and fill slopes shall be uniformly dressed to the slope, cross-section and alignment shown on the Drawings unless otherwise directed by the Engineer.

END OF SECTION

SECTION 31 2300

TRENCHING, BACKFILL, AND COMPACTION

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and perform all trenching for pipelines and appurtenances, including drainage, filling, backfilling, disposal of surplus material and restoration of trench surfaces and easements.
- B. Excavation shall extend to the width and depth shown on the Drawings or as specified herein and shall provide suitable room for installing pipe, structures and appurtenances.
- C. Furnish and place all sheeting, bracing and supports and shall remove from the excavation all materials which the Engineer may deem unsuitable for backfilling. The bottom of the excavation shall be firm, dry and in all respects, acceptable. If conditions warrant, deposit gravel for pipe bedding, or gravel refill for excavation below grade, directly on the bottom of the trench immediately after excavation has reached the proper depth and before the bottom of the trench has become softened or disturbed by any cause whatever. The length of open trench shall be related closely to the rate of pipe laying. All excavation shall be made in open trenches.
- D. All excavation, trenching and related sheeting, bracing, etc, shall comply with the requirements of OSHA excavation safety standards (29 CFR Part 1926.650 Subpart P) and all State and local requirements. Where conflict between OSHA and State regulations exists, the more stringent requirements shall apply.
- E. Wherever the requirement for percent compaction is referred to herein it shall mean "at least the specified percent of maximum density as determined by ASTM D1557, Method D".
- F. Prior to the start of work submit the proposed method of backfilling and compaction to the Engineer for review.

1.02 RELATED WORK

- A. Granular fill material is included in Section 31\_2330.
- B. Topsoil and seeding is included in Section 31\_2900.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 TRENCH EXCAVATION

- A. Trench excavation shall include material of every description and of whatever substance encountered. Pavement shall be cut with a saw, wheel or pneumatic chisel along straight lines before excavating.

- B. Strip and stockpile topsoil from grassed areas crossed by trenches. At the CONTRACTOR's option, topsoil may be otherwise disposed of and replaced, when required, with approved topsoil of equal quality.
- C. While excavating and backfilling is in progress, traffic shall be maintained, and all utilities and other property protected as provided in the General Conditions and General Requirements.
- D. Trenches shall be excavated to the depth indicated on the Drawings and in widths sufficient for laying the pipe, bracing and for pumping and drainage facilities. The bottom of the excavations shall be firm and dry and in all respects acceptable to the Engineer. Trench width shall be the practical minimum.
- E. Excavation and dewatering shall be accomplished by methods which preserve the undisturbed state of subgrade soils. The trench may be excavated by machinery to, or just below the designated subgrade, provided that material remaining in the bottom of the trench is no more than slightly disturbed. Subgrade soils which become soft, loose, "quick", or otherwise unsatisfactory as a result of inadequate excavation, dewatering or other construction methods shall be removed and replaced by screened gravel fill as required by the Engineer at the CONTRACTOR's expense.
- F. Clay and organic silt soils are particularly susceptible to disturbance due to construction operations. When excavation is to end in such soils, use a smooth-edge bucket to excavate the last 1-ft of depth.
- G. Where pipe is to be laid in screened gravel bedding, the trench may be excavated by machinery to the normal depth of the pipe provided that the material remaining in the bottom of the trench is no more than slightly disturbed.
- H. Where pipe is to be laid directly on the trench bottom, final excavation at the bottom of the trench shall be performed manually, providing a flat-bottom true to grade upon undisturbed material. Bell holes shall be made as required.

### 3.02 DISPOSAL OF MATERIALS

- A. Excavated material shall be stacked without excessive surcharge on the trench bank or obstructing free access to hydrants and gate valves. Inconvenience to traffic and abutters shall be avoided as much as possible. Excavated material shall be segregated for use in backfilling as specified below.
- B. Should conditions make it impracticable or unsafe to stack material adjacent to the trench, the material shall be hauled and stored at a location provided. When required, it shall be re-handled and used in backfilling the trench.
- C. The CONTRACTOR shall dispose of excess material at an area off-site. Disposal costs shall be the responsibility of the CONTRACTOR.

### 3.03 SHEETING AND BRACING

- A. Furnish, put in place and maintain sheeting and bracing required by Federal, State or local safety requirements to support the sides of the excavation and prevent loss of ground which could endanger personnel, damage or delay the work or endanger adjacent structures. If the Engineer is of the opinion that at any point sufficient or proper supports have not been provided, he/she may order additional supports placed at the expense of the CONTRACTOR. Compliance with



such order shall not relieve the CONTRACTOR from his/her responsibility for the sufficiency of such supports. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed.

- C. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and the screened gravel backfill.
  - 1. When installing rigid pipe (R.C., V.C., A.C., etc), any portion of the box extending below mid diameter shall be raised above this point prior to moving the box ahead to install the next pipe. This is to prevent the separation of installed pipe joints due to movement of the box.
  - 2. When installing flexible pipe (PVC, etc), trench boxes, moveable sheeting, shoring or plates shall not be allowed to extend below mid-diameter of the pipe. As trench boxes, moveable sheeting, shoring or plates are moved, screened gravel shall be placed to fill any voids created and the screened gravel and backfill shall be recompacted to provide uniform side support for the pipe.
- D. Permission will be given to use steel sheeting in lieu of wood sheeting for the entire job wherever the use of sheeting is necessary. The cost for use of sheeting will be included in the bid items for pipe and shall include full compensation for driving, bracing and later removal of sheeting.
- E. All sheeting and bracing shall be carefully removed in such manner as not to endanger the construction of other structures, utilities, or property, whether public or private. All voids left after withdrawal of sheeting shall be immediately refilled with sand by ramming with tools especially adapted to that purpose, by watering or otherwise as directed.
- F. No payment will be given for sheeting, bracing, etc, during the progress of the work. No payment will be given for sheeting which has actually been left in the trench for the convenience of the CONTRACTOR.
- G. Sheeting driven below mid-diameter of any pipe shall remain in place from the driven elevation to at least 1-ft above the top of the pipe.

### 3.04 TEST PITS

- A. Excavation of test pits may be required for the purpose of locating underground utilities or structures as an aid in establishing the precise location of new work.
- B. Test pits shall be backfilled as soon as the desired information has been obtained. The backfilled surface shall be maintained in a satisfactory condition for travel until resurfaced as specified.

### 3.05 EXCAVATION BELOW GRADE AND REFILL

- A. Whatever the nature of unstable material encountered or the groundwater conditions, trench drainage shall be complete and effective.
- B. If the CONTRACTOR excavates below grade through error or for the CONTRACTOR's own convenience, or through failure to properly dewater the trench, or disturbs the subgrade before dewatering is sufficiently complete, he may be directed by the Engineer to excavate below grade as set forth in the following paragraph, in which case the work of excavating below grade and furnishing and placing the refill shall be performed at his own expense.
- C. If the material at the level of trench bottom consists of fine sand, sand and silt or soft earth which may work into the screened gravel notwithstanding effective drainage, the subgrade material shall be removed to the extent directed and the excavation refilled with a 6-in layer of coarse sand, or a mixture graded from coarse sand to pea gravel, as approved by the Engineer, to form a filter layer preserving the voids in the gravel bed of the pipe. The composition and gradation of gravel shall be approved by the Engineer prior to placement. Screened gravel shall then be placed in 6-in layers thoroughly compacted up to the normal grade of the pipe. If directed by the Engineer, bank-run gravel shall be used for refill of excavation below grade.
- D. Geotextile filter fabric may be substituted for filter layer if approved by the Engineer. Filter fabric shall be Mirafi 140N; Supac equivalent, or equal.

### 3.06 BACKFILLING

- A. As soon as practicable after the pipe has been laid and jointed, backfilling shall begin and thereafter be prosecuted expeditiously. Bedding material, as specified for the type of pipe installed, shall be placed as specified in the pipe specification sections.
- B. In areas where naturally occurring groundwater levels necessitates the dewatering of the trench, an impervious dam or bulkhead cutoff of clay or other impervious material shall be constructed in the trench as directed, to interrupt the unnatural flow of groundwater after construction is completed. The dam shall be effectively keyed into the trench bottom and sidewalls. Provide at least one clay or other impervious material dam in the pipe bedding where directed or every 300-ft, whichever is less.
- C. Where the pipes are laid cross-country, the remainder of the trench shall be filled with common fill material in layers not to exceed 3-ft and mounded 6-in above the existing grade or as directed. Where a loam or gravel surface exists prior to cross-country excavations, it shall be removed, conserved and replaced to the full original depth as part of the work under the pipe items. In some areas it may be necessary to remove excess material during the clean-up process, so that the ground may be restored to its original level and condition.
- D. Where the pipes are laid in existing paved roads, streets, alleys, driveways, and parking lots, the trench shall be backfilled from trench bottom up to a depth of 3-in below the finished surface with crushed stone compacted to 95% modified proctor density. The crushed stone layers shall be placed in lifts not to exceed 6-in. The trench shall be capped with a minimum of 3-in. of compacted asphaltic concrete cold mix to serve as a temporary driving surface until permanent repairs are made.
- E. Where the pipes are laid in proposed paved roads, streets, alleys, driveways, and parking lots, the trench shall be backfilled from trench bottom up to the finished surface with crushed stone

compacted to 95% modified proctor density. The crushed stone layers shall be placed in lifts not to exceed 6-in.

- F. Where the pipes are laid in existing gravel roads, streets, alleys, driveways, and parking lots, the trench shall be backfilled from trench bottom up to the finished surface with crushed stone compacted to 95% modified proctor density. The crushed stone layers shall be placed in lifts not to exceed 6-in.
- G. When trenches pass through existing sidewalks, the trench shall be backfilled from the bedding material up to 3-in. below the finished surface with select fill material. Backfill and compaction of the select fill material shall proceed as specified in Part 3.06 D above, except the temporary cap shall be 3-in. of compacted structural fill or asphaltic concrete cold mix.
- H. To prevent longitudinal movement of the pipe, dumping backfill material into the trench and then spreading will not be permitted until bedding and selected material has been placed and compacted to a level 1-ft over the pipe.
- I. Bedding and backfill shall be brought up evenly on all sides. Each layer of material shall be thoroughly compacted by rolling, tamping, or vibrating with mechanical compacting equipment or hand tamping, to a minimum of 90 percent standard proctor density, or greater, as specified elsewhere and in the pipe specification sections. If rolling is employed, it shall be by use of a suitable roller or tractor, being careful to compact the fill throughout the full width of the trench.
- J. Where other methods are not practicable, compaction shall be by use of hand or pneumatic ramming with tools weighing at least 20 lbs; the material being spread and compacted in layers not over 6-in thick. If necessary, sprinkling shall be employed in conjunction with rolling or ramming.
- K. Backfill around structures shall be selected common fill material, may be compacted by puddling where approved by the Engineer. All backfill shall be compacted, especially under and over pipes connected to the structures.
- L. Subject to the approval of the Engineer, fragments of ledge and boulders smaller than 6-in may be used in trench backfill providing that the quantity in the opinion of the Engineer is not excessive. Rock fragments shall not be placed until the pipe has at least 2-ft of earth cover. Small stones and rocks shall be placed in thin layers alternating with earth to ensure that all voids are completely filled. Fill shall not be dropped into the trench in a manner to endanger the pipe.
- M. Bituminous paving shall not be placed in backfilling unless specifically permitted, in which case it shall be broken up as directed. Frozen material shall not be used under any circumstances.
- N. All road surfaces shall be broomed and hose-cleaned immediately after backfilling. Dust control measures shall be employed at all times.

### 3.07 TRACER WIRE

- A. A continuous 12 guage insulated (blue in color) solid copper tracing wire shall be installed with all non-metallic pipe. The wire shall be laid along the length of the pipe. The tracing wire shall be looped around valves, saddles, curb stops, and other appurtenances in such a manner that there is no interference with the operation of the appurtenances including water and sewer service lines. The tracing wire shall be looped up and left exposed above ground at all meter boxes, valve boxes, and pipe marker signs. Splices of the tracer wire shall be bare wire, twisted

and crimped together with a Red 3M Scotchlok and inserted into a 3M DBR Direct Bury Splice Connector. A continuity test shall be performed after installation.

### 3.08 RESTORING TRENCH SURFACE

- A. Where the trench occurs adjacent to paved streets, in shoulders, sidewalks, or in cross-country areas, thoroughly consolidate the backfill and shall maintain the surface as the work progresses. If settlement takes place, immediately deposit additional fill to restore the level of the ground.
- B. The surface of any driveway or any other area which is disturbed by the trench excavation and which is not a part of the paved road shall be restored to a condition at least equal to that existing before work began.
- C. In sections where the pipeline passes through improved grassed areas (such as lawns), remove and replace the sod (as applicable), or loam and seed the surface in accordance with Section 31\_2900.

END OF SECTION

SECTION 31 2323

FLOWABLE CONCRETE FILL

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install all flowable fill complete, when required per Specification 31\_2000, as specified herein.

1.02 RELATED WORK

- A. Earthwork is included in Section 31\_2000.
- B. Concrete formwork is included in Section 03\_3100.
- C. Cast-In-Place Concrete is included in Section 03\_3300.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01\_3000, shop drawings and product data. Submittals shall include the following:
  - 1. Constituent quantities per cubic yard of the flowable fill mix including water content, cement factor, type and amount of fly ash and type and manufacturer of cement.
  - 2. Technical data on all materials and components.
- B. Test Reports
  - 1. Sieve analysis of aggregate.
  - 2. Laboratory test results of the compressive strength of the proposed mix.

1.04 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
  - 1. ASTM C33 - Standard Specification for Concrete Aggregates.
  - 2. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
  - 3. ASTM C143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
  - 4. ASTM C150 - Standard Specification for Portland Cement.
  - 5. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.

6. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material Test Cylinders.

B. American Concrete Institute (ACI).

1. ACI 301 - Standard Specification for Structural Concrete.

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

#### 1.05 QUALITY ASSURANCE

A. All testing and inspection services required, unless otherwise specified, shall be provided and paid for by the UTILITY. Testing necessary to establish the mix shall be performed by and at the expense of the CONTRACTOR. Methods of testing shall comply with the latest applicable ASTM Methods except as specified herein.

B. Field testing of concrete grout will be as specified for concrete in Section 03300.

#### 1.06 DELIVERY, STORAGE AND HANDLING

A. Admixtures shall be stored in conformity with the manufacturer's recommendations.

B. Fly ash, aggregates and cement shall be stored or stockpiled in conformity with the recommendations of ACI 301.

### PART 2 PRODUCTS

#### 2.01 GENERAL

A. The use of manufacturer's name and model or catalog number is for establishing the standard of quality and general configuration desired.

B. Materials shall comply with this Section and any applicable State or local requirements.

#### 2.02 MATERIALS

A. Cement shall be domestic portland cement conforming to ASTM C150, Type II. The minimum cement content shall be 100 lbs/cu yd.

B. Fly ash shall conform to ASTM C618, Class C or Class F. The maximum fly ash content shall be 25 lbs/cu yd.

C. Aggregate shall be inert natural sand conforming to the requirements of ASTM C33 or inert natural sand containing aggregate sizes not greater than 3/8-in and having given satisfactory flowability, strength and setting time when used in comparable flowable fill mixes. Aggregates shall not be expansive or reactive.

- D. Water shall be potable, clean and free from injurious amounts of oils, acids, alkalis, organic matter, or other deleterious substances. The water content of the mix may be approximately 400 lbs/cu yd.
- E. Admixtures manufactured specifically manufactured for use in flowable fills will be considered for approval. Admixtures shall be free of chlorides and alkalis (except for those attributable to water). Admixtures shall be compatible with the mix and all other admixtures used in the mix. Admixtures causing retarded or accelerated setting of the mix shall not be used without written approval from the Engineer.

#### 2.03 MIXES

- A. Select proportions of ingredients to meet the minimum design strength of 500 psi and to produce a fill having proper placing properties, workability, durability and strength. Proportion ingredients to produce a homogenous mixture which will readily work into corners and angles without permitting materials to segregate.
- B. Compression Tests: Furnish testing of the proposed mix to demonstrate compliance with the compression strength requirements.
- C. Slump of the mix, as measured by ASTM C143, shall be approximately 8-in to full collapse of specimen.

#### 2.04 MEASURING, BATCHING, MIXING AND TRANSPORTING

- A. Measuring, batching, mixing and transporting shall conform to ASTM C94 and the requirements herein or as otherwise approved in writing by the Engineer.
- B. Ready-mixed flowable fill, whether produced by a concrete supplier or the CONTRACTOR shall conform to the requirements above. No hand mixing will be permitted.
- C. The flowable fill shall be mixed until there is uniform distribution of the materials and shall be discharged completely before the mixer is recharged. Fill which has been remixed or retempered shall be rejected.

### PART 3 EXECUTION

#### 3.01 INSPECTION AND COORDINATION

- A. The batching, mixing, transporting and placing and of the flowable fill shall be subject to the inspection of the Engineer at all times. No placement shall be made without the inspection and acceptance of the preparations by the Engineer.

#### 3.02 APPEARANCE

- A. The flowable fill shall have a homogeneous structure which, when hardened, will have the required strength and durability.

### 3.03 PLACING

- A. No flowable fill shall be placed until the condition of subgrade and method of placement have been approved by the Engineer. Before depositing flowable fill, all debris and foreign matter shall be removed from the excavation. Flowable fill shall not be placed in water or submerged within 24 hours after placing, nor shall running water be permitted to flow over the surface of fresh flowable fill.
- B. Deposit the mix as near its final position as possible to avoid segregation due to rehandling or flowing. Pumping of the mix will be permitted when the approved design mix is based on pumping. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials.

### 3.04 CURING AND PROTECTION

- A. Protect all flowable fill against injury from the elements and damage of any nature during construction operations.
- B. Flowable fill placed during cold weather shall be protected against freezing by methods specified in Section 03300. Salt, manure or other chemicals shall not be used for cold weather protection.

### 3.05 FIELD TESTS

- A. Sets of 6-in by 12-in test cylinders will be taken of the work by the construction manager following the procedures given in ASTM D4832. The number of sets of test cylinders shall be at the discretion of the construction manager. The cylinders shall be capped with neoprene for testing. When the average compressive strength of the cylinders in any set falls below the required compressive strength; the construction manager may reject the fill represented by the set of cylinders or require modification of the proportions of the design mix to achieve the required strengths.
- B. Cooperate in the making of tests by allowing free access to the work for the selection of samples, providing an insulated closed curing box for specimens, affording protection to the specimens against injury or loss through the operations and furnishing material and labor required for the purpose of taking test cylinder samples. All shipping of specimens will be paid for by the UTILITY.
- C. Slump tests will be made in the field by the construction manager in conformity with ASTM C143.

END OF SECTION



SECTION 31 2330

GRANULAR MATERIALS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and obtain materials for filling and backfilling, grading and miscellaneous sitework, for the uses shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Site Preparation is included in Section 31\_1100.
- D. Earthwork is included in Section 31\_2000.
- E. Trenching, Backfilling and Compaction is included in Section 31\_2300.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01\_3000, complete product data for materials specified in this Section.

1.04 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
  - 1. ASTM C33 - Standard Specification for Concrete Aggregates.
  - 2. ASTM D698 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft (600kN-m/m)).
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. Laboratory Testing
  - 1. At least 7 days prior to the placement of any backfill or fill materials, deliver a representative sample of the proposed materials weighing at least 50 lbs to the soils testing laboratory.
  - 2. Engage the soils testing laboratory to perform:
    - a. Grain size analyses of the samples to determine their suitability for use as backfill or fill material in conformance to the materials requirements specified herein.

- b. The appropriate Proctor analyses to determine the maximum dry densities required for compaction testing as specified elsewhere in the Contract Documents.
- 3. Test results and determinations of suitability shall be delivered to the resident project representative no later than 3 days prior to the placement of backfill or fill materials.

## PART 2 PRODUCTS

### 2.01 MATERIALS

- A. Backfill and Fill materials shall be suitable excavated materials, natural or processed mineral soils obtained from off-site sources or graded crushed stone or gravel. Backfill and Fill materials shall be free of all organic material, trash, snow, ice, frozen soil, or other objectionable materials which may be compressible or which cannot be properly compacted. Soft, wet, plastic soils which may be expansive, clay soils having a natural, in-place water content in excess of 30 percent, soils containing more than 5 percent (by weight) fibrous organic materials, and soils having a plasticity index greater than 30 shall be considered unsuitable for use as backfill and fill. Backfill and fill materials shall have a maximum of 1 percent expansion when testing is performed on a sample remolded to 95 percent of maximum dry density (per ASTM D698) at 2 percent below optimum moisture content under a 100 lbs/sq ft surcharge.
- B. Structural Fill shall be clean, crushed stone meeting the requirements of AHTD Aggregate Base Course Class 7. This shall be used under and within 5 feet around all structures.
- C. Selected Common Fill shall conform to the requirements of common fill except that the material shall not contain any materials larger than 2-in in largest dimension.
- D. Common Fill shall not contain granite blocks, broken concrete, masonry rubble, asphalt pavement, or any material larger than 6-in in any dimension. Common Fill shall have a plasticity index of less than 15 and shall conform to the following gradation limits:

<u>Sieve Size</u>	<u>Percent Finer By Weight</u>
No. 40	75
No. 200	20

- E. Crushed Stone shall be sound, durable stone, angular in shape, and free of any foreign material, structural defects and chemical decay. Crushed stone shall conform to the gradation requirements shown below:

<u>Sieve Size</u>	<u>Percent Finer By Weight</u>
3/4-in	100
No. 4	≤ 50
No. 200	≤ 5

- F. Pea Gravel shall be screened, uniformly rounded stone, free from sand, loam, clay, excess fines and other deleterious materials. Pea Gravel shall conform to the following gradation limits:

<u>Sieve Size</u>	<u>Percent Finer By Weight</u>
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1/2-in	100
3/8-in	90
No. 4	30
No. 8	10
No. 16	5

- H. Sand for concrete, grout, and masonry shall conform to ASTM C33 for fine aggregate. General purpose sand shall be Select Common Fill.
- I. Flowable Fill shall be ready-mix, cast-in-place concrete conforming to the requirements of Section 31\_2323.
- J. Filter fabric shall be Mirafi, Type 140N; Dupont, Type PAR, Style 3401, or equal product by Amoco and shall conform to the following requirements:
1. Minimum grab strength of 120 lbs per ASTM D1682.
  2. Equivalent open size (EOS) to be equal to or greater than the U.S. Standard Sieve No. 100 (0.210 mm) per ASTM D442.
  3. Percent open area not to exceed about 25 percent. The percent open area is defined as the ratio of the sum of 20 or more individual open areas (times 100) to the sum of the corresponding 20 or more individual total areas.
  4. Coefficient of permeability shall not be less than 10<sup>-2</sup> cm/sec.
- K. Impermeable Fill shall conform to the requirements of the Unified Soil Classification System for soil types CL, CH, or OH per ASTM D2487 and shall have a coefficient of permeability of 1 x 10<sup>-7</sup> cm/sec or less after compaction.
- L. Controlled Low-Strength Material (CLSM) used as backfill and fill shall be comprised of a mixture of Portland cement, coarse aggregate, fine aggregate and water. Materials, methods of preparation, and placement techniques shall comply with the requirements of Section 03\_3300 as for concrete. Design mix shall result in a flowable material with a 28 day compressive strength of approximately 60 psi. Recommended mix shall be as follows:
- |                  |      |                         |
|------------------|------|-------------------------|
| Portland Cement  | 40   | lbs/cu yd               |
| Coarse Aggregate | 1700 | lbs/cu yd               |
| Fine Aggregate   | 1900 | lbs/cu yd               |
| Water            | 325  | lbs/cu yd, or as needed |
- M. Low Density Cellular Concrete Fill shall conform to the requirements of Specification Section 03\_3400 of these contract documents.

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 31 2500

SWPPP AND EROSION AND SEDIMENTATION CONTROL

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Arkansas Department of Environmental Quality has promulgated the Construction General Permit (CGP) which authorizes stormwater discharges from large and small construction activities that result in a total land disturbance of equal to or greater than one acre, where those discharges enter surface waters of the State or a municipal separate storm sewer system (MS4) leading to surface waters of the State subject to the conditions set forth in the permit. This permit also authorizes stormwater discharges from any other construction activity designated by ADEQ where ADEQ makes that designation based on the potential for contribution to an excursion of a water quality standard or for significant contribution of pollutants to waters of the State.
- B. The CONTRACTOR is responsible for obtaining coverage under the Construction General Permit or other individual permit, if applicable. Automatic coverage and waivers are available for small construction sites for which submittal of a NOI, SWPPP and fee are not required. The CONTRACTOR shall prepare and post the Notice of Coverage (NOC) and the Stormwater Pollution Prevention Plan (SWPP) as required by the Construction General Permit for sites less than 5 acres. The CONTRACTOR should make sure to read and understand the conditions of the permit. A copy of the General Stormwater Construction Permit is available on the ADEQ web site at [www.adeq.state.ar.us/water/branch\\_permits/general\\_permits/stormwater/](http://www.adeq.state.ar.us/water/branch_permits/general_permits/stormwater/). You may also obtain a hard copy by contacting the ADEQ's General Permits Section at (501) 682-0623
- C. If the site is larger than 5 acres, the CONTRACTOR SHALL OBTAIN COVERAGE IN THE UTILITY'S NAME and submit a Notice of Intent (NOI), a stormwater pollution prevention plan (SWPPP), and pertinent fees and other requirements set forth in the CGP.

1.02 QUALITY ASSURANCE

- A. Be responsible for the timely installation and maintenance of all sedimentation control devices necessary to prevent the movement of sediment from the construction site to off site areas or into the stream system via surface runoff or underground drainage systems.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 31 2900

TOPSOIL AND SEEDING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and place topsoil, finish grade, apply lime and fertilizer, hydraulically apply seed and mulch and maintain all seeded areas as shown on the Drawings and as specified herein, including all areas disturbed and all existing lawn areas.

1.02 RELATED WORK

- A. Site Preparation is included in Section 31\_1100.
- B. Earthwork is included in Section 31\_2000.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, complete shop drawings, materials and equipment furnished under this Section including seed mixtures and product label information.
- B. Samples of all materials shall be submitted for inspection and acceptance upon Engineer's request.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Topsoil shall be fertile, natural sandy loam soil, free from large stones, roots, sticks, clay, peat, weeds and sod and obtained from naturally well drained areas. It shall not be excessively acid or alkaline nor contain toxic material harmful to plant growth. Topsoil stockpiled under other Sections of this Division may be used, but the CONTRACTOR shall furnish additional loam at his/her own expense if required.
- B. Fertilizer shall be a complete commercial fertilizer, 10-10-10 grade for grass areas. It shall be delivered to the site in the original unopened containers each showing the manufacturer's guaranteed analysis. Store fertilizer so that when used it shall be dry and free flowing.
- C. Lime shall be ground limestone containing not less than 85 percent calcium and magnesium carbonates.
- D. Grass seed shall be from the same or previous year's crop; each variety of seed shall have a percentage of germination not less than 90, a percentage of purity not less than 85 and shall have not more than 1 percent weed content. The mixture shall consist of that specified in Section 620, AHTD Standard Specifications for Highway Construction.
- E. The seed shall be furnished and delivered premixed in the proportions specified above. A manufacturer's certificate of compliance to the specified mixes shall be submitted by the

manufacturer for each seed type. These certificates shall include the guaranteed percentages of purity, weed content and germination of the seed and also the net weight and date of shipment. No seed may be sown until the certificates have been submitted.

- F. Mulch shall be a specially processed cellulose fiber containing no growth or germination-inhibiting factors. It shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the material become uniformly suspended to form a homogeneous slurry. When sprayed on the ground, the material shall allow absorption and percolation of moisture. Each package of the cellulose fiber shall be marked by the manufacturer to show the air dry weight content.

### PART 3 EXECUTION

#### 3.01 APPLICATION

- A. Unless otherwise shown on the Drawings, loam shall be placed to a minimum depth of 4-in. in all areas.
- B. For all areas to be seeded:
  - 1. Lime shall be applied at the rate of 25 lbs/1,000 sq ft.
  - 2. Fertilizer (10-10-10) shall be applied at the rate of 30 lbs/1,000 sq ft.
  - 3. Lawn grass seed shall be applied at the rate of 10 lbs/1,000 sq ft.
  - 4. Fiber mulch shall be applied at the rate of 20 lbs/1,000 sq ft.
- C. The application of fertilizer and lime may be performed hydraulically in one operation with hydroseeding and mulching. If lime is applied in this manner, clean all structures and paved areas of unwanted deposits.

#### 3.02 INSTALLATION

- A. The subgrade of all areas to be loamed and seeded shall be raked and all rubbish, sticks, roots and stones larger than 2-in shall be removed. Subgrade surfaces shall be raked or otherwise loosened immediately prior to being covered with loam. Subgrade shall be inspected and approved by the Engineer before loam is placed.
- B. Loam shall be placed over approved areas to a depth sufficiently greater than required so that after natural settlement and light rolling, the complete work will conform to the lines, grades and elevations indicated. No loam shall be spread in water or while frozen or muddy.
- C. After loam has been spread, it shall be carefully prepared by scarifying or harrowing and hand raking. All large stiff clods, lumps, brush, roots, stumps, litter and other foreign material shall be removed from the loamed area and disposed of. The areas shall also be free of smaller stones, in excessive quantities, as determined by the Engineer. The whole surface shall then be rolled with a hand roller weighing not more than 100 lbs/ft of width. During the rolling, all depressions caused by settlement of rolling shall be filled with additional loam and the surface shall be regraded and rolled until a smooth and even finished grade is created.
- D. Seeding, mulching and conditioning shall only be performed during those periods within the



seasons which are normal for such work as determined by the weather and locally accepted practice, as approved by the Engineer. Hydroseed only on a calm day.

- E. Schedules for seeding and fertilizing must be submitted to the Engineer for approval prior to the work.
- F. If lime and fertilizer are to be spread mechanically rather than in one operation with the hydroseeding, then:
  - 1. After the loam is placed and before it is raked to true lines and rolled, limestone shall be spread evenly over loam surface and thoroughly incorporated with loam by heavy raking to at least 1/2 the depth of loam.
  - 2. Fertilizer shall be uniformly spread and immediately mixed with the upper 2-in of topsoil.
- G. Seeding shall be done within 10 days following soil preparation. Seed shall be applied hydraulically at the rates and percentages indicated. The spraying equipment and mixture shall be so designed that when the mixture is sprayed over an area, the grass seed and mulch shall be equal in quantity to the specified rates. Prior to the start of work, the Engineer shall be furnished with a certified statement for approval as to the number of pounds of materials to be used per 100 gallons of water. This statement shall also specify the number of square feet of seeding that can be covered with the quantity of solution in the Hydroseeder.
- H. In order to prevent unnecessary erosion of newly graded slopes and unnecessary siltation of drainage ways, carry out seeding and mulching as soon as satisfactory completion of a unit or portion of the project. A unit of the work will be defined as not more than 20,000 sq ft.
- I. When protection of newly graded areas is necessary at a time that is outside of the normal seeding season, protect those areas by whatever means necessary (such as straw applied with a tar tack) or by other measures as approved by the Engineer.

### 3.03 SEEDING IN WOODED AND UNGRADED AREAS

- A. For preparation and seeding in wooded areas under this Contract and where no grading is required, all of the specified materials and procedures shall be utilized except that no disking shall be performed within the drip line of trees to be preserved. The seed bed shall be prepared by the addition of a thin layer of top soil roughly 1-in deep.

### 3.04 MAINTENANCE AND PROVISIONAL ACCEPTANCE

- A. Keep all seeded areas watered and in good condition, reseeding if and when necessary until a good, healthy, uniform growth is established over the entire area seeded and shall maintain these areas in an approved condition including a minimum of two mowings of the lawn areas until provisional acceptance.
- B. On slopes, provide against washouts by an approved method. Any washout that occurs shall be regraded and reseeded at the CONTRACTOR's expense until a good sod is established.
- C. The Engineer will inspect all work for provisional acceptance at the end of the 8 week grass maintenance period, upon the written request, received at least 10 days before the anticipated date of inspection.

- D. A satisfactory stand will be defined as a section of grass of 100 sq ft or larger that has:
  - 1. No bare spots larger than 2 sq ft.
  - 2. No more than 10 percent of total area with bare spots larger than 1 sq ft.
  - 3. Not more than 15 percent of total area with bare spots larger than 6-in square.
- E. Furnish full and complete written instructions for maintenance of the lawns to the UTILITY at the time of provisional acceptance.
- F. The inspection by the Engineer will determine whether maintenance shall continue in any area of manner.
- G. After all necessary corrective work and clean-up has been completed and maintenance instructions have been received by the UTILITY, the Engineer will certify in writing the provisional acceptance of the lawn areas. Maintenance of lawns or parts of lawns shall cease on receipt of provisional acceptance.

### 3.05 GUARANTEE PERIOD AND FINAL ACCEPTANCE

- A. All seeded areas shall be guaranteed for not less than 1 full year from the time of provisional acceptance.
- B. At the end of the guarantee period, inspection will be made by the Engineer upon written request submitted at least 10 days before the anticipated date. Lawn areas not demonstrating satisfactory stands as outlined above, as determined by the Engineer, shall be renovated, reseeded and maintained meeting all requirements as specified herein.
- C. After all necessary corrective work has been completed, the Engineer shall certify in writing the final acceptance of the lawns.

END OF SECTION

SECTION 33 0501

PIPELINE TESTING AND CLEANING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required and test and clean all new pipelines installed under this Contract as specified herein, including chlorination of all potable water lines.

1.02 RELATED WORK

- A. Buried pipelines are included in Division 33.
- B. Above grade and exposed pipelines are included in Division 40.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Furnish all necessary equipment and labor for cleaning, testing and disinfecting the pipelines. The procedures and methods shall be approved by the Engineer.
- B. Make any taps and furnish all necessary caps, plugs, etc, as required in conjunction with testing pipelines. Furnish a test pump, gauges and any other equipment required in conjunction with carrying out the hydrostatic tests.

3.02 CLEANING PIPELINES

- A. As pipe laying progresses and at the conclusion of the work thoroughly clean all new pipelines by flushing with water or other means to remove all dirt, stones, pieces of wood or other material which may have entered during the construction period. If, after this cleaning, obstructions remain, they shall be removed.

3.03 TESTING GRAVITY PIPELINES

- A. All gravity pipelines shall be tested for leakage by an infiltration or exfiltration test. Buried piping shall be tested by an infiltration test if the groundwater is more than 2-ft above the crown of the pipe for the full length of the section to be tested. Air testing may be used in lieu of an exfiltration test subject to approval of the Engineer.
- B. Exfiltration Test
  - 1. Leakage tests by exfiltration shall be made by creating a head in the pipeline to be tested by filling the line and either a manhole or temporary riser on one end of the line with water. The length of pipe to be tested shall be such that the head over the crown at the upstream end is not less than 2-ft and the head over the downstream crown is not more than 6-ft. The pipe shall be plugged by pneumatic bags or mechanical plugs in such a manner that the air

can be released from the pipe while it is being filled with water. Before any measurements are made, the pipe shall be kept full of water long enough to allow absorption and the escape of any trapped air to take place. Following this, a test period of at least one hour shall begin. Provisions shall be made for measuring the amount of water required to maintain the water at a constant level during the test period.

2. If any joint shows an appreciable amount of leakage, the jointing material shall be removed and the joint repaired. If any pipe is defective, it shall be removed and replaced. If the quantity of water required to maintain a constant head in the pipe does not exceed 1.9 gallons per inch of diameter per day per 100-ft of pipe and if all the leakage is not confined to a few joints, workmanship shall be considered satisfactory.

C. Infiltration Test

1. Pipe shall be tested for infiltration after the backfill has been placed and the ground water allowed to return to normal elevation. The length of line to be tested shall be not less than the length between adjacent manholes and not more than the total length of each size of pipe. The allowable infiltration shall be 1.9 gallons per inch of diameter per day per 100-ft of pipe in each section tested. There shall be no gushing or spurting leaks.
2. If an inspection of the completed pipeline or any part thereof shows pipes or joints which allow noticeable infiltration of water, the defective work or material shall be replaced or repaired as directed.
3. Rates of infiltration shall be determined by means of V-notch weirs, pipe spigots, or by plugs in the end of the pipe installed in an approved manner and at such times and locations as may be directed by the Engineer.

D. When the pipeline to be tested is reinforced concrete pipe, the allowable leakage in the above tests shall be 4.7 gallons per inch of diameter per 100-ft of pipe.

E. Low Pressure Air Test

1. Low-pressure air tests shall be made with equipment specifically designed and manufactured for the purpose of testing pipelines using low-pressure air. The equipment shall be provided with an air regulator valve or air safety valve so set that the internal air pressure in the pipeline cannot exceed 8 psig. Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be tested. All air used shall pass through a single control panel.
2. Install plugs at manholes. Brace plugs securely as required for safety and allow no one in the manholes while pressurizing the line or during the test.
3. Low-pressure air shall be introduced into the sealed line until the internal air pressure reaches 4 psig. The internal air pressure in the sealed line shall not be allowed to exceed 8 psig. At least 2 minutes shall be allowed for the air pressure to stabilize in the section under test. After the stabilization period, the low-pressure air supply hose shall be quickly disconnected from the control panel. The time required in minutes for the pressure in the section under test to decrease from 3.5 to 2.5 psig shall not be less than that shown in Table 1 below.

Table 1 – Minimum Specified Time Required for a 1.0 psig Pressure drop for Size and Length of Pipe Indicated

Pipe Diameter (in)	Minimum Time, min:s	Length for Minimum Time, ft	Time for longer lengths, s	Specification Time for Length (L) Shown, min:s							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
6	5:40	398	0.854L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.520L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	239	2.374L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	199	3.418L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	159	5.342L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	133	7.692L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	114	10.470L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31

Table 2 – Minimum Specified Time Required for a 0.5 psig Pressure drop for Size and Length of Pipe Indicated

Pipe Diameter (in)	Minimum Time, min:s	Length for Minimum Time, ft	Time for longer lengths, s	Specification Time for Length (L) Shown, min:s							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
6	2:50	398	0.427	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47	298	0.760	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	4:43	239	1.187	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	5:40	199	1.709	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50
15	7:05	159	2.671	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02
18	8:30	133	3.846	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51
21	9:55	114	5.235	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16

4. If the pipe section does not pass the air test (time of air pressure drop is lower than the minimum time require in the table above), sectionalize the section tested to determine the location of the leak. Once the leak has been located, repair and retest.

### 3.04 TESTING PRESSURE PIPELINES

- A. All pressure pipelines shall be pressure and leakage tested. Pipelines shall be subjected to a hydrostatic pressure of 50 percent above the normal operating pressure and this pressure maintained for at least 10 minutes. The leakage test shall be conducted at the maximum operating pressure as determined by the Engineer, and this pressure shall be maintained for at least two hours. The test pump and water supply shall be arranged to allow accurate measurement of the water required to maintain the test pressure. Where applicable, hydrant branch gate valves shall remain open during this test. The amount of leakage which will be permitted shall be in accordance with AWWA C600 as shown below:

$$L = SD\sqrt{P}/148,000$$

Where: L = makeup water in gallons per hour  
 S = length of pipe tested in feet  
 D = nominal pipe diameter in inches  
 P = average test pressure in psi

END OF SECTION

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SECTION 33 1101

DUCTILE IRON PRESSURE PIPE AND FITTINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required, install, and test ductile iron water pipe and fittings for piping as shown on the Drawings and as specified herein. This specification also governs the ductile iron pipe used for Wastewater and sludge forcemain applications.
- B. Piping shall include all piping and fittings extending outward, upward and downward into the ground from the outside face of all buildings. Piping shall begin at the outside face of the buildings. The first joint shall be not more than 2-ft from the outside face of the building or structure unless otherwise shown on the Drawings. Piping shall include all piping in valve vaults, manholes, cleanouts and similar yard structures.
- C. Piping shall be located substantially as shown on the Drawings. The Engineer reserves the right to make such modifications in locations as may be found desirable to avoid interference between pipes or for other reasons. Pipe fitting notation is for the CONTRACTOR's convenience and does not relieve him/her from installing and jointing different or additional items where required to achieve a complete piping system.
- D. Where the word "pipe" is used it shall refer to pipe, fittings, or appurtenances unless otherwise noted.

1.02 RELATED WORK

- A. Trenching, Backfilling and Compaction is included in Section 31\_2300.
- B. Valves, Hydrants and Appurtenances are included in Section 33\_1200.

1.03 SUBMITTALS

- A. Submit shop drawings and product data, including piping layouts, design calculations, warranty information, test reports, in accordance with Section 01\_3000 and the referenced standards.
- B. Submit design calculations in accordance with Paragraph 2.02 below signed by a Professional Engineer, as noted in Section 01300.
- C. Submit the name of the pipe and fitting suppliers and a list of materials to be furnished.
- D. Prior to shipment of pipe, certified copies of mill tests confirming the type of materials used in the pipe, and shop testing of pipe to show compliance with the requirements of the applicable standards, along with a sworn affidavit of compliance that the pipe complies with the referenced standards, shall be submitted.
- E. Submit copies of all shop tests, including hydrostatic tests.
- F. Submit information on all warranties per Section 01\_7836.

- G. Submit shop drawings with a tabulated laying schedule which references stations and invert elevations as shown on the Drawings as well as all fittings, bends, outlets, restrained joints, tees, special deflection bells, adapters, solid sleeves and specials, along with the manufacturer's drawings and specifications providing complete details of all items. The laying schedule shall show pipe class, class coding, station limits and transition stations for various pipe classes. The above shall be submitted to the Engineer for approval before manufacture and shipment. The location of all pipes shall conform to the locations indicated on the Drawings. Full length pipe may be supplied from inventory provided that all specification requirements are met. Shop drawings shall include but not be limited to:
1. Complete and dimensional working drawings of all pipe layouts, including pipe stationing, invert elevation at changes in grade or horizontal alignment, all elements of curves and bends both in horizontal alignment and vertical position.
  2. The grade of material; size, wall thickness, of the pipe and fittings and appurtenances, type and location of fittings, specials, and valves; and the type and limits of the lining, lining reinforcing and coating systems of the pipe and fittings. Methods and procedures recommended by the coating manufacturer will be documented.
  3. Joint details; methods and locations of supports; and complete information concerning type, size and location of all welds. Shop welds (no field welding will be allowed) will be clearly differentiated and welds will be clearly detailed with preparation procedures for all pipe and parent material comprising each weld. Critical welding procedures will be identified along with methods for controlling welding stresses and distortions. Locations and proposed joint details will also be clearly identified.
  4. Method of manufacture of pipe; joint details; fittings; and any specials.
  5. All other pertinent information for all items to be furnished; product data to show compliance of all couplings, supports, fittings, coatings and related items.
- H. Submit anticipated production and delivery schedule.
- I. Prior to shipment of pipe, submit a certified affidavit of compliance from the manufacturer stating that the pipe, fittings, gaskets, linings and exterior coatings for this project have been manufactured and tested in accordance with AWWA and ASTM standards and requirements specified herein.
- J. Submit handling procedures for all phases from finished fabrication through delivery including storage, transportation, loading, and unloading. This will include storage at the project site and required protection following installation prior to startup.

#### 1.04 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
1. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.



2. ASTM A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
  3. ASTM A242 – Standard Specification for High-Strength Low-Allow Structural Steel
  4. ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tesile Strength.
  5. ASTM A674 – Standard Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids.
  6. ASTM C150 - Standard Specification for Portland Cement.
- B. American Water Works Association (AWWA)
1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
  2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
  3. AWWA C110 - Ductile-Iron and Gray-Iron Fittings, 3-in through 48-in (75mm Through 1219mm) for Water.
  4. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
  5. AWWA C150 - Thickness Design of Ductile-Iron Pipe.
  6. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast, for Water.
  7. AWWA C115 – Flanged Ductile Iron Pipe With Ductile Iron or Grey Iron Threaded Flanges.
  8. AWWA C116 – Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior surfaces of Ductile Iron and Grey Iron Fittings for Water Supply Service.
  9. AWWA C153 - Ductile- Iron Compact Fittings, 3-in through 24-in and 54-in through 64-in, for Water.
  10. AWWA C550 – Protective Interior Coatings for Valves and Hydrants
  11. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
  12. AWWA C606 - Grooved and Shouldered Joints.
  13. AWWA C651 - Disinfecting Water Mains.
  14. AWWA M41 – Ductile Iron Pipe and Fittings Manual of Water Supply Practices

C. National Sanitation Foundation (NSF)

1. NSF 61 – Drinking Water System Components Health Effects.

- D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. It is a requirement of these Contract Documents to have all of the ductile iron pipe under this section designed and supplied by a single manufacturer rather than have selection and supply of these items by a number of different manufacturers. Similarly, it is a requirement of these Contract Documents to have all of the ductile iron fittings under this section designed and supplied by a single manufacturer rather than have selection and supply of these items by a number of different manufacturers. All connections between the pipe and fittings shall be compatible, as detailed in Section 1.06.
- B. Each length of ductile iron pipe supplied for the project shall be hydrostatically tested at the point of manufacture to 500 psi for a duration of 10 seconds per AWWA C151. Testing may be performed prior to machining bell and spigot. Failure of ductile iron pipe shall be defined as any leak or rupture of the pipe wall. Certified test results shall be furnished in duplicate to the Engineer prior to time of shipment.
- D. All ductile-iron pipe and fittings to be installed under this project shall be inspected and tested at the foundry as required by the standard specifications to which the material is manufactured. Furnish in duplicate to the Engineer sworn certificates of such tests and their results at least 5 days prior to the shipment of the goods.
- E. Inspection of the pipe and fittings will also be made by the Engineer or representative of the UTILITY after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the Specification requirements even though pipe may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery (including defects from manufacturing or delivery/transport) shall be marked for identification and shall immediately be removed from the job at the Contractor's expense.
- F. All pipe and fittings to be installed under this Contract may be inspected at the plant for compliance with this Section by an independent testing laboratory selected by the UTILITY at the UTILITY's expense.
- G. A manufacturer's representative shall be made available to the UTILITY and UTILITY's representative during the manufacturing, furnishing, transporting, and unloading of the pipe during installation and testing of the pipe to assist in insuring that the pipe is properly fabricated, transported, unloaded, stored in the field, joined and tested. Manufacturer's responsibilities relate only to the proper care and treatment of the pipe during these procedures and not the techniques or procedures used during installation and testing.
1. The designated factory representative shall be made available at any time the UTILITY may request. The field or site representative shall be made available a minimum of [2] working days (time on site) during the project when requested by the UTILITY.

2. The cost for the services of the factory representative, including expenses, shall be considered incidental to the project and will not be paid separately.
- H. The manufacturer shall meet the following criteria and furnish the necessary project information , which demonstrates the required experience:
1. Experience that includes successful fabrication (followed by installation, acceptance and service) to AWWA C151 standards of at least [50,000] lineal feet of the largest specified diameter or larger ductile iron pipe with similar linings/coatings within the past 5 years.
  2. Experience shall include the successful fabrication of at least 50- fittings in compliance with AWWA C110 or C153 of the largest specified diameter or larger with similar lining/coatings within the past 5 years.
  3. Experience that includes the successful fabrication (followed by installation, acceptance and service) of at least 10,000 lineal feet of the largest specified diameter or larger push-on style, boltless restrained joint for ductile iron pipe within the last 5 years.
- I. All pipe and fittings shall be marked in accordance with all applicable AWWA standards. Legibly and permanently mark all pipe, fittings, specials and appurtenances to be consistent with the laying schedule and marking drawings (if required) with the following information:
1. Manufacturer, date.
  2. Size, type, class, or wall thickness.
  3. AWWA Standard(s) produced to.
  4. Each pipe shall be identified with sequential numbering consistent with the laying schedule and marking drawings and each marked pipe will appear on the marking drawings in the identified location for installation.
  5. Special fittings, bends, and appurtenances requiring specific orientation will be appropriately marked with the words "TOP" in the correct position and in a consistent location.

#### 1.06 DESCRIPTION OF SYSTEMS

- A. Pipe shall be made in the United States. Fittings may be made outside the United States, but shall be supplied by one of the named pipe manufacturers or engineer approved equal. Pipe and fittings shall be as supplied by the American Cast Iron Pipe Co., U.S. Pipe and Foundry, Griffin Pipe Products, all pipe divisions of the McWane Company or an approved equal who is a member of the Ductile Iron Pipe Research Association (DIPRA). All ductile iron pipe shall be supplied by a single manufacturer and all ductile iron fittings shall be supplied by a single manufacturer. The fittings supplier shall certify in writing that their fittings are compatible with the supplied brand of pipe.
- B. Pipe is to be installed in those locations shown on the Drawings, and only where specifically indicated.
- C. CONTRACTOR is responsible for compatibility between joints of all items they supply.

- D. In the case of conflict between information on the pipe schedule, Drawings, and or this section especially concerning pressures, coatings, linings minimum thickness etc. the information given in the pipe schedule shall govern.

#### 1.07 DELIVERY, STORAGE AND HANDLING

- A. Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe, pipe linings and pipe coatings. See AWWA C600 and the referenced AWWA Standards for Shipping, handling and storage procedures. All pipe and fittings shall be examined as noted in Division 1. Any damage to linings or coatings discovered during the examination shall be repaired to the satisfaction of the Engineer at the cost of the CONTRACTOR, before proceeding with the work.
- B. Pipe shall be transported to the job site on padded bunks or oak timbers and secured with steel banding or nylon tie down straps to adequately protect the pipe and coating. Slings, hooks, or pipe tongs or other devices acceptable to the Engineer shall be used in pipe handling. No uncushioned ropes, chairs, wedges, cables or levers shall be used in handling finished pipe, fittings or couplings. Under no circumstances shall the pipe or fittings be dropped or skidded against each other. Care shall be taken to preventing marring the pipe coating. Padded wooden pipe cradles, or chocks suitable for the protection of coatings shall be used between finished pipes and beneath them when pipes are placed upon rough surfaces. Pipe shall not be stored on bare ground unless soft sand berms are used to support the pipe and is approved by the Engineer.
- C. Materials, if stored, shall be kept safe from damage. The interior of all pipe, fittings and other appurtenances shall be kept free from dirt, excessive corrosion or foreign matter at all times.
- D. Pipe shall not be stacked higher than the limits recommended by its manufacturer. The bottom tier shall be kept off the ground on timbers, rails, or concrete. Stacking shall conform to manufacturer's recommendations and/or AWWA C600.
- E. Gaskets for mechanical and push-on joints to be stored shall be placed in a cool location out of direct sunlight. Gaskets shall not come in contact with petroleum products. Gaskets shall be used on a first-in, first-out basis.
- F. Lined and/or coated pipe shall be suitably protected from exposure and heating of the sun at all times following procedures recommended by the coating/lining system manufacturer. Exposure will not be allowed (except for short periods such as installation, assembly and repairs).
- G. No metal tools or heavy objects shall be permitted to come in contact unnecessarily with the finished coating. Workers will be permitted to walk upon the coated pipe only when necessary, in which case they shall wear footwear with rubber or composition soles and heels that are sufficiently free of dirt and mud that coating remains undamaged.
- H. It shall be the responsibility of the CONTRACTOR to prevent damage to the linings and coatings that might be caused by handling and/or onsite storage of the finished pipe at low temperatures (due to embrittlement), high temperatures or direct sunlight.

#### 1.08 Warranties

- A. Provide warranties as required in Section 017836

## PART 2 PRODUCTS

### 2.01 MATERIALS

- A. Ductile iron pipe shall conform to AWWA C151 or ASTM A746. Pipe shall be supplied in standard lengths as much as possible.
- B. Thickness design shall be per AWWA C150. The pipe supplier shall perform thickness analysis as referenced in Paragraph 2.02. All ductile iron pipe supplied shall meet the minimum wall thickness and pressure class indicated on the drawings.

### 2.02 DUCTILE IRON PIPE DESIGN

- A. Ductile iron pipe shall have a minimum tensile strength of 60,000 psi with minimum yield strength of 42,000 psi (per AWWA M-41). Design shall be done for external and internal pressures separately using the larger of the two for the net design thickness. Additional allowances shall be made for service allowance and casting tolerance per AWWA C150. The pipe classes determined for various sizes and conditions shall provide the total calculated thickness at a minimum or conform to minimum pipe class specified in Paragraph 2.01 B above, or as shown on the Drawings, whichever is greater.
- B. Design for the net thickness for external loading shall be taken as the greater of the following conditions:
  - 1. 2.5-ft of cover with AASHTO H-20 wheel loads, with an impact factor of 1.5.
  - 2. Depth from existing ground level of future proposed grade (whichever is greater) to top of pipe as shown on the Drawings, with truck load.
  - 3. Soil Density: 125 lbs/cu ft
  - 4. Laying Conditions; AWWA C150, Type 2.
- C. Design for the net thickness shall be based upon the following internal pressure conditions:
  - 1. Design pressure: 350 psi
  - 2. Surge allowance: 100 psi
  - 3. Safety factor: 2
  - 4. Total internal pressure design:  $2(350 + 100) = 900$  psi
  - 5. E': 300 psi
- D. Copies of design calculations showing that the pipe meets all of the requirements specified herein shall be furnished to the Engineer for approval during shop drawing review in accordance with Section 01\_3000. Yield strength of 42,000 psi shall be used during design calculations.

## 2.03 END TREATMENTS/JOINTS

- A. Ductile iron pipe joints shall be push-on rubber gasket type or rubber-gasket mechanical joint per AWWA C111, except where flanged joints are required as shown on the drawings. All gasket materials shall comply with Table 5-1 of AWWA M-41. Rubber-gasket joints shall conform to AWWA C111. Gasket shall be of styrene butadiene rubber (SBR).
- B. Unless otherwise noted, all buried ductile iron pipe fitting joints shall be rubber-gasket mechanical joint per AWWA C111 and shall be restrained with a Megalug Series 1100 retaining gland at each side.
- C. Unless otherwise noted, all exposed ductile iron pipe fitting joints shall be flanged joint per AWWA C110/C153.
- D. Threaded ductile iron flanges for ductile iron pipe shall be fabricated per AWWA C115 and sealed during installation with a special high pressure, full face gasket per AWWA C111. At the pipe manufacturer's option, the use of 250 lb pattern flanges, which are faced and drilled in accordance with ANSI B16.1 may be substituted in order to match valves or other equipment and/or to meet the required working pressure requirements. All flanges shall be rated for the same pressure as the adjacent pipe in all cases. Compatibility of the flanges with the 250 lb class and higher special class AWWA valves will be the responsibility of the CONTRACTOR.
  - 1. Flanges shall be pre drilled and then faced after being screwed onto the pipe, with flanges true to 90 degrees of the pipe axis and shall be flush with the end of the pipe.
  - 2. Gaskets shall be full face rubber, 1/8" thick SBR material, such as American Toruseal Gasket, or approved equal. Special material ring gaskets such as those by Garlock or equal may be required for pressures exceeding 250 for ANSI rated and custom flanges.
  - 3. Flanged joints shall be supplied with bolts and nuts on one end, bolt studs with a nut at each end, or studs with nuts on one end where the flange is tapped. The number and size of bolts shall comply with the same standard as the flange. Bolts and nuts shall, except as otherwise specified or noted in the Specifications or on the Drawings, comply with ASTM A193, grade B7.
  - 4. Blind flanges shall mate with regular flanges.
  - 5. Filler flanges and beveled flange fillers shall be furnished faced and drilled complete with extra length bolts.
- E. Couplings and Adapters
  - 1. Sleeve type couplings shall be Dresser Style 38, 138 or equal.
    - a. Buried sleeve-type couplings shall have a protective wrapping of "Denso" material by DENSO Inc. of Texas or equal. Where "Denso" material is used, the joint shall be packed up with "Densyl mastic" to give an even contour for wrapping with "Densopol" tape. A 1.5 mm thick coating of "Denso" paste shall be applied following by 100 mm or more wide "Densopol" tape wound spirally round the joint with at least 50 percent overlap.

2. Split Sleeve type flexible couplings shall be Victaulic Depend-O-Lok Style E x E (unrestrained) or F x F (self-restrained) or equal.
3. Grooved flexible joints for ductile iron pipe sizes 36-in and smaller must be in accordance with AWWA C606 and shall be Victaulic Style 31 or equal.
4. Shouldered flexible joints for ductile iron pipe larger than 36-in shall be Victaulic Style 44 or equal.

#### 2.04 FITTINGS

- A. Pipe fittings shall be ductile iron with pressure rating of 350 psi. Fittings shall meet the requirements of AWWA C110 or AWWA C153 as applicable. Fittings shall have the same pressure rating and joining system, as a minimum, of the connecting pipe, unless shown otherwise.
- B. Closures shall be made with mechanical joint ductile iron solid sleeves, restrained with follower glands on each end, unless alternate approved coupling systems as described in paragraph 2.03E are used and shall be located in straight runs of pipe at minimum cover outside the limits of restrained joint sections. Location of closures shall be subject to approval of the Engineer.
- C. Unless otherwise noted, all buried ductile iron pipe fitting joints shall be rubber-gasket mechanical joint per AWWA C111 and shall be restrained with a Megalug Series 1100 retaining gland at each side.
- D. Unless otherwise noted, all exposed ductile iron pipe fitting joints shall be flanged joint per AWWA C110/C153.

#### 2.05 INTERIOR LINING

- A. Ductile iron pipe and fittings shall have the same type of lining, as specified herein.
- B. Ductile iron pipe and fittings for use in RAW WASTEWATER applications (defined as any flow prior to the clarified/decanted effluent from the activated sludge final clarifier) shall have Protecto 401 Ceramic Epoxy lining or Polybond Plus composite lining, as indicated on the drawings.
- C. Ductile iron pipe and fittings for use in GRIT, SLUDGE, or SCUM applications shall have glass lining (SG-14 or equal), as indicated on the drawings.
- D. All other ductile iron pipe and fittings shall have cement mortar lining.

#### 2.06 EXTERIOR COATING

- A. Buried pipe and fittings shall be installed with a bituminous coating in accordance with AWWA C151 and C110 respectively.
- B. Buried pipe and fittings shall be installed with polyethylene encasement. Polyethylene encasement shall have a minimum thickness of 8 mils and meet or exceed the minimum standards established by AWWA C105, current edition. Acceptable manufacturers include Fulton or approved equal.

1. Polyethylene encasement shall meet minimum size requirements per TABLE 3 of section 2.15 of DIPRA's Installation Guide For Ductile Iron Pipe.
  2. Test results from an independent testing agency certifying that the polyethylene encasement meets all criteria established by AWWA C105, current edition, shall be submitted to the Engineer prior to approval of the polyethylene encasement for use. In general, samples shall be submitted and include test results in accordance with the AWWA standard associated with tensile strength, elongation, dielectric strength, impact resistance, and propagation tear resistance.
  3. A 2-inch wide plastic adhesive tape, such as Calpico Vinyl, Polyken 900, or approved equal, shall be used for sealing seams, cuts, or tears in polyethylene encasement. Duct tape shall not be allowed.
- C. Exposed pipe and fittings shall be installed with an epoxy primer coating (shop primed) as specified for field top-coat in Section 099100, or equal, or supplied as uncoated pipe and field primed and painted in accordance with Section 099100.

## PART 3 EXECUTION

### 3.01 GENERAL

- A. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe, lining or coatings. Pipe and fittings shall not be dropped or skidded against each other. Slings, hooks or pipe tongs shall be used for pipe handling. All pipe and fittings shall be examined before laying and no piece shall be installed which is found to be defective. Any damage to the pipe, lining or coatings shall be repaired per manufacturer's recommendations. Handling and laying of pipe and fittings shall be in accordance with manufacturer's instruction and as specified herein.

If any defective pipe is discovered after it has been laid, it shall be removed and replaced with a sound pipe in a satisfactory manner. All pipe and fittings shall be thoroughly cleaned before laying, shall be kept clean until they are used in the work and when installed or laid, shall conform to the lines and grades required.

- B. Materials, if stored, shall be kept safe from damage. The interior of all pipe, fittings and other appurtenances shall be kept free from dirt, excessive corrosion or foreign matter at all times.
- C. Pipe shall not be stacked higher than the limits recommended by its manufacturer. The bottom tier shall be kept off the ground on timbers, rails, or concrete. Stacking shall conform to manufacturer's recommendations and/or AWWA C600.
- D. Gaskets for mechanical and push-on joints to be stored shall be placed in a cool location out of direct sunlight. Gaskets shall not come in contact with petroleum products. Gaskets shall be used on a first-in, first-out basis.

### 3.02 INSTALLING DUCTILE IRON PIPE AND FITTINGS

- A. Ductile iron pipe and fittings shall be installed in accordance with requirements of AWWA C600, except as otherwise specified herein. A firm, even bearing throughout the length of the pipe shall be provided by digging bell holes at each joint and by tamping backfill materials at the side of the



pipe to the springline per details shown on the Drawings. Blocking will not be permitted. If any defective pipe or fitting is discovered after it has been laid, it shall be removed and replaced with a sound pipe or fitting in a satisfactory manner by the CONTRACTOR, at his/her own expense.

All pipe and fittings shall be kept clean until they are used in the work and shall be sound and thoroughly cleaned before laying. When laid, the pipe and fittings shall perform to the lines and grades required. When laying is not in progress, including lunch breaks, open ends of the pipe shall be closed by a watertight plug or other approved means. Sufficient backfill shall be placed to prevent flotation. The deflection at joints shall not exceed that recommended by the manufacturer.

All ductile iron pipe laid underground shall have a minimum of 3 of feet of cover unless otherwise shown on the Drawings or as specified herein. Pipe shall be laid such that the invert elevations shown on the Drawings are not exceeded.

Fittings, in addition to those shown on the Drawings shall be provided, where required, in crossing utilities which may be encountered upon opening the trench. Solid sleeve closures shall be installed at locations approved by the Engineer.

The pipe interior shall be maintained dry and broom clean throughout the construction period.

When field cutting the pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. The end of the cut pipe shall be beveled to conform to the manufacturer's recommendations for the spigot end. Any coating removed from the cut end shall be repaired according to manufacturer's recommendation and/or Section 2.06 whichever method is more stringent in the opinion of the Engineer. Lining shall be undamaged. Cutting of restrained joint pipe will not be allowed, unless approved at specific joints in conjunction with the use of restrainer glands by EBAA Iron or field adaptable restrained joints. Where field cuts are permitted, the pipe to be cut shall be supplied by the factory as "gauged full length". Should full length gauged pipe be unavailable, the pipe to be cut shall be field gauged at the location of the new spigot using a measuring tape, or other means approved by the manufacturer, to verify that the diameter is within the tolerances permitted in Table 1 of AWWA C151.

## B. Jointing Ductile-Iron Pipe

1. Push-on joints shall be made in strict accordance with manufacturer's instructions, AWWA C600 and Appendix B of AWWA C111. If there is conflict, the manufacturer's instructions shall take precedence. Pipe shall be laid with bell ends looking ahead. A rubber gasket shall be inserted in the groove of the bell end of the pipe. The joint surfaces shall be cleaned and lubricated and the plain end of the pipe shall be aligned with the bell of the pipe to which it is to be joined and pushed home. After joining the pipe, a metal feeler shall be used to make certain that the rubber gasket is properly seated.
2. Mechanical joints shall be assembled in strict accordance with the manufacturer's instructions, AWWA C600 and Appendix A of AWWA C111. If there is conflict, the manufacturer's instructions shall take precedence. Pipe shall be laid with bell ends looking ahead. To assemble the joints in the field, thoroughly clean and lubricate the joint surfaces and rubber gasket. Bolts shall be tightened to the specified torques. Under no condition shall extension wrenches or pipe over handle of ordinary ratchet wrench be used to secure greater leverage. After installation, apply a bitumastic coating to bolts and nuts and install polyethylene encasement as specified.

3. Bolts in mechanical or restrained joints shall be tightened alternately and evenly. Restraint for mechanical joint pipe shall use retainer glands for restraining joint. All restrained mechanical joints shall be suitable for the specified test pressure.
  4. Restrained joints shall be installed according to pipe manufacturer's instructions.
  5. Flanged joints shall be assembled in strict accordance with the manufacturer's instructions and Appendix C of AWWA C111. If there is conflict, the manufacturer's instructions shall take precedence. Extreme care shall be taken to ensure that there is no restraint on opposite ends of pipe or fitting, which would prevent uniform gasket compression, cause unnecessary stress, bending or torsional strains, or distortion of flanges or flanged fittings. Adjoining push on joints shall not be assembled until flanged joints have been tightened. Flange bolts shall be tightened uniformly to compress the gasket uniformly and obtain a seal. Flange bolts shall be left with approximately 1/2-inch projection beyond the face of the nut after tightening. After installation apply a bitumastic coating to the bolts and nuts as specified.
  6. Sleeve couplings shall only be installed for closure or as shown on the Drawings. Couplings shall not be assembled until adjoining joints have been assembled. After installation. Apply a heavy bitumastic coating to the bolts and nuts and install protective wrap recommended by the manufacturer or as required herein. Care shall be exercised to insure that the insulating properties of insulating and dielectric couplings are maintained.
- C. All blowoffs, outlets, valves, fittings and other appurtenances required shall be set and jointed as indicated on the Drawings in accordance with manufacturer's instructions.
- D. Install polyethylene encasement around ductile iron pipe to limits shown on the Drawings and in accordance with pipe manufacturer's recommendations.
1. Polyethylene encasement shall be installed per ANSI/ AWWA C105/A21.5, Method 'A' in accordance with section 2.15 of DIPRA's Installation Guide For Ductile Iron Pipe.
  2. A fabric type or padded sling shall be used when handling polyethylene encased pipe to prevent damage to the polyethylene encasement.
  3. All seams in the polyethylene encasement shall be sealed completely with approved 2-inch wide plastic adhesive tape.
  4. Extreme care shall be taken to ensure that all rips or tears in the polyethylene encasement are properly repaired with additional tape and film as described in ANSI/AWWA C105/A21.5
  5. Extreme care shall be taken when backfilling to avoid damaging the polyethylene encasement

### 3.03 BEDDING AND BACKFILL

- A. All buried ductile iron pipe shall be bedded in compacted crushed stone extending from 6" below the pipe up to the pipe centerline. The bedding material shall be installed in lifts not to exceed 6" and compacted to 90% modified proctor density (ASTM D 1557).
- B. For open ground areas, select common fill shall be used to backfill the pipe from the pipe centerline up to the top of the pipe. The material shall be installed in lifts not to exceed 6" and compacted to 90% modified proctor density.

- C. For paved areas, AHTD Class 7 Aggregate fill shall be used to backfill the pipe from the pipe centerline up to the top of the pipe. The material shall be installed in lifts not to exceed 6" and compacted to 90% modified proctor density.
- D. All trenches shall be backfilled as soon as possible after installation of the pipelines and appurtenances. It may be necessary to backfill only a portion of the trench to allow adequate curing of concrete. The CONTRACTOR shall limit all open trenches to a minimum of 300 linear feet along public streets/highways/roads and shall completely backfill all trenches daily. Temporary road plating of open trenches in paved areas is allowed if approved by the street/road/highway department.
- E. All backfilling shall meet the requirement of Section 31\_2300.

### 3.04 CONNECTIONS TO STRUCTURES

- A. Wherever a pipe 3-in in diameter or larger passes from concrete to earth horizontally, two flexible joints spaced from 2 to 5-ft apart depending on pipe size shall be installed, within 5-ft of the exterior face of the wall, whether or not shown on the Drawings.
- B. Unless otherwise specified, all pipes passing through a wall will utilize a wall sleeve designed to pass the thrust through the wall via restraint to the wall sleeve (either restrained joint or Megalug restrained MJ follower gland).
- C. Piping underneath structures shall be concrete encased.

### 3.05 FILLING AND TESTING

- A. After installation, the pipe shall be tested for compliance as specified herein. Furnish all necessary equipment and labor for the hydrostatic pressure test on the pipelines.
- B. Submit detailed test procedures and method for Engineer's review. In general, testing shall be conducted in accordance with AWWA C600. The method and procedures for performing the hydrostatic pressure test shall be approved by the Engineer. Submit the plan for testing to the Engineer at least 10 days before starting a test.
- C. Pressure pipelines shall be pressure and leakage tested in accordance with Section 31\_0501. The hydrostatic testing allowances shall not exceed those indicated in AWWA C600. Provide suitable restrained bulkheads as required to complete the hydrostatic testing specified.
- D. CONTRACTOR shall make any taps and furnish all necessary caps, plugs etc, as may be required in conjunction with performing the testing.
- E. Gravity pipelines shall be subjected to hydrostatic pressure test as specified in AWWA C600.
- F. All valves and valve boxes shall be properly located and installed and operable prior to testing. Bulkheads shall be provided with a sufficient number of outlets for filling and draining the line and for venting air.

- G. Hydrostatic pressure tests shall conform to Section 5.2 of AWWA C600. Furnish gauges, meters, pressure pumps and other equipment needed to fill the line slowly and perform the required hydrostatic pressure tests.
- H. The UTILITY will provide a source of supply from the existing treated water distribution system for CONTRACTOR's use in filling the lines. An air break shall be maintained at all times between the UTILITY's distribution system and the CONTRACTOR's equipment to prevent cross-connection. The line shall be slowly filled with water and the specified test pressure shall be maintained in the pipe for the entire test period by means of a pump furnished by the CONTRACTOR. Provide accurate means for measuring the quantity of makeup water required to maintain this pressure.
- I. The UTILITY shall supply, at no cost to the CONTRACTOR, a maximum quantity of water equal to 110 percent of the volume of the pipelines for testing. Additional water required by the CONTRACTOR will be provided at standard billing rates for the volume required. The line shall be slowly filled with water and the specified test pressure shall be maintained in the pipe for the entire test period by means of a pump furnished by the CONTRACTOR. Provide accurate means for measuring the quantity of makeup water required to maintain this pressure.
- J. Duration of pressure test shall not be less than 2 hours. All leaks evident at the surface shall be repaired and leakage eliminated regardless of the total leakage as shown by test. Lines which fail to meet tests shall be repaired and retested as necessary until test requirements are complied with. Defective materials, pipes, valves and accessories shall be removed and replaced.

### 3.06 CLEANING

- A. At the conclusion of the work, thoroughly clean all of the pipe by flushing with water or other means to remove all dirt, stones, pieces of wood, or other material which may have entered during the construction period. All debris shall be removed from the pipeline. The lowest segment outlet shall be flushed last to assure debris removal.
- B. After the pipe has been cleaned and if the groundwater level is above the pipe or water in the pipe trench is above the pipe following a heavy rain, the Engineer will examine the pipe for leaks. If defective pipes, fittings or joints are discovered at this time, they shall be repaired or replaced by the CONTRACTOR.

END OF SECTION

SECTION 33 1102  
POLYVINYL CHLORIDE (PVC) PRESSURE PIPE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: Furnish all labor, materials, equipment and incidentals required and install and test all polyvinyl chloride (PVC) piping, fittings and appurtenances as shown on the Drawings and specified herein.
- B. General Design: The equipment and materials specified herein are intended to be standard types of PVC pipe, PVC fittings, and ductile iron fittings for use in transporting potable water, wastewater and sludge under pressure.

1.02 QUALITY ASSURANCE

- A. Qualifications: All of the PVC pipe, fittings, and ductile iron fittings shall be furnished by manufacturers who are fully experienced, reputable, and qualified in the manufacture of the materials to be furnished. The pipe and fittings shall be designed, constructed, installed in accordance with the best practices and methods and shall comply with these specifications as applicable.
- B. Standards:
  - 1. AWWA C900/C905
  - 2. NSF 14
  - 3. UNI-B-1 through 5
  - 4. ASTM D2241
- C. Factory Tests: The manufacturer shall perform the factory tests described in Section 3 - AWWA C900/C905, or ASTM D2241 as applicable.
- D. Quality Control:
  - 1. The manufacturer shall establish the necessary quality control and inspection practice to ensure compliance with the referenced standards.
  - 2. In addition to the manufacturer's quality control procedures, the UTILITY may select an independent testing laboratory to inspect the material at the production facility for compliance with these specifications. The UTILITY will pay for the cost of facility inspection requested by the UTILITY.

### 1.03 SHOP DRAWINGS AND SUBMITTALS

- A. Submittals shall be submitted for review and acceptance prior to construction in accordance with the General Conditions and specifications Section 01\_3000.
- B. Materials and Shop Drawings
- C. Manufacturer's Certification
  - 1. Submit sworn certification of factory tests and their results.

### 1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery and Storage: Delivery and storage of the materials shall be in accordance with the manufacturer's recommendations. PVC pipe shall be covered with black plastic with a minimum thickness of 15-mil. Joint gaskets shall be stored in a clean, dark and dry location until use.
- B. Handling: Care shall be taken in loading, transporting and unloading to prevent damage to the pipe or fittings and their respective coatings. Pipe or fittings shall not be rolled off the carrier or dropped. Pipe shall be unloaded by lifting with a forklift or crane. All pipe or fittings shall be examined before installation and no piece shall be installed which is found to be defective. Pipe shall be handled to prevent damage to the pipe or coating. Accidental damage to pipe or coating shall be repaired to the satisfaction of UTILITY or it shall be removed from the job. When not being handled, the pipe shall be supported on timber cradles or on level ground, graded to eliminate all rock points and to provide uniform support along the full pipe length. When being transported, the pipe shall be supported at all times in a manner to prevent distortion or damage to the lining or coating. Any unit of pipe that, in the opinion of the UTILITY, is damaged beyond repair by the CONTRACTOR shall be removed from the site.
- C. The CONTRACTOR shall be responsible for all materials furnished and stored until the date of project completion. The CONTRACTOR shall replace, at his expense, all materials found to be defective or damaged in handling or storage. The CONTRACTOR shall, if requested by the UTILITY, furnish certificates, affidavits of compliance, test reports, samples or check analysis for any of the materials specified herein. All pipe delivered to project site for installation is subject to random testing for compliance with the designated specifications.

## PART 2 - PRODUCTS

### 2.01 GENERAL

- A. All material supplied shall be from manufacturers that are regular members of the PVC Pipe Association.

### 2.02 MATERIALS

- A. Polyvinyl Chloride (PVC) Pipe
  - 1. Standards: ASTM D 2241

2. Compounds: Class 12454-A or Class 12454-B
  3. PVC Pressure Pipe and Fittings: All PVC pipe of nominal diameter 1.5 to 12-inches shall be manufactured in accordance with ASTM D 2241. The PVC pipe shall have a minimum SDR of 21. Pipe shall accommodate ductile iron pipe fittings with transition gasket.
  4. Joints:
    - a. Push-on integral bell elastomeric gasket joints:
      - (1) Standards: ASTM D3212/D3139/F477 and UNI-B-1
      - (2) Gaskets:
        - (a) Potable Water Service: Styrene Butadiene Rubber (SBR) rieber type.
      - (3) Pipe Markings: Pipes shall have a manufacturer's home-mark on the spigot. On field cut pipe, the CONTRACTOR shall provide home-mark on the spigot in accordance with manufacturer's recommendations.
    - b. Restrained Joints, if and where as shown on the drawings:
      - (1) Restrained joint devices shall be made specifically for PVC pipe and meet or exceed the requirements in ASTM F-1674.
      - (2) PVC Pipe Manufacturer's Internal Joint Restraint Systems, such as Eagle Loc IPS, or equal.
      - (3) Design pressure rating equal to or above test pressure as specified herein.
    - c. Pipe Length:
      - (1) 20-feet maximum nominal length
- B. Fittings - Pressure Systems (nominal diameter 2-inches and greater):
1. Materials: Ductile iron
  2. Joints: Mechanical Joint, Minimum 350-psi pressure rating
  3. Restraint: Midco retainer glands as manufactured by Midland Manufacturing Company, Ft. Worth, TX, or equal, at each side of fitting.
  4. Gaskets: Potable Water Service: Styrene Butadiene Rubber (SBR) ring type
  5. Exclusions: Standard double bell couplings will not be acceptable where the pipe will slip completely through the coupling.
  6. All fittings shall conform to either ANSI/AWWA C110/A21.10 and/or C153/A21.53, latest revision, and shall be ductile iron.
  7. All fittings shall have a date code cast (not printed or labeled), with identification of the date, factory and unit at which it was cast and machined. Fittings shall have distinctly cast on them the pressure rating, nominal diameter of openings, manufacturer's name, the country where cast, and deflection angle. Ductile iron fittings shall have the letters "DI" or "Ductile" cast on them.
  8. All potable water main fittings shall have NSF certification and ISO 9001 certification for both the foundry and manufacturer. The NSF 61 certification shall be issued on all coatings and linings, from the said manufacturers that are used for potable water applications.
  9. All ductile iron fittings shall have exterior coatings, including markings and colors, and interior linings in conformance with Section 33\_1101.
- C. Fittings - Pressure Systems (nominal diameter less than or equal to 1.5 inches)
1. Material: Polyvinyl Chloride (PVC)
  2. Joints: Slip fitting tapered socket with solvent weld
  3. Solvent: IPS Weld-On or acceptable equal

4. Exclusions: Plastic saddle and flange joint fittings shall not be used

## 2.03 TRACER WIRE

Refer to Specification Section 31\_2300 Part 3.07.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

#### A. Standards: AWWA C605/UNI-B Chapter 10

#### B. Underground Polyvinyl Chloride (PVC) Pipe and Fittings

1. Bedding and Backfill: Refer to Part 3.02 below. Blocking under the pipe will not be permitted.
2. Placement/Alignment:
  - a. Installation shall be in accordance with lines and grades shown on the Drawings. For pressure systems, deflection of joints shall not exceed 75% of that recommended by the manufacturer.
  - b. All pipe and fittings shall be inspected prior to lowering into trench to insure no cracked, broken or otherwise defective materials are being used. All homing marks shall be checked for the proper length so as to not allow a separation or over homing of connected pipe. Homing marks incorrectly marked on pipe shall result in rejection of pipe and removal from site. The CONTRACTOR shall clean ends of pipe thoroughly and remove foreign matter and dirt from inside of pipe and keep clean during and after installation.
  - c. Proper implements, tools and facilities shall be used for the safe and proper protection of the Work. Pipe shall be lowered into the trench in such a manner as to avoid any physical damage to the pipe. Pipe shall not be dropped or dumped into trenches under any circumstances.
  - d. Trench Dewatering and Drainage Control: CONTRACTOR shall prevent water from entering trench during excavation and pipe laying operations to the extent required to properly grade the bottom of the trench and allow for proper compaction of the backfill. Pipe shall not be laid in water.
  - e. Pipe Laying in Trench: Dirt or other foreign material shall be prevented from entering the pipe or pipe joint during handling or laying operations and any pipe or fitting that has been installed with dirt or foreign material in it shall be removed, cleaned and re-laid. Pigging of pipe may be used to remove foreign materials in lieu of flushing. At times when pipe installation is not in progress, the open ends of the pipe shall be closed by a watertight plug or by other means approved by the UTILITY to ensure absolute cleanliness inside the pipe. The pipe text shall be viewed from the top of pipe when installed. When installing PVC pipe, no additional joints will be installed until the preceding pipe joint has been completed and the pipe carefully embedded and secured in place.
  - f. PVC Pressure Pipe Installation and Training: PVC pipe shall be installed in accordance with standards set forth in the UNI-BELL "Handbook of PVC Pipe", AWWA C605, and AWWA Manual M-23. The pipe shall be laid by inserting the spigot end into the bell



flush with the insertion line or as recommended by the manufacturer. At no time shall the bell spigot end be allowed to go past the "insertion line" or "homing mark" for pressure pipe applications and homing mark shall be visible.

- g. Field Cutting: PVC pipe can be cut with a handsaw or power driven abrasive disc making a square cut. The end shall be beveled with a beveling tool, wood rasp or power sander to the same angle as provided on the factory-finished pipe. The insertion line on the spigot shall be remarked to the same dimensions as the factory-marked spigot.
- h. Joint Placement:
  - (1) Push on joints: Pipe shall be laid with the bell ends facing upstream. The gasket shall be inserted and the joint surfaces cleaned and lubricated prior to placement of the pipe. After joining the pipe, a metal feeler shall be used to verify that the gasket is correctly located.
  - (2) Mechanical Joints: Pipe and fittings shall be installed in accordance with the "Notes on Method of Installation" under ANSI A21.11/AWWA C111. The gasket shall be inserted and the joint surfaces cleaned and lubricated with soapy water before tightening the bolts to the specified torque.

C. Thrust Restraint

- 1. Thrust restraint shall be accomplished by the use of mechanical restraining devices, such as Midco Retainer Glands, and concrete thrust blocking, unless specifically identified otherwise on the Drawings or herein.
- 2. Length of restrained joints shall be in accordance with the lengths listed in the table as shown on the Drawings.

D. Installation of Pipes on Curves:

- 1. No joint deflection or pipe bending is allowed in PVC pipe. The maximum allowable tolerance in the joint due to variances in installation is  $0.75^\circ$  (degrees) (3-inches per joint per 20-foot stick of pipe). No bending tolerance in the pipe barrel shall be acceptable. Alignment change shall be made only with sleeves and fittings.

3.02 BEDDING AND BACKFILL

- 1. All PVC water pipe shall be bedded in compacted crushed stone extending from 6" below the pipe up to 6" above the pipe. The bedding material shall be installed in lifts not to exceed 6" and compacted to 95% modified proctor density (ASTM D 1557).
- 2. Common fill meeting the requirements of Section 31\_2330 shall be used for the remainder of the backfill, except as modified for special surfaces in Section 31\_2300.
- 3. All trenches shall be backfilled as soon as possible after installation of the pipelines and appurtenances. It may be necessary to backfill only a portion of the trench to allow adequate curing of concrete. The CONTRACTOR shall limit all open trenches to a minimum of 300 linear feet along public streets/highways/roads and shall completely backfill all trenches daily. Temporary road plating of open trenches in paved areas is allowed if approved by the street/road/highway department.
- 4. All backfilling shall meet the requirement of Section 31\_2300.

3.03 CLEANING AND FIELD TESTING

- A. At the conclusion of the Work, the CONTRACTOR shall provide all associated cleaning and field testing as specified in associated sections of these specifications.

END OF SECTION

## SECTION 33 1200

### VALVES

#### PART 1 GENERAL

##### 1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install complete and ready for operation and test all non-buried valves as shown on the Drawings and as specified herein.
- B. The equipment shall include the following:
  - 1. Valve Actuators - General
  - 2. Plug Valves
  - 3. Gate Valves
  - 4. Check Valves
  - 5. Air Release Valves
  - 6. Ball Valves

##### 1.02 RELATED WORK

- A. Piping is included in the respective Sections of Division 40.
- B. Certain appurtenances for individual types of pipe or systems are specified with the specific type of pipe or system. However, additional items are specified in this Section.
- C. Certain items similar to those specified in this Section may be specified to be furnished and installed with individual equipment or systems. In case of a conflict, those individual equipment or system requirements shall govern.
- D. Valve operators of all types, rate of flow controllers (including modulating valves and operators) and other types of valves which are part of the automated instrumentation (such as some solenoid valves) if not included herein are included in Division 11. Valve operators shall, however, be mounted at the factory on the valves as specified herein, as part of the work of this Section.

##### 1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Section 01 3000, materials required to establish compliance with this Section. Submittals shall include at least the following:
  - 1. Certified drawings showing all important details of construction and dimensions.
  - 2. Descriptive literature, bulletins and/or catalogs of the equipment.
  - 3. The total weight of each item.

4. A complete bill of materials.
5. Additional submittal data, where noted with individual pieces of equipment.
6. Location of the valve and actuator manufacturing facility.
7. Electrical characteristics and wiring diagrams including but not limited to voltage, load in kW, Hp or FLA and phase.

B. Test Reports

1. Provide certified hydrostatic test data, per manufacturer's standard procedure or MSS-SP-61 for all valves.

C. Certificates

1. For each valve specified to be manufactured, tested and/or installed in accordance with AWWA and other standards, submit an affidavit of compliance with the appropriate standards, including certified results of required tests and certification of proper installation.

D. Manufacturer's Installation and Application Data

E. Operating and Maintenance Data

1. Operating and maintenance instructions shall be furnished to the Engineer as provided in Section 01 8823. The instructions shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions and other information required to instruct operating and maintenance personnel unfamiliar with such equipment.

F. Manufacturer's Warranty

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
2. ASTM A536 - Standard Specification for Ductile Iron Castings.
3. ASTM B30 - Standard Specification for Copper Alloys in Ingot Form.

B. American Water Works Association (AWWA)

1. AWWA C504 - Rubber-Seated Butterfly Valves
2. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service
3. AWWA C540 - Power-Actuating Devices for Valves and Slide Gates

4. AWWA C550 - Protective Interior Coatings for Valves and Hydrants

C. American National Standards Institute (ANSI)

1. ANSI B2.1 - Specifications, Dimensions, Gauging for Taper and Straight Pipe Threads (except dry seals).
2. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings
3. ANSI B16.10 - Face-to-Face and End-to-End Dimensions of Valves
4. ANSI B16.104 - Butterfly Valves

D. American Iron and Steel Institute (AISI)

E. Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS)

1. MSS-SP-61 - Pressure Testing of Steel Valves.
2. MSS-SP-67 - Butterfly Valves.
3. MSS-SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
4. MSS-SP-71 - Cast Iron Swing Check Valves, Flanges and Threaded Ends.
5. MSS-SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Services.
6. MSS-SP-78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
7. MSS-SP-80 - Bronze Gate, Globe, Angle and Check Valves.
8. MSS-SP-82 - Valve Pressure Testing Methods
9. MSS-SP-98 - Protective Coatings for the Interior of Valves, Hydrants and Fittings.

F. National Electrical Manufacturers Association (NEMA)

G. Underwriters Laboratories (UL)

H. Factory Mutual (FM)

- I. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. Qualifications

1. Valves and appurtenances shall be products of well-established firms who are fully experienced, minimum 10 years, reputable and qualified in the manufacture of the particular equipment to be furnished. Bonds in lieu of experience will not be acceptable.

2. The equipment shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with this Section as applicable.
3. All units of the same type shall be the product of one manufacturer.

B. Certifications

1. The manufacturers shall furnish an affidavit of compliance with Standards referred to herein as specified in Paragraph 1.03C above. Refer to PART 3 for testing required for certain items in addition to that required by referenced standards.

- C. Inspection of the units may be made by the Engineer or other representative of the Owner after delivery. The equipment shall be subject to rejection at any due to failure to meet any of the specified requirements, even though submittal data may have been accepted previously. Equipment rejected after delivery shall be marked for identification and shall be removed from the job site at once.

1.06 SYSTEM DESCRIPTION

- A. All of the equipment and materials specified herein is intended to be standard for use in controlling the flow of water and air as noted on the Drawings.
- B. Valves, appurtenances and miscellaneous items shall be installed as shown on the Drawings and as specified, so as to form complete workable systems.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Reference is made to Section 01 6610 for additional information.
- B. Packing and Shipping
  1. Care shall be taken in loading, transporting and unloading to prevent injury to the valves, appurtenances, or coatings. Equipment shall not be dropped. All valves and appurtenances shall be examined before installation and no piece shall be installed which is found to be defective. Any damage to the coatings shall be repaired as acceptable to the Engineer.
  2. Prior to shipping, the ends of all valves shall be acceptably covered to prevent entry of foreign material. Covers shall remain in place until after installation and connecting piping is completed.
    - a. All valves 3-in and larger shall be shipped and stored on site until time of use with wood, plywood, or plastic covers on each valve end.
    - b. Valves smaller than 3-in shall be shipped and stored as above except that heavy cardboard covers may be used on the openings.
    - c. Rising stems and exposed stem valves shall be coated with a protective oil film which shall be maintained until the valve is installed and put into use.
    - d. Any corrosion in evidence at the time of acceptance by the Owner shall be removed, or the valve shall be removed and replaced at no cost to the Owner.

C. Storage and Protection

1. Special care shall be taken to prevent plastic and similar brittle items from being directly exposed to the sun, or exposed to extremes in temperature, to prevent deformation. See the individual piping sections and manufacturer's information for further requirements.

1.08 MAINTENANCE

- A. Special tools including packing maintenance hardware and the manufacturer's standard spare parts, if required for normal operation and maintenance, shall be supplied with the equipment in accordance with Sections 01 8823 and where noted, as specified herein.
- B. Provide all special tools required for normal maintenance. Tools shall be packaged in a steel case, clearly and indelibly marked on the exterior to indicate equipment for which tools are intended.
- C. Provide to the Owner a list of all spare and replacement parts with individual prices and location where they are available. Prices shall remain in effect for a period of not less than 1 year after start-up and final acceptance.

1.09 WARRANTY

- A. The Contractor shall obtain from each valve and actuator manufacturer its warranty that the equipment shall be warranted for a period of 1 year from the date of Substantial Completion, as defined in the General Conditions, Division 0 and specified in Section 01 7836, to be free from defects in workmanship, design or material. If the equipment should fail during the warranty period due to a defective part(s), the part(s) shall be replaced in the equipment and the unit(s) restored to service at no expense to the Owner.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT - GENERAL

- A. Reference is made to Division 1 for additional requirements, including nameplates, provisions for temporary pressure gauges, protection against electrolysis and anchor bolts.
- B. The use of a manufacturer's name and/or model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- C. Valves and appurtenances shall be of the size shown on the Drawings or as noted and as far as possible equipment of the same type shall be identical and from one manufacturer.
- D. Valves and appurtenances shall have the name of the maker, nominal size, flow directional arrows, working pressure for which they are designed and standard referenced, cast in raised letters or indelibly marked upon some appropriate part of the body.
- E. Unless otherwise noted, items shall have a minimum working pressure of 250 psi or be of the same working pressure as the pipe they connect to, whichever is higher and suitable for the pressures noted where they are installed.

- F. Joints, size and material - unless otherwise noted or required by the Engineer:
  - 1. Except where noted, all buried joints referred to herein shall be mechanical joint.
  - 2. Valves and appurtenances shall be of the same nominal diameter as the pipe or fittings they are connected to unless otherwise specified.
  - 3. All valves exposed to view, or in vaults.
    - a. 2-1/2-in and smaller - threaded or soldered ends as required.
    - b. 3-in - threaded or flanged as shown.
    - c. 4-in and larger flanged ends.
- G. Provide all special adaptors as required to ensure compatibility between valves, appurtenances and adjacent pipe.
- H. Valves and actuators located outdoors but not within a building; within maximum 2-ft above liquid; in vaults; or where otherwise noted shall be designed for submerged service where water may completely submerge the valve and operator. All other units shall have NEMA 4X enclosures. Valves and actuators to be installed within valve vaults in yard and designed for submerged service shall have Type 316 stainless steel bolts and hardware.

## 2.02 VALVE ACTUATORS - GENERAL

- A. See the Paragraph 2.01H above for submergence requirements.
- B. The valve manufacturer shall supply, mount and test all actuators on valves at the factory. The valves and their individual actuators shall be shipped as a unit.
- C. All actuators shall be capable of moving the valve from the full open to full close position and in reverse and holding the valve at any position part way between full open or closed.
- D. Each operating device shall have cast on it the word "OPEN" and an arrow indicating the direction of operation.
- E. Floor boxes for operating nuts recessed in concrete shall be standard cast iron type, cast-in-place, with fastening top by Clow or equal.
- F. Stem guides shall be of the adjustable wall bracket type, bronze bushed, with maximum spacing of 10-ft as manufactured by Clow; Rodney Hunt or equal. Extended operating nuts and/or stems shall have universal joints and pin couplings, if longer than 10-ft and a rating of at least five times the maximum operating torque. Stem adaptors shall be provided.
- G. Where required by the installation, or as specified, provide the following: extended stem; floor stand and handwheel; position indicator and etched or cast arrow to show direction of rotation to open the valve; resilient, moisture-resistant seal around stem penetration of slab.
- H. Additional valve actuator requirements are included with the individual valve types and as noted in Paragraph 1.02 above.



- I. All position indication and direction of opening arrows shall be embossed, stamped, engraved, etched or raised castings. Decals or painted indications shall not be allowed.
- J. Unless otherwise noted, all valves larger than 3-in nominal diameter shall be provided with position indicators at the point of operation.

#### 2.03 CHECK VALVES

- A. Check valves for wastewater service shall be Val-Matic Swing-Flex check valves, or equal flexible disc swing check valves.

#### 2.04 PLUG VALVES

- B. All plug valves shall be Model PEF 100% Port Eccentric Plug Valves as manufactured by DeZURIK or approved equal. Refer to drawings for connection types (FL, MJ, etc..).
- C. Plug valves supplied by SBR manufacturer as part of the SBR Equipment scope are specified in Section 44-4520 SBR Equipment.

#### 2.05 VALVE BOXES

- A. All gate, butterfly and plug valves shall be provided with extension shafts, operating nuts and valve boxes as follows:
  - 1. Extension shafts shall be Type 304 stainless steel and the operating nut shall be 2-in square. Shafts shall be designed to provide a factor of safety of not less than four. Operating nuts shall be pinned to the shafts.
  - 2. Top of the operating nut shall be located 2-in below the rim of the valve box.
  - 3. Valve boxes shall be as manufactured by Clow; Mueller; Tyler; or equal and shall be a heavy-pattern cast iron, three-piece, telescoping type box with dome base suitable for installation on the buried valves. Inside diameter shall be at least 4-1/2-in. Barrel length shall be adapted to the depth of cover, with a lap of at least 6-in when in the most extended position. Covers shall be cast iron with integrally-cast direction-to-open arrow, and the word "VALVE" shall also be integrally cast. Aluminum or plastic are not acceptable. A means of lateral support for the valve extension shafts shall be provided in the top portion of the valve box.
  - 4. The upper section of each box shall have a top flange of sufficient bearing area to prevent settling. The bottom of the lower section shall enclose the stuffing box and operating nut of the valve and shall be oval.
  - 5. An approved operating key or wrench shall be furnished.
  - 6. All fasteners shall be Type 304 stainless steel.

#### 2.06 RESILIENT SEATED GATE VALVES

- A. Valves 3-in through 12-in shall be manufactured in accordance with AWWA C509 and as specified herein. Valves shall be:

1. The Series 2639 and 2640 resilient seated gate valve (available in 2-in through 12-in) by Clow Valve Company (A Division of McWane Inc.) of Oskaloosa, Iowa;
  2. The 8000 Series resilient seated gate valve (available in 3-in through 12-in) by Kennedy Valve Company (A Division of McWane Inc.) of Elmira, New York;
  3. The RS series resilient wedge gate valve (available in 3-in through 12-in) by M&H Valve Company of Anniston, Alabama;
  4. The Series 2360 resilient wedge gate valve (available in 2-in through 12-in) by Mueller Company of Decatur, Illinois;
  5. The Model A-USP0 resilient wedge gate valve (available in 2-in through 12-in) by the US Pipe & Hydrant Division of Mueller Company of Decatur, Illinois;
  6. Or equal.
- B Alternatively, valves 3-in through 36-in shall be manufactured in accordance with AWWA C515 and as specified herein. Valves shall be:
1. The Series 2638 resilient seated gate valve (available in 4-in through 36-in) by Clow Valve Company (A Division of McWane Inc.) of Oskaloosa, Iowa;
  2. The 7000 Series resilient seated gate valve (available in 4-in through 36-in) by Kennedy Valve Company (A Division of McWane Inc.) of Elmira, New York.
  3. The RS series resilient wedge gate valve (available in 4-in through 36-in) by M&H Valve Company of Anniston, Alabama;
  4. The Series 2500 ductile iron resilient wedge gate valve (available in 2-in through 48-in) by American Flow Control of Birmingham, Alabama;
  5. The Series 2361 ductile iron resilient wedge gate valve (available in 14-in through 48-in) by Mueller Company of Decatur, Illinois;
  6. The Model A-USP1 resilient wedge gate valve (available in 14-in through 48-in) by the US Pipe & Hydrant Division of Mueller Company of Decatur, Illinois;
  7. Or equal.
- C. All valves shall be fully manufactured in North America.
- D. Valves shall be provided with a minimum of two O-ring stem seals.
- E. Bonnet and gland bolts and nuts shall be [either fabricated from a low alloy steel for corrosion resistance or electroplated with zinc or cadmium.] [either Type 304 or 316 stainless steel.] The hot-dip process in accordance with ASTM A153 is not acceptable. Allen-wrench type bonnet and gland fastening shall not be acceptable and will be rejected.
- F. Wedges shall be totally encapsulated.
- G. Units shall be, in addition, UL and FM approved.

- H. Cast the word "OPEN" and an arrow indicating direction to open on each valve body or operator.
- I. Operating nut for all gate valves shall be 2-in square.
- J. Extension stems shall be fabricated from solid steel. Stems shall not be smaller in diameter than the valve stem. Equip stem with wrench nut. Ensure all stem connections are pinned.
- K. Valves shall be non-rising stem.
- L. AWWA requirements for thrust collar and stem to be integrally cast (not pinned on), and copper alloy valve stems shall be strictly enforced.
- M. Valves shall have mechanical joint ends compliant with AWWA C111 unless otherwise noted.
- N. A 10-year warranty shall be provided for all resilient seated gate valves furnished on the Project.
- O. The pH of the fluids flowing through the valves is expected to be between 6.5 and 8.5 pH units.
- P. Gearing shall be required for gate valves 14-in diameter and larger, and shall be in accordance with AWWA C509 Part 4.4.9 and AWWA C515 Part 4.4.9.

#### 2.07 TAPPING SLEEVES AND TAPPING VALVES

- A. Tapping sleeves shall be of ductile iron, designated for working pressure not less than 200 psi. Armored end gaskets shall be provided for the full area of the sleeve flanges. Sleeves shall be as manufactured by A.P. Smith Division of U.S. Pipe; Mueller; Clow, or equal. Nuts and bolts shall be Type 304 stainless steel.
- B. Tapping valves shall conform to the requirements specified above for gate valves except that one end shall be flanged and one mechanical, unless otherwise noted. Tapping valves shall be provided with an oversized opening to permit the use of full size cutters.

#### 2.08 COMBINATION AIR VALVES

- A. The combination air valves shall be the 2" Model D-25 reinforced nylon body valve as manufactured by A.R.I. Flow Control Accessories, LTD.
- B. Valves shall be supplied with 2" NPT inlet.

#### 2.09 BALL VALVES

- A. Ball valves shall be manually actuated unless otherwise shown on the Drawings. Valves shall be two piece, threaded, full port, 316 stainless steel construction. Valve seats shall be R-PTFE and easily accessible and replaceable. Valves shall be Dixon SSBV Series, or equal.

## 2.10 VALVE ACTUATORS

- A. The valve manufacturer shall supply, mount and test actuators on valves at the factory. The valves and their individual actuators shall be shipped as a unit.
- B. Unless otherwise noted on the Drawings, valves shall be manually actuated. Buried and exposed valves with operating nuts shall have a non-rising stem with an AWWA 2-in nut; At least two tee handles shall be provided for each different size operating nut. Unless otherwise noted, operation for valves shall be counterclockwise open. Where shown on the drawings exposed valves shall be supplied with geared actuators and handwheels.
- C. Actuators shall be capable of moving the valve from the full open to full close position and in reverse and holding the valve at any position part way between full open or closed.
- D. Each operating device shall have cast on it the word "OPEN" and an arrow indicating the direction of operation.

## 2.11 SURFACE PREPARATION AND SHOP COATINGS

- A. Notwithstanding any of the specified requirements, all coatings and lubricants in contact with potable water shall be certified as acceptable for use with that fluid.
- B. If the manufacturer's requirement is not to require finished coating on any interior surfaces, then manufacturer shall so state and no interior finish coating will be required, if acceptable to the Engineer.
- C. The exterior surface of various parts of valves, operators, floor-stands and miscellaneous piping shall be thoroughly cleaned of all scale, dirt, grease or other foreign matter and thereafter one shop coat of an approved rust-inhibitive primer shall be applied in accordance with the instructions of the paint manufacturer. Primer shall be compatible with the finish coat provided.
- D. Unless otherwise noted, interior ferrous surfaces of all valves shall be given a shop finish of an AWWA C550 approved epoxy with a minimum thickness of 4 mil.
- E. Ferrous surfaces obviously not to be painted shall be given a shop coat of grease or other suitable rust-resistant coating. Mounting surfaces shall be especially coated with a rust preventative.
- F. Special care shall be taken to protect uncoated items and plastic items, especially from environmental damage.

## 2.12 FACTORY INSPECTION, TESTING AND CORRECTION OF DEFICIENCIES

- A. Factory inspection, testing and correction of deficiencies shall be done in accordance with the referenced standards and as noted herein.
- B. See Division 1 for additional requirements. Also refer to PART 1, especially for required submission of test data to the Engineer.

- C. In addition to all tests required by the referenced standards, the following shall also be factory tested:
  - 1. Pressure regulating valves shall be factory tested at the specified pressures and flows.

### PART 3 EXECUTION

#### 3.01 INSTALLATION - GENERAL

- A. All valves and appurtenances shall be installed per the manufacturer's instructions in the locations shown, true to alignment and rigidly supported. Any damage to the above items shall be repaired to the satisfaction of the Engineer before they are installed.
- B. Install all brackets, extension rods, guides, the various types of operators and appurtenances as shown on the Drawings, or otherwise required. Before setting these items, check all Drawings and figures which have a direct bearing on their location. The Contractor shall be responsible for the proper location of valves and appurtenances during the construction of the work.
- C. All materials shall be carefully inspected for defects in construction and materials. All debris and foreign material shall be cleaned out of openings, etc. All valve flange covers shall remain in place until connected piping is in place. All operating mechanisms shall be operated to check their proper functioning and all nuts and bolts checked for tightness. Valves and other equipment which do not operate easily, or are otherwise defective, shall be repaired or replaced at no additional cost to the Owner.
- D. Where installation is covered by a referenced standard, installation shall be in accordance with that standard, except as herein modified, and the Contractor shall certify such. Also note additional requirements in other parts of this Section.
- E. Unless otherwise noted, joints for valves and appurtenances shall be made up utilizing the same procedures as specified under the applicable type connecting pipe joint and all valves and other items shall be installed in the proper position as recommended by the manufacturer. Contractor shall be responsible for verifying manufacturers' torquing requirements for all valves.

#### 3.02 INSTALLATION OF MANUAL OPERATIONAL DEVICES

- A. Unless otherwise noted, all operational devices shall be installed with the units of the factory, as shown on the Drawings or as acceptable to the Engineer to allow accessibility to operate and maintain the item and to prevent interference with other piping, valves and appurtenances.
- B. For manually operated valves 3-in in diameter and smaller, valve operators and indicators shall be rotated to display toward normal operation locations.
- C. Floor boxes, valve boxes, extension stems and low floor stands shall be installed vertically centered over the operating nut, with couplings as required and the elevation of the box top shall be adjusted to conform with the elevation of the finished floor surface or grade at the completion of the Contract. Boxes and stem guides shall be adequately supported during concrete pouring to maintain vertical alignment.

#### 3.03 INSPECTION, TESTING AND CORRECTION OF DEFICIENCIES

- A. See also Division 1. Take care not to over pressure valves or appurtenances during pipe testing. If any unit proves to be defective, it shall be replaced or repaired to the satisfaction of the Engineer.
- B. No testing shall be performed until the manufacturer's service engineer has provided written certification that the following installed equipment has been examined and found to be in complete accordance with the manufacturer's requirements:
  - 1. All motorized valves.
  - 2. All pressure regulating valves.
  - 3. Combination sewage air valve.
- C. Functional Test: Prior to startup, all items shall be inspected for proper alignment, quiet operation, proper connection and satisfactory performance. All motorized units shall be operated through 20 complete cycles, without vibration, jamming, leakage, or overheating and perform the specified function. All manual actuators shall be operated through ten complete cycles.
- D. The various pipelines in which the valves and appurtenances are to be installed are specified to be field tested. During these tests any defective valve or appurtenance shall be adjusted, removed and replaced, or otherwise made acceptable to the Engineer.
- E. Various regulating valves, strainers, or other appurtenances shall be tested to demonstrate their conformance with the specified operational capabilities and any deficiencies shall be corrected or the device replaced or otherwise made acceptable to the Engineer.

#### 3.04 CLEANING

- A. All items (including valve interiors) shall be cleaned prior to installation, testing and final acceptance.

END OF SECTION

SECTION 331500  
FABRICATED WEIR GATES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The equipment provided under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by the engineer.

Gates and operators shall be supplied with all the necessary parts and accessories indicated on the drawings, specified or otherwise required for a complete and properly operating installation, and shall be the latest standard product of a manufacturer regularly engaged in the production of fabricated water control gates.

- B. Unit Responsibility: To insure compatibility of all components directly related to the slide gates, unit responsibility for the slide gates, actuators and accessories as described in this section shall be the responsibility of the slide gate manufacturer unless specified otherwise.

1.02 SUBMITTALS

- A. Submittals shall be in accordance with Sections 013000 and as specified herein.

Submittals shall include as a minimum:

1. Shop Drawings
2. Manufacturer's operation and maintenance manuals and information.
3. Manufacturer's installation certificate.
4. Manufacturer's equipment warranty.
5. Design calculations demonstrating lift loads and deflection in conformance to the application requirements.

1.03 QUALITY ASSURANCE

- A. Qualifications

1. All of the equipment specified under this Section shall be furnished by a single manufacturer with a minimum of 20-years of experience designing and manufacturing slide gates. The manufacturer shall have manufactured stainless steel slide gates of the type described herein for a minimum of 20 similar projects.
2. The sealing system shall be certified and tested for operation and performance to leakage specifications compliant with AWWA C-561 for a minimum of 100,000 cycles.
3. The project design is based on the Waterman SS-250 Series Fabricated Slide Gate as manufactured by Waterman Industries of Exeter, California. Proposed alternates must be pre-approved, per addendum, at least 14-days prior to close of bid. Requests for alternates must be supplemented with detailed drawings, specifications, and references. Any/all

additional costs for structure modifications or other changes associated with utilizing a brand other than Waterman are to be borne by the contractor.

4. To insure quality and consistency, the slide gates listed in this section shall be manufactured and assembled in a facility owned and operated by the slide gate manufacturer. Third-party manufacturers contracted for fabrication and assembly of the slide gates will not be permitted.

## PART 2 EQUIPMENT

### 2.01 GENERAL

- A. The gates shall be self-contained with yoke and bench stand operators, in accordance with the requirements of these specifications.
- B. The gates shall be compliant with the latest version of AWWA C561 as described below.
- C. Specific configurations shall be as noted on the gate schedule or as shown on the plans.
- D. Materials:

COMPONENTS	MATERIALS
Frame, Yoke, Cover Slide, Wall Thimbles	Stainless Steel ASTM A240, Type 316
Seat/Seals & Stem Sleeves	Ultra High Molecular Weight Polyethylene (UHMWPE) ASTM D-4020
Cord Seal	Viton ASTM D1418
Flush Bottom Seals	Viton ASTM D1418
Stems	Stainless Steel: ASTM A-276, AISI Type 316
Stem cover	Galvanized A-53 Steel
Stem Guides	Stainless Steel (ASTM A-240 – Type 316L) UHMW Bushed
Wall Brackets	Stainless Steel: ASTM A-240, AISI Type 316L
Pedestals	Not Applicable
Fasteners and Anchor Bolts	Stainless Steel: ASTM A-593 and 594, Type 316 CW
Finish	Polyamide Epoxy



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E. Gate Schedule:

Equipment Number	Gate Size, inch <sup>1</sup>	Gate type <sup>2</sup>	Opening Direction <sub>3</sub>	Bottom Seating <sup>4</sup>	Design Head, feet		Operator Type
					Seating	Unseating	
Gates 1&2 (2 total)	60x72	W	D		10	5	Handwheel

Notes:

1. Clear opening width by height.
2. E = embedded frame, W = wall mounted, Y = self-contained, F = flatback
3. U = upward, D = downward
4. FB = flush bottom

2.02 FRAME AND GUIDE RAILS

- A. The gate frame shall be composed of stainless steel guide rails with UHMW seat/seals upstream and downstream. The seat/seals shall form a tight seal between the frame and the slide (disc). The guides will be of sufficient length to support ½ the height of the slide when in the full open position.
- B. Yoke shall not deflect more than 1/360<sup>th</sup> of the span under full head break load.
- C. Seals shall be replaceable without removing the frame from the wall. In the case of embedded gates, they shall be constructed in a manner that allows replacement of the seals without removal of the gate frame from the embedment.

2.03 STEM AND STEM GUIDE

- A. Material
  1. The stem shall be solid stainless steel of the specified grade.
- B. Design
  1. Guides shall be adjustable with split stem sleeves. Guides shall be spaced per the manufacturer's recommendations. The stem L/r ratio shall not exceed 200.
  2. Stem threads shall be machine-cut 29-degree full Acme or stub Acme type.
  3. Nominal diameter of the stem shall not be less than the crest of the threaded portion.

2.04 SEALS

- A. The seals shall be self-adjusting. Seals requiring periodic maintenance and adjustments to maintain specified leakage rates will not be permitted.

- B. The top seal design on upward opening gates consisting of four side seals shall incorporate a self-cleaning wiping function that prevents debris from building-up above the top seal and causing premature wear of the seats, seals, and gate face.
- C. The UHMW seats shall impinge on the slide (disc) by way of a continuous loop cord seal. Seal designs incorporating resilient seals such as “J-bulb” or “P” seals that come in direct contact with the friction surface of the slide will not be considered.
- D. The cord seal shall function as a seal between the frame and the UHMW, and as a spring force to maintain contact between the UHMW and the slide (disc).
- E. The resilient bottom seal shall be set into the invert member of the frame which shall be formed in a manner to protect 3 sides of the seal only exposing the side that will come in contact with the slide. Disc-mounted invert seals exposing additional surface area will not be permitted.
- F. The self-adjusting seal system shall provide an allowable leakage rate of no more than ½ AWWA leakage rate per minute per peripheral foot of perimeter opening for seating and unseating heads.

## 2.05 SLIDE COVER

- A. The slide cover shall be stainless steel plate reinforced with structural shapes welded to the plate.
  - 1. The slide cover shall not deflect more than 1/720th of the span, or 1/16” at the seated sealing surface of the gate under maximum specified head.
  - 2. The stem to gate connection shall be either the clevis type, with structural members welded to the slide and a bolt or bolts to act as a securing method, or a threaded and bolted (or keyed) thrust nut supported in a welded nut pocket.
  - 3. The clevis, or pocket and yoke, of the gate shall be capable of taking, without damage, at least twice the rated thrust output of the operator at 40 pounds of pull on a hand wheel or hand crank, and at locked-rotor stall of a motor operator.
  - 4. The slide cover shall be constructed with vertical and horizontal reinforcement ribs.
  - 5. All welds shall be performed by an AWS-certified welding technician.

## 2.06 ANCHOR BOLTS

- A. Anchor hardware shall be provided by the slide gate manufacturer.
  - 1. The size, quantity, and location of the anchor hardware shall be engineered by the slide gate manufacturer. Upon client request manufacturer shall provide calculations for anchor bolt sizing and quantity.
  - 2. Anchor hardware consisting of studs, nuts and washers shall be provided by the manufacturer.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Installation of the gates shall be performed in accordance with standard industry practices. It shall be the responsibility of the CONTRACTOR to handle, store, and install the equipment specified in this Section in strict accordance with the Manufacturer's recommendations.
- B. The CONTRACTOR shall review the installation drawings and installation instructions prior to installing the gates.
- C. The gate frames shall be installed in a true vertical plane, square and plumb, with no twist, convergence, or divergence between the vertical legs of the guide frame.
- D. The CONTRACTOR shall fill any void between the guide frames and the structure with non-shrink grout as shown on the installation drawing and in accordance with the grout manufacturer's recommendations.
- E. The frame cross rail shall be adjusted as required to maintain consistent seal compression across the full width of the gate.

### 3.02 FIELD TESTING

- A. After installation, all gates will be field tested in the presence of the ENGINEER and OWNER to ensure that all items of equipment are in full compliance with this Section. Each gate assembly shall be water tested by the CONTRACTOR at the discretion of the ENGINEER and OWNER, to confirm that leakage does not exceed the specified allowed leakage.

END OF SECTION



SECTION 432136

POSITIVE DISPLACEMENT ROTARY LOBE SCUM PUMPS

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

The CONTRACTOR Furnish all material, equipment and incidentals required for positive displacement, rotary lobe pumps, motors and coordinated control systems as hereinafter specified. Furnish pumps, motor, motor controls and other equipment as show on the Drawings. The station shall be complete with pumps, motors, piping, valves, electrical work (including motor controls), structures, connections and appurtenances, tested and ready for operations.

B. TYPE:

The pumping units shall be of the positive displacement, HiFlo® rotor type, specifically designed for pumping Sludge, Scum. The rotor lobes shall be of a HiFlo® design to provide uniform Pulse free flow throughout the entire operating range. The pump shall have not less than 6 rotor tips.

C. PERFORMANCE REQUIREMENTS:

Equipment shall be designed and selected for continuous duty pumping of Sludge/ Scum. Pumps shall be capable of running dry, for a short period of time, without damage to the pump and or drive unit. Pumps shall be suitable for exposure to Sludge, Scum, and organic particles in concentrations as great as 1 percent. The pumped fluids are expected to range in temperatures up to 100 °F degrees F, and a pH of 7 pH.

The pumps, along with associated drive appurtenances, shall be mounted on an in-line fabricated steel, channel base plate with split coupling. The base plate shall be hot dip galvanized after fabrication.

These Specifications are intended to give a general description of what is required, but do not cover all details which will vary in accordance with the requirements of the equipment application. It is, however, intended to cover the furnishing, the shop testing, the storage and delivery of all materials, equipment and all appurtenances for the complete pumping units as herein specified, whether specifically mentioned in these Specifications or not.

## 1.02 QUALITY ASSURANCE:

### A. REFERENCES

Design, manufacturing, and assembly of elements of the equipment herein specified shall be in accordance with the standards of the below listed organizations. Where reference is made to a standard of one of the following or other organizations, the version of the standard in effect at the time of the bid opening shall apply.

1. American Gear Manufacturing Association (AGMA)
2. American Institute of Steel Construction (AISC)
3. American Iron and Steel Institute (AISI)
4. American Society of Mechanical Engineers (ASME)
5. American National Standards Institute (ANSI)
6. American Society for Testing Materials (ASTM)
7. American Water Works Association (AWWA)
8. American Welding Society (AWS)
9. Anti-Friction Bearing MANUFACTURERS Association (AFBMA)
10. Hydraulic Institute Standards
11. Institute of Electrical and Electronics Engineers (IEEE)
12. National Electrical Code (NEC)
13. National Electrical MANUFACTURERS Association (NEMA)
14. Occupational Safety and Health Administration (OSHA)
15. Steel Structures Painting Council (SSPC)
16. Underwriters Laboratories, Inc. (UL)

## 1.03 QUALIFICATIONS

To assure unity of responsibility, the pumps and motors, shall be furnished and coordinated by the pump manufacturer (MANUFACTURER). The CONTRACTOR shall assume full responsibility for the satisfactory operation of the entire pumping systems including pumps, motors, and controls as specified.

The equipment covered by these Specifications shall be standard units of proven ability as manufactured by competent organizations having long experience in the production of such equipment. The pumps shall be the standard cataloged product of the MANUFACTURER. The pumps furnished shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed. Pumps shall be manufactured in accordance with the Hydraulic Institute Standards, except as otherwise specified herein.

All Equipment furnished under this Specification shall be new and unused and shall be the standard product of MANUFACTURERS showing a successful record of manufacturing and servicing the equipment and systems specified herein for a minimum of twenty (20) years, and be ISO 9001:2008 compliant, and shall be either fully assembled or manufactured in the United States of America.

The MANUFACTURER shall be fully responsible for the design, arrangement, and operation of all connected rotating components of the assembled pumping unit to ensure that neither harmful nor damaging vibrations occur within the specified operating range. Design shall include a fabricated steel baseplate for mounting the units.

#### 1.04 SUBMITTALS

Copies of all materials required establishing compliance with the specifications shall be submitted in accordance with the provisions of Section 0. The submittal format shall be in the form of a booklet, suitably tabbed and divided, to cover at least the areas noted below for each major equipment item. The submittal booklet shall include adequate detail and sufficient information for the ENGINEER to determine that all of the equipment proposed meets the detailed requirements of the Specifications. Incomplete or partial submittals will not be reviewed. Submittals shall include at least the following:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. Certified shop and erection drawings showing all, important details of construction, dimensions, and anchor bolt locations.
3. Descriptive literature, bulletins and/or catalogs of the equipment.
4. Data on the characteristics and performance of each pump. Data shall include guaranteed performance curves, based on actual shop tests of similar units, which show that they meet the specified requirements for head, capacity and horsepower. Curves shall be submitted on 8 ½" by 11" sheets, at as large a scale as is practical. Catalog sheets showing a family of curves will not be acceptable.

5. A complete total bill of materials of all equipment (may be furnished with Operation and Maintenance manuals specified under paragraph 1.05).
6. A list of the MANUFACTURER'S recommended spare parts, in addition to those specified in paragraph 1.06. with the manufacturer's current price for each item, shall be supplied. Include gaskets, packing, etc. on the list. List bearings by the bearing manufacturer's numbers only.
7. Complete motor and control systems data.
8. Warranty as described in paragraph 1.08.

All tests shall be performed in North America according to Hydraulic Institute Standards, Section 3.6.

Complete operating and maintenance instructions shall be furnished for all equipment included under these specifications. The maintenance instructions shall include troubleshooting data and full preventative maintenance schedules and complete spare parts lists with ordering information.

Submit the MANUFACTURER'S Certificate of Installation, Testing, and Instruction.

In the event that it is impossible to conform to certain details of the specifications due to different manufacturing techniques, describe completely all non-conforming aspects.

#### 1.05 OPERATING INSTRUCTIONS:

- A. Operating and maintenance manuals shall be furnished. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc., that are required to instruct operation and maintenance personnel who are unfamiliar with such equipment.
- B. A trained instructor, with complete knowledge of proper operation and maintenance for all major components, shall be provided for two days to instruct representatives of the OWNER and the ENGINEER on proper operation and maintenance. With the OWNER'S permission, this work may be conducted in conjunction with the inspection of the installation and test run as provided under PART 3. If there are difficulties in operation of the equipment due to the MANUFACTURER'S design or fabrication, additional service shall be provided at no cost to the OWNER.



## 1.06 TOOLS AND SPARE PARTS

One set of special tools shall be provided for servicing all pumps. In addition, the following spare parts shall be provided for each size and type of pump:

- 2 – sets of Cartridge mechanical seals
- 2 - spare rotor sets, as specified, for each size pump
- 2 - sets of front and back wear plates

Spare Parts shall be properly bound and labeled for easy identification without opening the packaging and suitably protected for long term storage.

## 1.07 PRODUCT HANDLING:

- A. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.
- B. All equipment and parts must be properly protected against any damage during a prolonged period at the site. Pumps shall be rotated 2 revolutions every 30 days of storage time.
- C. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the ENGINEER.
- D. Finished surfaces of all exposed pump openings shall be protected by wooden blanks, strongly built and securely bolted thereto.
- E. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.
- F. After hydrostatic or other tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage, and handling.
- G. Each box or package shall be properly marked to show its net weight in addition to its contents.

## 1.08 WARRANTY

The equipment shall be warranted to be free from defects in workmanship, design, and materials for a period of two (2) years. If any part of the equipment should fail during the warranty period, it shall be replaced in the machine(s), and the unit(s) restored to service at no expense to the OWNER.

The equipment shall be warranted to be free from defects in workmanship, design, and materials for a period of two (2) years. If any part of the equipment should fail during the warranty period, it shall be replaced in the machine(s), and the unit(s) restored to service at no expense to the OWNER.

The MANUFACTURER’S warranty period shall run concurrently with the CONTRACTOR’S warranty period. No exception to this provision shall be allowed.

## PART 2 – PRODUCTS

### 2.01 ACCEPTABLE PRODUCTS

The Owner and Engineer believe the following candidate manufacturer is capable of producing equipment and/or products in the United States of America that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this Section. The equipment specified herein shall be Vogelsang Model VX100-90H6Q, or equal, modified to provide the specified features and to meet specified operating conditions.

### 2.02 MATERIALS

Component	Material
Casting and casing cover plates	0.6025 (Grey Cast Iron), 230 to 260 Brinell hardness, 370-430 HB Brinell on end cover plate
Rotors	HiFlo® Cast iron core with NBR covering as specified
Shafts	Carbon steel, ASTM A293, 45 mm Diameter
Shaft sleeve	Stellite coated stainless steel
O-Rings	NBR
Lip Seals	HNBR
Mechanical Seal	fitted into the cartridge seal Seal Carrier in Mild Steel 304 Stainless Steel (1.4301) vs. Duronit

### 2.03 EQUIPMENT

#### A. OPERATING CONDITIONS:

Primary Duty Point	50.0 gpm
Differential Pressure	10.0 psi
Suction Conditions	25.0 ft. NPSHA
Medium	Sludge, Scum

Percent of Solids	1 -2 %
Viscosity	not Provided
Density	not Provided
Maximum HP at Duty Condition	1.5 BHP
Suction and Discharge Flange Size	4 inch ANSI
NPSHR shall not exceed	15 ft.
Shaft Deflection Shall Not Exceed	0.0010 inch
Maximum RPM shall be	366 RPM
Minimum volumetric efficiency shall be	86.50%
Minimum number of lobe tips	6

#### B. PERFORMANCE REQUIREMENTS:

1. There shall be no significant change in vibration and noise level over the entire listed range of operating conditions of operating conditions of the pumping system.
2. Maximum motor speed shall not exceed 1800 rpm on in-line mounted units, and 1200 RPM on overhead or piggyback mounts.
3. A motor sizing shall provide a minimum of 10% reserve hp as evidenced by specific requirements at maximum design condition on the certified performance curve.

#### C. PUMPS:

Each pump shall be of heavy duty, positive displacement rotary lobe design. The wet end shall be constructed of High Wear Resistant Special Steel. The front cover shall be constructed of 0.6025 (Grey Cast Iron), with a minimum Brinell hardness of 230 – 260, and permit removal of the rotors without disturbing piping, bearings, and mechanical seals. The case shall also be machined to accept a reversible front and rear wear plate, constructed of High Wear Resistant Special Steel, to a finished hardened reversible surface of 370-430 HB Brinell. Pumps not equipped with a removable wear plate that use the front door for its wear surface or require bolts that are recessed below the lobe path, are not acceptable for any wearing surface.

The pump shall utilize at minimum, HiFlo® 6-tip rotors, which are driven through positive timing gears running in oil. Solid cores of Grey Cast Iron A48, Class 40 B shall be covered with a layer of NBR, with a Durometer hardness 58. The geometry of the rotor core shall be the same as that of the finished rotor, pulse free. The rotor shall be specifically designed for pumping Sludge, Scum. Rotors shall be positioned to the shaft by replaceable hardened keyways and secured to the shaft by internal/external expansion bolt and flush discs requiring no recesses in the end cover. Pumps utilizing lobe designs with fewer than 6 tips, will not be considered, due to the high potential for wear on the lobes, as a result of fewer sealing lines. Designs with replaceable lobe tips shall not be acceptable.

Both front and rear rotor case cover plates shall be fitted with a renewable hardened wear surfacing, with a minimum Brinell hardness of 370-430 HB Brinell. Rotors shall be positioned on the shaft by replaceable hardened keyways and secured to the shaft by internal/external expansion bolt that is tightened from the inside of the support cover.

The shafts shall be of carbon steel ASTM A293 fitted with replaceable stainless steel sleeves where passing through the seal area. They shall be timed in their rotation by straight cut timing gears running in a separate oil chamber which also contains the ball and roller bearings for each shaft. Pumps requiring external re-timing in the event of blockage will not be considered. The shaft shall be a minimum of 45 mm in diameter where the rotors, bearings, and mechanical seals contact the shaft, to decrease the potential of torsional shaft fatigue. The use of step down, angular v-notch cut, or threaded, shafts will not be acceptable due to shaft fatigue and potential of breakage. The shaft sleeves where the mechanical seal rides, shall be removable through the front of the pump, when removing the cartridge mechanical seal, and without disturbing the surrounding piping. Maximum shaft deflection at operating pressure shall be 0.0010 inch.

Cartridge mechanical seals shall be provided of Seal Carrier in Mild Steel 304 Stainless Steel (1.4301) vs. Duronit for each positive displacement pump. The seal shall include the mechanical seal faces, the seal holder and carrier, all applicable o-rings, the mechanical seal faces, and stainless steel shaft sleeve. The use of manual pre-load mechanical seals will not be accepted. A blocking chamber located behind the mechanical seal, and in front of the bearing housing lip seal shall be fitted into the cartridge seal of the pump to prevent contamination of the bearings on the event of a seal failure. This chamber shall be suitable for fill, from the top of the pump, and have an external pressurized oil bottle to review the status of the mechanical seals operation, mounted on the top of the pump, located in easy view of the operator. Pumps with open to air cavities located behind the mechanical seal housing, those that require water flush or quench, or those without oil bottles, will not be accepted, due to their potential for product spill failure on the surrounding areas of the pump, and the added maintenance and cost associated with mechanical seal water flushing systems.

Port connections shall be ANSI Class 150 # raised face, 4-inch Gooseneck x Gooseneck designed flanges to reduce the chance of vapor locking, and increase the reliability and suction lift capability, through its unique design. They shall be hot dipped galvanized steel, for long life, and abrasion resistance.

The removable end cover shall be flush with no recesses or dead pockets where solids can accumulate. The cover shall be sealed with NBR O-rings and provide complete access to the pump chamber without disconnecting pipe work glands or bearings. The removable front cover is to be mounted to the pump with 4 individual bolts to provide unhindered access to the rotors to facilitate ease of maintenance and operator safety.

The pump and motor shall be mounted on a steel base plate complete with necessary, guards, and mounting hardware.

Pumps and motors shall operate at any point within their operating range without undue noise and vibration. Vibration at any point in the operating range shall not exceed the limits allowed by the Hydraulic Institute.

The top and bottom housing segments of the pump shall be constructed of 0.6025 (Grey Cast Iron), hardened to a minimum of 160-250 HB Brinell, and be adjustable based on wear. The adjustment shall be accomplished by simply moving steel shims from one hole to the next in the pump housing, allowing for the closing of tolerance around the rotors. This adjustment must be available a minimum of two times from factory tolerance. The use of one-piece, block, cast housings or the use of radial wear plates will not be accepted; due to the fact that their ability to be hardened is limited and frequent replacement when a rebuild is required due to wear.

Bearings shall be B-10 Life, 100,000 hours. Bearings and timing gears for all pump sizes shall run in an oil chamber provided with a bolt to show the level with the centerline of the lower shaft.

The pump timing gears shall run in oil and shall be mounted in a gear case contiguous with the pump case. The gear case shall be fitted with oil fill and drain connections on the top and bottom. Designs that use side drains will not be acceptable, due to the inability to completely drain the fluids on the pump.

The manufacturer shall be ISO 9001:2008 compliant, as evidenced with a current ISO certificate at the time of bid. The pumps in the specification shall be manufactured or fully assembled in the United States of America. Manufacturers that are ISO compliant, but not certified to ISO 9001:2008, or do not fully assemble or manufacture their pumps in the USA, will not be considered.

## 2.04 MOTORS

### A. General:

Component	Type
Drive Type	In-Line Geared Motor
In-Line Geared Motor Manufacture	Nord
Coupling or V-Belt	TB Woods - Split Hytrel Sleeve
Motor HP	3.0HP
Motor Enclosure Type	IP 55, TEFC

Component	Type
Motor Efficiency	Premium Efficiency 90 %
Motor Insulation Class	F
Motor RPM	1800 RPM
Motor Voltage	230/460 V

1. All motors shall be built in accordance with latest NEMA, IEEE, ANSI and AFBMA standards where applicable.
2. Motors shall conform to all requirements stipulated in the motor section of this specification.
3. The motors supplied shall be specifically designed for inverter duty to allow for the potential of future variable frequency drives. The motors shall be compatible with the pumps provided by the MANUFACTURER.

## 2.05 PUMP DISCHARGE GAUGES

- A. Pump Suction and Discharge Gauges: The CONTRACTOR shall furnish and install for each pump in tapped holes in the discharge and suction piping to accommodate the gauges which shall be supplied by the CONTRACTOR as shown on the Drawings.

## 2.06 PRESSURE RELIF CONTROL

- A. Pump discharge pressure switch: The CONTRACTOR shall furnish and install for each pump pressure switches on the pump discharge line. The pressure switches shall be set to the MANUFACTURER'S recommendations.

## 2.07 CONTROL PANEL

- A. Pump supplier shall provide a control panel as shown on the drawings.
- B. The enclosure shall be NEMA Type 3R and shall be fabricated from 14 gauge S.S. The weatherproof, rain tight enclosure shall be designed for mounting in an unprotected outdoor location. It shall have a gasketed, hinged, front weather door with a locking hasp in addition to latches.
- C. The enclosure shall be equipped with fans, vents, heaters, and other equipment to maintain normal operating temperatures and humidity conditions for all interior equipment.
- D. The panel shall be equipped with a terminal block mounted surge protection device, independent power monitors (on load side of pump disconnect), motor starter, control

transformer with transformer primary circuit breaker, auxiliary power circuit breaker and 15-amp convenience receptacle, and pump controller as specified in paragraph E. below.

- E. The pump control shall be a timed based control. A level switch (mini-float) within the scum beach shall initiate PUMP ON and an adjustable countdown timer shall control the PUMP ON time. The timer shall be adjustable from 5 sec to 5 minutes (300 sec). Pump shall not run without level switch activation.
- F. Panel shall provide a 3-pole, 4-amp feed breaker to feed the clarifier drive control panel. Clarifier drive control panel to be supplied by clarifier manufacturer.

## PART 3 – EXECUTION

### 3.01 INSTALLATION:

- A. Installation in strict accordance with the MANUFACTURER’S instructions and recommendations in the locations shown on the Drawings. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the MANUFACTURER’S recommendations. Anchor bolts shall be set in accordance with the MANUFACTURER’S recommendations.
- B. Upon completion of the installation, the CONTRACTOR shall submit a certificate from the MANUFACTURER stating that the installation of the equipment is satisfactory, that the equipment is ready for operation, and that the operating personnel have been suitably instructed in the operation of lubrication and are of each unit.

### 3.02 SHOP PAINTING

- A. Before exposure to weather and prior to shop painting all surfaces shall be thoroughly cleaned, dry and free from all mill-scale, rust, grease, dirt and other foreign matter.
- B. All exposed portions of the pumps and motors shall be shops primed, with primer compatible with field painting as specified.
- C. All nameplates shall be properly protected during painting.
- D. All pumps shall be painted in the USA and a certificate confirming conformance to this requirement shall be submitted during the submittal phase of this specification.

### 3.03 FIELD PAINTING

- A. Field painting is specified under Painting Section of this specification. The primer and paint used in the shop shall be products of the same MANUFACTURER as the field paint to assure compatibility.
- B. All nameplates shall be properly protected during painting.

### 3.04 INSPECTION AND TESTING

#### A. General:

- 1. The ENGINEER shall have the right to inspect, test or witness tests of all materials or equipment to be furnished under these specifications, prior to their shipment from the point of the manufacture.
- 2. The ENGINEER shall be notified in writing prior to initial shipment, in ample time so that arrangements can be made for inspection by the ENGINEER.
- 3. Field tests shall not be conducted until such time that the entire installation is complete and ready for testing.

#### B. FACTORY PUMP TESTS:

- 1. Factory testing in accordance with the standards of the Hydraulic Institute shall be required for all pumps. The entire assembly, including the pump and motor assembled on the base, shall be tested. This test must take place at an ISO certified facility within the USA. All pumps shall be witness tested by the pump MANUFACTURER in the presence of the ENGINEER. All witness travel and out-of-pocket expenses shall be included in the CONTRACTOR'S bid price.
- 2. Certified pump performance curves shall be submitted, including head, capacity, and brake horsepower, for each pump supplied.
- 3. Prior to conducting a pump test, notification of such test and a list of test equipment and test procedures shall be forwarded to the Engineer at least ten working days before the scheduled test date. All electronic transducers, meter, gauges, and other test instruments shall have been calibrated in accordance with the requirements of the Hydraulic Institute Standards. Copies of calibration data shall be provided.
- 4. All pumps shall be tested at full speed and complete staging through the specified range of flow, and head/capacity/efficiency curves plotted at maximum output speed. During each test, the pump shall be run at each head condition for sufficient time to accurately determine discharge, head, power input, and efficiency.



5. If any pump tested, fails to meet any specification requirement, it will be modified until it meets all specification requirements. If any pump tested, fails to meet the efficiency requirements at any of the listed flow or head conditions listed and all reasonable attempts to correct the inefficiency are unsuccessful, the pump(s) shall be replaced with units(s) which meet the specified requirements.

C. FIELD INSPECTION AND OWNER INSTRUCTION:

1. The CONTRACTOR shall furnish the services of the MANUFACTURER'S field service technician, who has complete knowledge of proper operation and maintenance of the equipment, for a period of no less than two (2) days to inspect the installed equipment, supervise the initial test run, and to provide instruction to the plant personnel. These services shall be completed in two (2) separate site visits. The first visit shall be checking and inspecting the equipment after it is installed. The second visit will be to operate and supervise the initial field test.
2. At least one (1) of the two (2) days shall be allocated solely to instruction of plant personnel in operation and maintenance of the equipment. The instruction period shall be scheduled at least 14 days in advance with the OWNER and shall take place prior to start up and acceptance by OWNER. The final copies of operation and maintenance manuals specified must be delivered to the ENGINEER prior to scheduling the instruction period with the OWNER with the permission of the ENGINEER, these services may be combined with those specified by Paragraph 1.05.

D. FIELD PUMP TESTS:

1. In the presence of the ENGINEER such tests as necessary to indicate that the pumps and motors conform to the operating conditions specified shall be performed. A 30-day operating period of the pumps will be required before acceptance. If a pump performance does not meet the specified requirements, corrective measures shall be taken. All test procedures shall be in accordance with factory test procedures specified above and certified results of tests shall be submitted. Provide, calibrate, and install all temporary gauges and meters, make necessary tapped holes in the pipes, and install all temporary piping and wiring required for the field acceptance tests. Written test procedures shall be submitted to the ENGINEER for approval 30 days prior to testing.
2. Noise and vibration tests shall be conducted in conformance with the Hydraulics Institute Test Codes and OSHA Standards of Occupational Noise Exposure. Maximum allowable noise level, corrected for background sound, shall not exceed 85 dBA when measured at a horizontal distance of 3 meters from the equipment being tested, at a height of 3 meters above floor level. The

actual natural frequency of the installed pumping units will be verified using industry accepted procedures.

3. All pumps operating settings, alarms, controls, and shutdown devices shall be calibrated and tested during the field tests.
4. The CONTRACTOR shall furnish all power, water, facilities, labor, materials, supplies and test instruments required to conduct field test.
5. Deliver to the ENGINEER, upon completion of satisfactory testing of the equipment, reports as specified in Part 1.

E. FIELD ELECTRONIC CONTROL SYSTEM TESTS:

1. The electric control system shall be test operated for proper functioning prior to the pump mechanical test. The control system shall be checked out using simulated operating signals as per pump MANUFACTURER'S recommendations.
2. The CONTRACTOR shall check all drives for correct clearances, alignment, and lubrication in accordance with MANUFACTURER'S instructions. The CONTRACTOR shall check direction of rotation of all motors and reverse connections if necessary.
3. The CONTRACTOR shall meet all the testing requirements of Division 16.

F. FIELD ALARM SYSTEM TESTING:

1. Check each alarm and detection device for proper operation.

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

SECTION 44-4220  
CENTER FEED, UNITUBE SLUDGE HEADER CLARIFIER

PART 1 GENERAL

1.01 SCOPE

A. Description of Work

1. Furnish one (1) suction header type clarifier mechanism(s) and components as specified herein for use in removal of activated sludge.

B. Work and Components Included (But Not Limited To):

1. The Equipment Manufacturer shall furnish the items listed below:
  - a. Drive mechanism complete with a gearmotor reduction unit, micro-switch torque overload devices and shear pin
  - b. Center support pier
  - c. Center pier anchor bolt template
  - d. Tow-Bro® Unitube sludge removal header(s), manifold, seals, clamp kit and supports
  - e. Center cage, truss arm(s) and tie chord A-frame(s) with clevis assembly(ies)
  - f. Access bridge including center platform, grating, hand-railing and toe plate
  - g. One (1) surface skimmer assembly which includes scum blade and hinged skimmer assembly
  - h. One (1) scum trough with flushing device
  - i. FEDWA® energy dissipating inlet (EDI) baffle system and supports
  - j. Flocculation feedwell and supports
  - k. All associated hardware and anchor bolts
2. Like items of equipment specified herein shall be the end products of one manufacturer in order to achieve standardization for operation, maintenance, spare parts and manufacturer's service.

C. Work Not Included

1. The following items are specified under other sections of these specifications:
  - a. Sitework
  - b. Concrete and Grout

- c. Metal Fabrication
- d. Paint
- e. Electrical

D. References

1. American Gear Manufacturers Association (AGMA):
  - a. 201.02 - Tooth Proportions for Coarse-Pitch Involute Spur Gears.
  - b. 390.03a - Handbook - Gear Classification, Materials and Measuring Methods for Bevel, Hypoid, Fine Pitch Wormgearing and Racks Only as Unassembled Gears.
  - c. 908 - Information Sheet - Geometry Factors for Determining the Pitting Resistance and Bending Strength of Spur, Helical and Herringbone Gear Teeth.
  - d. 2000 - Gear Classification and Inspection Handbook - Tolerances and Measuring Methods for Unassembled Spur and Helical Gears (Including Metric Equivalents).
  - e. 2001 - Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth.
  - f. 2004 - Gear Materials and Heat Treatment Manual.
  - g. 6019 - Standard for Gearmotors Using Spur, Helical, Herringbone, Straight Bevel or Spiral Bevel Gears.
  - h. 6022 - Design Manual for Cylindrical Wormgearing.
  - i. 6034 - Practice for Enclosed Cylindrical Wormgear Speed Reducers and Gearmotors.
  - j. 9005 - Industrial Gear Lubrication.
2. American Institute of Steel Construction (AISC):
  - a. Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design.
  - b. Code of Standard Practice for Steel Bridges and Buildings.
3. American Society of Mechanical Engineers (ASME)
  - a. B29.1M - Precision Power Transmission Roller Chains, Attachments and Sprockets.
4. American Society for Testing and Materials (ASTM):
  - a. A 36/A 36M - Standard Specifications for Structural Steel.
  - b. A 48 - Standard Specification for Gray Iron Castings.
  - c. A 148/A 148M - Standard Specification for Steel Castings, High Strength, for Structural Purposes.
  - d. A 276 - Standard Specification for Stainless Steel Bars and Shapes.

- e. A 325 - Standard Specification for High-Strength Bolts for Structural Steel Joints.
- f. A 536 - Standard Specification for Ductile Iron Castings.
- 5. American Welding Society (AWS):
  - a. D 1.1 - Structural Welding Code for Steel.
- 6. American Bearing Manufacturers Association (ABMA):
  - a. 9 - Load Ratings and Fatigue Life for Ball Bearings.
- 7. International Conference of Building Officials (ICBO):
  - a. Uniform Building Code (UBC).
- 8. National Electrical Manufacturers Association (NEMA):
  - a. 250 - Enclosures for Electrical Equipment (1,000 volts maximum).
- 9. Related Work Specified Elsewhere
  - a. The provisions of this section are a direct extension of the GENERAL MECHANICAL REQUIREMENTS, and although set forth only once within the specification, shall apply equally to this section.

## 1.02 QUALIFICATIONS

### A. Manufacturer

- 1. It is the intention of this specification to cover minimum acceptable quality for a complete installation with the exception of the motor controls, electrical work and piping requirements.
- 2. Basis of Design for the material and equipment specified is the Tow-Bro® clarifier design and FEDWA inlet designed by Envirex® Products of Evoqua Water Technologies in Waukesha, WI.

### B. Manufacturer's Experience

- 1. The equipment Manufacturer shall have not less than fifteen (15) successful years of experience in the design, construction and operation of the type specified at ten (10) different plants.
- 2. The Engineer may require evidence, in the form of operating records, from these plants to substantiate any claims concerning the ability of the equipment to perform as required.

### C. General

- 1. The design and layout shown on the drawings are based on Evoqua Water Technologies – Envirex Equipment. If equipment other than Envirex is submitted to the Engineer for consideration as an alternate, it shall be the responsibility of the requesting Bidder to submit the following items for the substituting piece of equipment:

- a. A revised drawing of the mechanical equipment and basin layouts. This revised drawing shall show the proposed location of the substitute unit and area required for replaceable or serviceable components. This drawing shall also show clearances of adjacent equipment and service area required by that equipment.
- b. Changes in architectural, structural, electrical, mechanical and plumbing requirements for the substitution shall be the responsibility of the Bidder wishing to make the substitution. This shall include the cost of redesign by affected designers. Any additional cost incurred by affected subcontractors shall be the responsibility of the Bidder and not the Owner.
- c. A minimum of five (5) references of identical or larger installations including:
  1. Site City, State and Project Name
  2. Clarifier size, dimensions and general description
  3. Reference drawings of each installation
  4. Contact Name, phone number and email address of individual employed by the owner of the equipment

### 1.03 SUBMITTALS

- A. Operating instructions, manuals and shop drawings shall be submitted in accordance with SECTION 01-3000.

### 1.04 GUARANTEE AND WARRANTY

- A. Seller shall furnish its standard warranty against defects in material and workmanship for all Equipment provided by Seller under this Section. The Seller shall warrant the Equipment, or any components thereof, through the earlier of:
  1. eighteen (18) months from delivery of the Equipment or
  2. Twelve (12) months from initial operation of the Equipment.

## PART 2 DESIGN

### 2.01 MANUFACTURERS

- A. The OWNER and ENGINEER believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this section.
  1. Evoqua Water Technologies, LLC - Envirex Products, of Waukesha, WI
  2. Or equal

## 2.02 EQUIPMENT

### A. General

1. Furnish and deliver suction type sludge collector(s) for installation in one (1) new concrete settling tank(s).
  - a. Tank diameter to be 40 feet with inboard effluent launder.
  - b. Tank side water depth to be 12 feet.
  - c. Tank freeboard to be 2 feet.
  - d. Floor slope to be 1/16 inch per 1 foot.
2. Clarifier Mechanism
  - a. Provide a center pier supported, center feed design with peripheral overflow.
  - b. Provide a center drive mechanism that supports a walkway, maintenance platform and rotating structural steel cage.
  - c. The cage shall support the Tow-Bro® Unitube header(s), manifold and one (1) truss arm(s).
  - d. One (1) surface skimmer assembly which includes scum blade and hinged skimmer assembly.
  - e. Fabricated steel structures shall be shipped in the largest sub-assemblies permitted by carrier regulations, properly match-marked and identified for ease of field erection.
3. Clarifier Mechanism Design – Hydraulics
  - a. Influent/Effluent
    1. Minimum flow (MGD) 0.2
    2. Average flow (MGD) 0.5
    3. Maximum flow (MGD) 1.5
  - b. Return Activated Sludge (RAS) Flow
    1. Minimum flow (MGD) 0.1
    2. Average flow (MGD) 0.25
    3. Maximum flow (MGD) 2.25
4. Clarifier Mechanism Design – Equipment
  - a. Dimensions
    1. Internal Diameter, feet 40
    2. Side-water Depth, feet 12
    3. Minimum Freeboard, feet 2
    4. Floor Slope (by grout bed) 1/16 on 12
  - b. Center Pier
    1. Minimum inside diameter, inches 18

- c. Flocculation Well
  - 1. Diameter 8'-7"
  - 2. Depth below water surface 4'-0"
  - 3. Number of Scum Ports 4
  - 4. Well Thickness 3/16"
  - 5. Configuration Circle
- d. FEDWA Inlet
  - 1. Plate thickness 3/16"
  - 2. Impingement Zones 4
- e. Skimmer and Scum Trough
  - 1. Number of skimmer arms One (1)
  - 2. Trough width 4'-0"
- 5. Clarifier Design – Drive Mechanism
  - a. Ball Race Diameter, inches 30
  - b. Torque Requirements
    - 1. AGMA Rated Torque, ft-lbs. 12,100
    - 2. Motor Shut-Off Torque, ft-lbs. 14,520
    - 3. Momentary Peak Torque, ft-lbs. 24,200
    - 4. Service Factor 1.25
  - c. Drive Output Speed, RPM 0.04

B. Clarifier Design - Materials

- 1. Drive housing: Cast iron
- 2. Non-Submerged steel: A36 carbon steel
- 3. Submerged steel: A36 carbon steel
- 4. Grating: Aluminum grating
- 5. Handrails: Aluminum
- 6. Anchor bolts and hardware: Type 316 stainless steel.

C. Structural Members

- 1. Structural steel shall conform to the references listed in Part 1.01-D.
- 2. Structural steel components shall have minimum thickness of 1/4" unless otherwise specified.
- 3. Sharp corners of cut or sheared edges will be dulled with one pass of a power grinder to create a smooth edge.
- 4. All welding shall conform to American Welding Society Standard AWS D1.1. Structural support members shall be shop welded for bolted field assembly. Field welding shall be minimal.



5. Design components so that stresses developed do not exceed allowable stresses, as defined by current AISC standards when designed for the AGMA rated torque.
6. Panel lengths and member sizes shall be selected such that slenderness ratios do not exceed 200 for compression and 240 for tension. For strength, the controlling member force shall be used to determine member size.
7. Maximum deflection in a span under combined live and dead loads shall not exceed  $L/360$ .

#### D. Drive Mechanism

##### 1. General

- a. Drive mechanism consisting of primary helical gear reduction, intermediate worm gear reduction unit and enclosed final reduction unit consisting of internal spur gear and pinion in a turntable base is to be completely assembled and finish painted in the Manufacturer's shop.
- b. All gearing shall be enclosed in gray cast iron ASTM A-48 Class 40B housings. Fabricated steel housings, exposed gearing and submerged bearings will not be acceptable.
- c. The drive shall be designed to allow removal and replacement of internal gear, balls and strip liners without raising the walkway.
- d. All components of the drive mechanism shall be designed in accordance with AGMA Standard 6034-B92 "Practice for Enclosed Cylindrical Worm Gear Speed Reducers and Gearmotors", and Standard 2001-D04 "Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth"; for 24-hour continuous, uniform load duty and 20-year design gear life at the specified output speed. The AGMA rated torque of the drive shall be the lowest value computed for worm gear set, spur gear and pinion for strength and durability.
- e. Select conservative values for bending strength and pitting resistance life factors  $K_I$  and  $C_I$  based on a minimum of 420,000 cycles of the main gear. The drive AGMA torque rating shall be as specified above with a minimum 1.25 service factor.
- f. All bearings shall be designed for a minimum B-10 life of 200,000 hours.

##### 2. Primary Reduction Unit

- a. Provide commercially available helical gear reducer or gearmotor in a cast housing.
- b. All bearings shall be anti-friction type running in oil.
- c. Motor shall be totally enclosed, ball bearing type, of ample power for starting and continuously operating the drive mechanism without overloading.
- d. Motor to conform to NEMA standards and be suitable for operation on 460 volt, 3 phase, 60 Hertz current.

- e. Primary reduction unit shall drive the intermediate reduction through a chain and sprocket arrangement with #80L self-lubricating chain and non-corrosive OSHA approved removable chain guard.
  - f. Provide proper chain tension by an adjustable steel base mounted on the intermediate reduction unit.
3. Intermediate Reduction Unit
- a. Provide worm gear speed reduction with grease and oil lubricated anti-friction type bearings in cast iron housing securely bolted on the machined top face of the final reduction unit. Worm and shaft shall be a two-piece assembly for ease of maintenance. Cycloidal and planetary gearing will not be acceptable.
  - b. Align and maintain accurate centers with the final reduction gearing. Swivel base mounting of the intermediate unit will not be acceptable.
  - c. Mount an electro-mechanical overload device on the thrust end of the worm shaft consisting of plate spring assembly, plunger, indicator dial two (2) micro-switches (one N.O. and one N.C.) and a terminal block, all enclosed in a weather tight, gray cast iron housing. Amperage metering devices will not be considered equal to the overload device specified.
  - d. Micro-switches shall be factory set to: (1) sound an alarm when the load on the mechanism reaches 100% of the AGMA torque; and (2) stop the motor when the load reaches 120% of the AGMA torque.
  - e. Provide a shear pin device mounted on the drive end of the worm shaft.
4. Final Reduction
- a. Provide internal, full depth involute tooth design, ductile iron spur gear driven by a heat treated steel pinion from the slow speed shaft of the intermediate reduction unit. Stub tooth design will not be acceptable.
  - b. Provide bearings at top and bottom of pinion to ensure complete tooth contact between mating surfaces. Pinion and pinion shaft shall be furnished as a two-piece assembly for ease of maintenance.
  - c. Provide cast iron turntable base with annular raceway to contain balls upon which the internal gear rotates. The ball race shall ensure low unit ball load, long life and stability without the use of submerged guide shoes, bumpers or steady bearings.
  - d. Provide four (4) 3/8" thick x 3/4" wide renewable special hardened (38-42 Rockwell C) steel liner strips force fitted (pins and cap screws not permitted) into the turntable base and internal gear for balls to bear on vertically and horizontally.
  - e. Provide an internal gear of split design with precision mating surfaces for ease of removal of gear, balls and liner strips without raising bridge. Drives without this feature are not acceptable.

- f. Internal gear, pinion and balls to run in an oil bath and be protected by a felt seal and vertical neoprene dust shield.
- g. Provide oil filling and level pipe along with a drain plug and sight gauge.
- h. Turntable base shall be bolted to the center column and be designed to support the bridge, internal gear and rotating mechanism.

E. FEDWA Flocculation Baffles

- 1. Provide inlet baffles to promote effective mixing and tapered flocculation.
- 2. Flow shall impinge three (3) overlapping vertical target baffles in succession with a series of four (4) impingement zones.
- 3. Design to provide a "Gt" (t in seconds) value in the well not exceeding 6,000 with a velocity gradient "G" within the well of at least 35 fps/ft and not exceeding 60 fps/ft at a minimum water temperature of 10 degrees-C at peak influent flow.
- 4. Provide horizontal shelf baffles to prevent downward movement in flocculation zone.
- 5. Baffles shall bolt to center cage and well support beams.
- 6. The baffles to be fabricated from minimum 3/16" thick A36 carbon steel plate.
- 7. Hydraulic calculations shall be provided showing dimensional characteristics, port area, velocity, headloss, and mixing intensity.
- 8. LA EDI system shall be the only acceptable alternative to the FEDWA design.

F. Flocculation Feedwell

- 1. The flocculation feedwell fabricated from 3/16" steel plate sections supported from the drive cage or bridge extensions.
- 2. Incorporate steel stiffeners at the top and bottom to maintain shape and rigidity.
- 3. Feedwell shall be of adequate size to diffuse the flow into the tank at a uniform flow through velocity.
- 4. Ports shall be cut into the flocculation feedwell to permit entrapped scum to escape.
- 5. Ports shall be baffled to prevent short circuiting to the weirs.
- 6. For the diameter of the proposed flocculation feedwell, straight segmented pieces are not allowed.

G. Center Pier

- 1. A cylindrical 3/8" thick steel plate center pier shall support the drive, collector mechanism and access bridge.
- 2. Top of pier to have a drive mounting plate set plumb with the centerline.

3. Drive to be positioned, leveled and grouted in place on top of pier with a non-shrink grout.
4. Manufacturer to provide minimum eight (8) 1" diameter anchor bolts and steel template/grout shield to accurately locate anchors.
5. Center pier shall serve as the influent pipe.
6. Center pier shall have a minimum of three (3) overflow areas at its upper end to diffuse flow into the flocculation feedwell at a velocity not to exceed 1.75 fps at maximum design mixed liquor flow.

#### H. Sludge Collection Header

- a. The header(s) shall be parallel to the tank floor and have a series of inlet orifices such that the entire tank bottom is swept clean in a single revolution.
- b. The header shall be designed to uniformly remove sludge in proportion to the area swept with the removal of a larger volume of sludge at greater distances from the tank center.
- c. Sludge shall be transported through the header to the center manifold, with removal being accomplished by hydrostatic pressure.
- d. Provide a fully tapered, rectangular-shaped Unitube header varying in cross section from a maximum near the tank center to a minimum at the outer wall.
- e. Fabricate header from 1/4" thick steel plate.
- f. Provide steel plate counterweights not exceeding 50# each as necessary for proper equipment balance. Field welding of galvanized header or supports will not be allowed.
- g. Longitudinal cross-sectional axis to be mounted at an angle of 45 degrees to tank bottom to trap sludge.
- h. Provide a 2" fluidizing vane as an integral part of header. Attach neoprene squeegee to fluidizing vane provided with 1" vertical adjustment.
- i. Manufacturer to size and space header inlet orifices at regular intervals not exceeding 30".
- j. Orifice design to be proportionate to the volume of sludge withdrawn from the entire tank floor at all flows.
- k. Provide header flange with silicone seal for bolted connection to center manifold. Tie bar shall provide header support.
- l. Alternate Manufacturers shall submit header verification field data in accordance with the Substitute Equipment Section of this specification.

- m. Sludge withdrawal by means of individual riser pipes or stepped header construction will not be acceptable.

I. Center Cage, Truss Arm and Manifold

- 1. Center cage to be of an all-welded box truss construction made up of structural steel members having a minimum thickness of 1/4"
- 2. Truss arm(s) shall be furnished with a triangular three-point contact design for ease of installation and alignment. Truss shall be constructed with 1/4" minimum thick members. Truss shall be pinned at the base for vertical adjustment and connected to the center cage through strut and adjustable clevis assembly. Tie-rod and turnbuckle designs that do not provide lateral support will not be acceptable.
- 3. Provide a cylindrical manifold with two (2) seals for bolted connection to the sludge collection header and bottom of cage. A bottom seal plate shall be furnished by the equipment Manufacturer securely anchored to the floor and grouted in place after final adjustment.

J. Surface Skimmer

- 1. Provide One (1) skimmer assembly consisting of scum blade and hinged wiper assembly.
  - a. The scum blade shall span the full length between the flocculation feedwell and scum trough. Scum blade shall have a height of 5-in rigidly attached to vertical pipe supports and structural A-frame. The A-frame shall be bolted to the truss arm at maximum of 15' spacing.
  - b. Mount a hinged wiper assembly on the end of the scum blade to form a pocket for trapping scum. The wiper assembly shall maintain continual contact and proper alignment between scum blade, outer scum baffle and scum trough. The wiper blade shall have a wearing strip on its outer end which contacts the scum baffle and neoprene strip on its inner and lower edges which contact the scum trough.
  - c. All springs, pivot points and threaded fasteners shall be constructed of 302 stainless steel. The hinged wiper assembly shall be hot dipped galvanized. The wiper blade shall be neoprene with Durometer range 50-60. The wiper assembly shall be the same dimension of the scum trough.
  - d. Provide a manual lockout mechanism on hinged skimmer assembly to allow for flexible independent operation for surface ice. Lockout mechanism shall raise hinged skimmer assembly above water surface without removal.
- 2. Provide one (1) scum trough 4'-0" wide with inclined beach of 1/4" thick plate, supported from the tank wall.
  - a. Scum trough shall have an overall length of 4'-9" along the scum baffle consisting of beach plate, inner radius baffle, hopper and 6" discharge pipe. Manufacturer shall provide a loose plate flange for contractor to field weld and connect to scum drain piping.

- b. Beach plate to slope at a nominal incline of 1-3/4" per foot to a point 5" below the maximum water elevation. The trough shall be provided with a submerged shelf extension spanning an additional 4'-0" along the scum baffle. An inner radius baffle extending 9" below and 3" above maximum water level shall run from the trough to the end of the submerged shelf.
3. Provide a counterweighted flushing device actuated by the main tank skimmer arm. Actuator arm shall pivot on a 3/4" minimum diameter stainless steel pin riding in an oil impregnated sintered bronze bushing. The actuator arm shall be counterweighted by steel plates to assure positive valve closure. The flapper valve shall be held open to allow 15 to 20 gallons of flushing water per trip.

K. Access Bridge

1. Provide a bridge of wide flange beam construction extending from the tank wall to the stationary drive base.
2. Provide a bridge extension to provide access to the far-side of the drive mechanism.
3. Bridge to be designed for the dead load and a live load of 50#/sq. ft., with a deflection not exceeding L/360 of the span.
4. Provide a 3' wide walkway of 1-1/4" x 3/16" aluminum grating extending over the entire bridge length.
5. Provide a 2-rail handrail consisting of 1-1/2" diameter, Sch. 40 mechanically fastened Aluminum pipe for rails and Sch. 80 posts. Post spacing not to exceed 5'. Omit handrail only where truss bridge members at 21" and 42" above the walkway provide the same function.
6. Provide a 4" high aluminum toe plate along both sides of bridge and bridge extension.
7. Provide a minimum 8'-0" x 10'-0", rectangular platform to provide a 2' working clearance around the drive.

L. Effluent Weirs and Scum Baffles *(to be provided by Installing Contractor)*

1. Fabricate weirs from 3/16" thick x 9" FRP.
2. Weir shall have 90 degree, 2.5 inch deep "V" notches spaced 6" on centers.
3. Fabricate scum baffle from 1/4" thick x 12" FRP.

M. Anchor Bolts

1. All equipment anchor bolts shall be Type 316 stainless steel.
2. Equipment Manufacturer shall furnish steel template and grout shield to accurately locate center pier anchors and allow for grouting beneath the pier and manifold seal plate after final plumbing.

2.03 SURFACE PREPARATION AND FINISHING

- A. The center drive mechanism shall be shipped, assembled and finish painted with manufacturer's standard paint system.
- B. Fabricate header from 1/4" thick steel plate hot-dip galvanized after fabrication per ASTM-A123.
- C. Submerged components will be prepared by blasting to SSPC-SP10 and prime painted with one (1) shop coat. Finish coats are to be applied in the field by the Contractor.
- D. Non-submerged components will be prepared by blasting to SSPC-SP10 and prime painted with one (1) shop coat. Finish coats are to be applied in the field by the Contractor.
- E. Galvanized and stainless-steel components will be shipped unpainted.

2.04 CONTROL PANEL

- A. Clarifier supplier shall provide a control panel as shown on the drawings.
- B. The enclosure shall be NEMA Type 3R and shall be fabricated from 14 gauge S.S. The weatherproof, rain tight enclosure shall be designed for mounting in an unprotected outdoor location. It shall have a gasketed, hinged, front weather door with a locking hasp in addition to latches.
- C. The enclosure shall be equipped with fans, vents, heaters, and other equipment to maintain normal operating temperatures and humidity conditions for all interior equipment.
- D. The panel shall be equipped with a motor starter, control transformer with transformer primary circuit breaker, auxiliary power circuit breaker, and 15-amp convenience receptacle.

PART 3 TESTING

3.01 CLARIFIER START-UP

- A. A start-up inspection and test shall be performed on each clarifier to verify proper installation, alignment and operation.
- B. Testing shall include the following:
  - 1. Drive
    - a. Alignment and Installation
      - 1. Check alignment of the drive and driven sprockets
      - 2. Check chain for proper tension

3. Ensure proper fit of chain guard
4. Measure the stop block clearance and lower drive housing
5. Review and confirm the correct motor, gear reducer, and drive chain have been installed on the clarifier drive per the defined mechanism design
6. Confirm installation of the proper shear pin
7. Bump motor to confirm correct rotation
- b. Lubrication
  1. Check the drive mechanism for the correct lubrication levels
  2. Service all lubrication points and grease fittings
  3. Check the air vents in the gear reducers
- c. Micro-switches
  1. The torque protection micro-switches must be connected per the diagram on the drive drawing.
  2. The shut-down switch must be connected: a manual reset must be wired in the circuit when the motor shut-off switch is activated.
  3. Set alarm and motor shut-off torque overload gap per the drive drawing
2. Clarifier Mechanism
  - a. Installation
    1. Confirm proper installation of all field bolt material
    2. Check the bridge and platform for proper level installation
    3. Ensure proper spacing has been installed on the bridge expansion end to allow for sufficient room to expand and contract
    4. Run the mechanism and check the horizontal plane at four points on the wall (90 deg. apart) for tanks up to 80' in diameter, eight points (45 deg. Apart) for large tanks. Always recheck starting point.
    5. Check manifold runs concentric to center pier
    6. Check the slope of the header at fluidizing blade
    7. Confirm that the upper and lower manifold seals are installed properly
    8. Check the elevation and scum beach level relative to the max water surface
    9. Perform alignment check of the header and truss arms
    10. Proper tracking and alignment of skimmer assembly with water elevation and scum



trough

PART 4 EXECUTION

4.01 INSTALLATION AND FIELD SERVICE REQUIREMENTS

- A. The Contractor shall install the clarifier as shown on the drawings.
- B. Equipment shall be installed in accordance with GENERAL MECHANICAL REQUIREMENTS and in accordance with the Manufacturer's recommendations to provide a complete installation.
- C. The Contractor shall complete the following:
  - 1. Plumb and grout the center pier
  - 2. Add grout beneath the manifold seal ring and adjust for horizontal plane
  - 3. Grout the floor in accordance with the Manufacturer's recommendations
  - 4. Add grout between the center pier and drive unit
- D. Operating Instructions and/or Operator Training
  - 1. Manufacturer to provide two (2) trips and three (3) days total of on-site field service.
  - 2. One day shall be dedicated to a pre-grout inspection. After installation, a post-grout inspection shall be conducted followed by a general training seminar.
  - 3. An additional one (1) not less than one-half day shall be provided for operation assistance of the equipment supplied.



SECTION 44-4223  
CLARIFIER REHABILITATION

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes, but is not necessarily limited to, the rehabilitation of an existing 40-ft diameter Tow-Bro clarifier as indicated on the Drawings, herein specified, and as necessary for the proper and complete performance of this Work.
- B. Major Items of Work:
  - 1. Dewater, remove trash and debris, and pressure wash interior clarifier walls and all clarifier equipment.
  - 2. Blast all metallic components of the existing clarifier (SP10 – Near White Metal Blast)
  - 3. Recoat all existing ferrous metal components
  - 4. Install new sludge manifold seal
  - 5. Install new clarifier launder covers and stainless steel hardware
- C. Related Sections:
  - 1. Documents affecting work of this Section include, but are not necessarily limited to:
    - a. General Conditions, Supplementary Conditions and Section in Division 9 of these Specifications.

PART 2 – PRODUCTS

REFER TO DIVISION 9 FOR PAINT PRODUCTS AND A PAINTING SCHEDULE.

PART 3 – EXECUTION

3.1 FINAL CLARIFIER REHABILITATION:

- A. Remove the aluminum grating on the bridge
- B. Pressure wash all clarifier walls, floor, and equipment
- C. Sandblast and Surface Prep all ferrous metal
- D. Replace the scum skimmer squeegee with an OEM kit from EVOQUA.
- E. Replace the sludge squeegees at each fluidizing vane on the uni-tube sludge header with an OEM kit from EVOQUA
- F. Replace the upper and lower manifold seals and T-bolt clamps with OEM kits from EVOQUA
- G. The Clarifier drive housing must be prepared for painting by hand or other suitable mechanical means only. The exterior of the drive housing shall be painted by hand only. The Contractor shall be responsible for any internal or external damage or contamination of the drive components resulting from the surface prep and recoating of the clarifier mechanism. The Contractor shall use every precaution to prevent contamination of the drive housing and internal components from paint related materials, construction related materials, dust, and debris, throughout the project.
- H. Install new launder covers.

3.2 MANUFACTURER'S SERVICES:

A. General:

Provide a minimum of one (1) trip and one (1) days to the Site by a factory-trained Manufacturer's Service Technician. The technician shall inspect the cleaned (drained, sludge & trash removed, and pressure washed) clarifier and compile a list of items needing repair or service that are not a part of this contract. The Owner will be responsible for performing the additional work and must be given a minimum of 2 months to perform the work. If more than 2 months is required and results in delaying the work of this contract, the additional time (above 2 months) will be added to the contract time of this contract.

END OF SECTION

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SECTION 44-4225  
FRP CLARIFIER EQUIPMENT

PART 1 GENERAL

1.1. SUBMITTALS

A. Shop Drawings

- i. Manufacturer's catalog information, descriptive literature, specifications and identification of materials of construction, including resins and glass fiber content and layout for FRP constructions.
- ii. Detailed drawings showing equipment fabrication, dimensions, method of attachment including number, locations and size of fasteners and weights of fabrications.
- iii. Manufacturer's recommended Cover dimensions, mounting configuration and location for each application.

B. Quality Control Submittals

- i. Manufacturer's Certificate of Compliance.
- ii. Special shipping, storage and protection and handling instructions.
- iii. Manufacturer's written/printed installation instructions.
- iv. Must be manufactured in the U.S.A.
- v. A list of ten installations of comparable size in operation for at least ten years.
- vi. Certify that the cover meets local building code specifications for wind load, including uplift and deflection.
- vii. Certified test reports of the physical and mechanical properties of the product. Each panel shall have the following minimum physical properties:

<u>Property</u>	<u>Test</u>	<u>Value</u>
Tensile Strength	ASTM D-638	18,900 psi
Flexural Strength	ASTM D-790	24,200 psi
Flexural Modulus	ASTM D-790	1.07 x 10 <sup>6</sup> psi
Barcol Hardness	ASTM D-2853	45
Notched Izod	ASTM D-256	10 ft-lbs/in
Water Absorption	ASTM D-570	0.1%

1.2. WARRANTY

- A. Manufacturer shall expressly warrant the weirs, baffles, and Launder Cover System to be free of defects in materials and workmanship for a period of one year from the date of installation, exclusive of misuse, negligence or accident on the part of the installation contractors or owner.

1.3. COORDINATION

- A. Manufacturer shall coordinate the equipment design and installation requirements with the clarifier mechanism, scum box and launder effluent channel configurations.

## PART 2 PRODUCTS

### 2.1. MANUFACTURERS

- A. Materials, equipment and components in this section shall be the products of:

NEFCO, Incorporated, represented by Environmental Technical Sales, Inc. (ETEC):

Chad B. Cooley, P.E.  
Environmental Technical Sales, Inc.  
900 S. Shackelford, Suite 300  
Little Rock, AR 72211  
Phone: (501) 978-1025 Fax: (501) 978-1026  
Cell: (501) 690-3721  
E-mail: [ccooley@etec-sales.com](mailto:ccooley@etec-sales.com)

### 2.2. DESIGN OF LAUNDRER COVERS

- A. The Launder Cover shall consist of a system of molded fiberglass panels that are attached together to form a continuous cover over the launder trough, weir and scum baffle within the treatment tank. The Cover shall be designed and manufactured to inhibit incident sunlight from striking the surfaces of the launder and weir. Each Cover section shall be molded of UV-protected fiberglass and shall be opaque to sunlight. Individual sections shall be a minimum of four feet in length and curved to follow the curvature of the tank. The Cover shall extend over the trough and weir as far as possible and may extend to a point immediately inside the scum baffle so long as the Cover does not interfere with the sweep arm. The Cover shall be designed such that adjacent panels fit together properly and the completed Cover, when installed, forms a rigid structure and has a well-engineered and professional appearance.
- B. Provision shall be made to support the Cover in such a manner that the panels are held securely in place, with the panels hinged to provide access to the launder and weir for inspection and maintenance. Neither the Cover nor the means used to support it shall interfere with effluent flow over the weir or within the trough. Cover supports shall not impede personnel from entering and traversing the launder. Cover supports that cantilever from the outer effluent launder wall without support at the weir wall are unacceptable.
- C. Launder cover panels shall have a curved or arched shape over the width of the launder trough with sufficient radius to strengthen the panel and minimize possible deflections against snow loads.
- D. The Cover shall be designed to open away from the operator and toward the center of the tank. Each Cover segment shall consist of a fixed Mounting Section and two (2) Cover Sections, each connected to the Mounting Section by a continuous stainless steel hinge. The Mounting Section shall provide a rigid mount for the Cover Sections and ensure the proper fixed spacing between them.
- i. If the Cover opens toward the center of the tank, the Mounting Section is fastened to the weir wall with stainless steel brackets, and extends inward to a point just inboard the scum baffle. The hinged Cover Sections extend outward toward the outer launder wall and swing open to allow inspection and maintenance of the launder and weir. The hinge point of the Cover is

strategically positioned to maximize visibility of the launder and weir when the Cover is open. In the closed position, the Cover Sections rest on an FRP support flange attached to the outer launder wall.

- E. The hinged Cover sections shall be designed to allow alternate panels to open independent of every-other panel. Alternate panels have an integral tab at both sides that rests on the adjacent panel and covers the seams between panels. The panels adjacent to a middle panel must be opened before the middle panel opens.
- F. Provision shall be made to secure the Cover in the closed position for safety and security. This is accomplished by means of an easily operated, spring-loaded latch mechanism that secures the hinged Cover Sections. A means of limiting the travel of the hinged Cover sections, in the form of a restraint cable or tether, shall also be provided to protect against damage. Covers with inspection hatches or cleanout doors are unacceptable.
- G. Where the circumference of the trough is interrupted by a bridge-support or another obstacle, a fixed panel(s) shall be installed over the trough beneath the support such that the surface of the Cover is continuous around the entire tank. Alternatively, vertical panels may be installed on both sides of the bridge supports to block out sunlight.
- H. The Cover system shall be designed to withstand common wind and snow loads but the entire Cover shall not be intended as a "walk-on" Cover designed to support the weight of plant personnel. Adequate stiffeners shall be integral to each panel, but panels reinforced with balsa or foam cores are not acceptable except where a single or double length reinforced walk-on section is used for safe entry to the launder.

### 2.3. DESIGN OF WEIRS AND SCUM BAFFLES

- A. All FRP weirs and scum baffles shall be manufactured of FRP plate
  - 1. Fabricate weirs from 3/16" thick x 9" FRP.
  - 2. Weir shall have 90 degree, 2.5 inch deep "V" notches spaced 6" on centers.
  - 3. Fabricate scum baffle from 1/4" thick x 12" FRP.
  - 4. Aqua Color shall be molded in with UV inhibitor.

### 2.4. MATERIALS

- A. All FRP equipment shall be molded of fiberglass, reinforced plastics. The resins and fiberglass reinforcing materials shall be consistent with the environmental conditions and structural requirements of the application.
- B. The resin shall be an industrial quality, isophthalic polyester resin with UV suppression additives, Corezyn COR75-AQ-010, or equivalent. The resin shall be pigmented to ensure that the resulting part is opaque. The glass reinforcement shall be chopped strand roving, 357-211 PLN CTC, or equivalent, with a minimum 1/2-inch strand length. Additional reinforcement in the form of stiffening ribs shall be added when necessary. The glass content of the finished laminate shall be not less than 30% by weight. The nominal thickness of each panel shall be 1/4 inch. The laminate

shall consist of a 20 mil outer layer of marine quality white gelcoat, followed by chopped strand roving. The laminations shall be dense and free of voids, dry spots, cracks or crazes. All factory-trimmed edges shall be sanded and sealed. The finished laminate shall have a smooth, even appearance.

- C. All fasteners, handles, hinge and latches shall be stainless steel. The weir wall mounting brackets shall be stainless steel. The latch/handle shall be a spring-loaded mechanism with a positive detent positioned to indicate the closed/locked position of the handle. The latch is activated by pressing down on the spring-loaded handle and turning it. The magnetic latch is disengaged by pulling upward on the cover, ring or other fixture with sufficient force to overcome the force of the magnet.
- D. The tether or restraint cable shall consist of a length of stainless steel cable secured to the tank wall and the hinged Cover Section by means of stainless steel eyebolts. The length of the cable is selected to limit the travel of the Cover.

## PART 3 EXECUTION

### 3.1. INSTALLATION

- A. The Cover sections shall be mounted to the weir wall on stainless steel brackets. The free end of each Cover panel shall be supported at the outer tank wall by an FRP support flange that attaches to the entire periphery of the tank.
- B. The weir and scum baffle shall be mounted to the inside of the weir wall as shown on the drawings using stainless steel brackets and mounting hardware.
- C. The installation contractor shall install the FRP equipment in accordance with the contract drawings, manufacturing drawings and manufacturer's recommendations. Field cutting of panels shall be allowed to complete the structure and accommodate in-tank obstructions. All cut ends shall be dressed as per the manufacturer's recommendations.
- D. All of the fasteners and brackets required for the installation shall be Stainless Steel and shall be supplied by the FRP equipment manufacturer. The support flange and weir wall brackets are installed using 3/8" x 3-3/4" expansion anchors with flat washers, lock washers and hex nuts.

END OF SECTION



SECTION 44-4230  
FRP DENSITY CURRENT BAFFLES

PART 1 GENERAL

1.1. SUBMITTALS

A. Shop Drawings

- i. Manufacturer's catalog information, descriptive literature, specifications and identification of materials of construction, including resins and glass fiber content and layout for FRP constructions.
- ii. Detailed drawings showing equipment fabrication, dimensions, method of attachment including number, locations and size of fasteners and weights of fabrications.
- iii. Manufacturer's recommended baffle dimensions, deflection angle and location for each application.

B. Quality Control Submittals

- i. Manufacturer's Certificate of Compliance.
- ii. Special shipping, storage and protection and handling instructions.
- iii. Manufacturer's written/printed installation instructions.
- iv. A list of five installations of comparable size in operation for at least three years.
- v. Certified test reports of the physical and mechanical properties of the product. Each panel shall have the following minimum physical properties:

<u>Property</u>	<u>Test</u>	<u>Minimum Value</u>
Tensile Strength	ASTM D-638	10,000 psi
Flexural Strength	ASTM D-790	16,000 psi
Flexural Modulus	ASTM D-790	1.0 x 10 <sup>6</sup> psi
Barcol Hardness	ASTM D-2853	40
Notched Izod	ASTM D-256	12 ft-lbs/in
Water Absorption	ASTM D-570	0.2%

1.2. WARRANTY

- A. Manufacturer shall warrant the Density Current Baffle to be free of defects in materials and workmanship for a period of five years after the date of Substantial Completion.

1.3. COORDINATION

- A. Manufacturer shall coordinate the Stamford Density Current Baffle design and installation requirements with the clarifier mechanism, scum box and launder effluent channel configurations.

## PART 2 PRODUCTS

### 2.1. MANUFACTURERS

Materials, equipment and components in this section shall be the products of: NEFCO, Incorporated, represented by Environmental Technical Sales, Inc. (ETEC):

Chad B. Cooley, P.E.  
Environmental Technical Sales, Inc.  
900 S. Shackelford, Suite 300  
Little Rock, AR 72211  
Phone: (501) 978-1025 Fax: (501) 978-1026  
Cell: (501) 690-3721  
E-mail: [ccooley@etec-sales.com](mailto:ccooley@etec-sales.com)

### 2.2. DESIGN

A. The Stamford Density Current Baffle shall consist of a series of baffle panels that are attached to the wall of the clarifier to form an inclined, shelf-like surface around the entire inner periphery of the tank. Each panel shall be molded of corrosion-resistant, UV- treated fiberglass. The panel shall be a maximum of 8 feet in length and shall be curved to follow the curvature of the clarifier tank. The width, inclination angle and mounting location of the baffle shall be determined based upon the clarifier configuration in order to provide optimum baffle performance. The panels shall be designed such that adjacent panels fit together without overlapping or cutting, and the completed baffle when installed, has a well-engineered and professional appearance.

B. The inclination angle of the baffle shall be 30 degrees as measured from the horizontal and the horizontal projection of the baffle shall be defined by the following equation:

$$\text{Horizontal Projection (Inches)} = 18 \text{ inches} + 0.3 \text{ in/ft} \times (\text{tank diameter (ft)} - 30)$$

Suppliers offering alternate configurations must provide CFD modeling results showing that the proposed alternate equals the performance of the specified configuration.

C. Provision shall be made to attach the panels to the clarifier wall and support them at the proper angle using a triangular panel bracket. The panel and bracket shall be molded as an integral part of each panel, forming a baffle module, or separate panels and brackets may be supplied. If the panel and bracket are molded as an integral unit with adequate stiffeners, only one bracket is required per panel. A specially formed "free-end" bracket shall be provided to support the free end of the last panel where the run of panels is interrupted by an obstruction. Panels may be cut as required to fit around obstructions.

D. If separate panels and brackets are supplied, the panels shall be molded of fiberglass and shall meet the specifications of this section. The brackets shall be fabricated of 3" x 3" x 1/4" stainless steel angle and shall be triangular in shape, with the corners welded. Brackets shall be installed at a maximum spacing of four (4) feet. The panels shall be fastened to the brackets with stainless steel nuts, bolts and lock washers every 8 inches.

E. Mount the baffle directly to the tank wall at least two feet above the top of the sludge blanket.

- F. A method of interconnecting adjacent panels shall be provided such that the entire assembly forms a rigid structure capable of supporting its own weight plus snow and wind loads in the event the tank is out of service. The baffle shall also be designed to withstand a buoyant force load equal to the weight of the water displaced from the volume beneath the baffle. The angled working surface of each baffle shall be sufficient in pitch and width to divert the flow and to create a self-cleaning action of the baffle itself.
- G. Provision shall also be made to vent gases that may form beneath the baffle through 3" diameter half-round openings molded into the panel at its highest point. The vents should aim radially towards the center of the tank, such that any bubbling and/or by-passing current is directed away from the weir, preventing short-circuiting. Specially in cases where the panels are to be launder-mounted, with the vents sitting directly below the weir and scum baffle.

### 2.3. MATERIALS

- A. Each baffle panel shall be molded of fiberglass-reinforced plastic. The resins and fiberglass reinforcing material shall be consistent with the environmental conditions and structural requirements.
- B. The resin shall be an isophthalic polyester resin with corrosion-resistant properties, Corezyn COR75-AQ-010 or equivalent, suitable for use in submerged waste treatment applications. The resin shall not contain fillers except as required for viscosity control. For viscosity control, a thixotropic agent up to 5% by weight may be added to the resin. The resin shall be treated to provide UV suppression.
- C. Glass reinforcement shall consist of chemically bonded surfacing mat and chopped strand roving. Surfacing mat shall be Type C veil. The glass reinforcement shall be 357-211 PLN CTC chopped strand roving or equivalent. The glass content of the finished laminate shall not be less than 30% by weight. The nominal thickness of each baffle panel shall be 1/4"  $\pm$  1/16 inch thick with resin rich surfaces and edges to prevent migration of moisture and fiber "blooming." The baffle shall be black in color.
- D. The upper surface of each panel shall be mold smooth and no glass fibers shall be exposed. Laminations shall be dense and free of voids, dry spots, cracks or crazes. The upper surface of the baffle shall be reinforced with one layer of surfacing veil followed by 2 ounces or more of chopped strand roving. In addition, the vertical mounting flange (return flange on launder mount applications) shall be reinforced with one layer of 24 oz woven roving.
- E. No other glass product is permitted between these layers. All factory-trimmed edges shall be "hot coated" with resin to prevent wicking.

## PART 3 EXECUTION

### 3.1. INSTALLATION

- A. The installation contractor shall field verify existing dimensions and install the baffle in accordance with the contract drawings, approved shop drawings and manufacturer's

recommendations. Mounting holes shall be factory drilled. Field cutting of baffle panels will be allowed to complete the structure and accommodate in-tank obstructions. All fieldcut or drilled edges shall be coated per the manufacturer's recommendations to prevent fiber blooming or fraying. All of the fasteners required for installation shall be supplied by the baffle manufacturer. The baffle panels shall be attached to the wall using 3/8" x 3-3/4" concrete expansion anchors with oversized 1/8" x 2-1/4" stainless steel washers, and hex nuts, Adjacent baffle panels are fastened together using 1/4" bolts, 2 flat washers, lock washer, and hex nut. All of the installation fasteners shall be stainless steel.

- B. The density current baffle shall extend completely around the tank and shall be level, rigid and free of sway that could work anchors loose or cause undue wear.

END OF SECTION

SECTION 44 4473  
ULTRAVIOLET DISINFECTION EQUIPMENT  
REPLACEMENT AND REHABILITATION

1.0 GENERAL

1.1 DESCRIPTION

A. Scope:

Furnish all labor, materials, equipment and appurtenances required to rehabilitate an existing, low pressure high intensity ultraviolet lamp (UV) disinfection system complete with an automatic mechanical/chemical cleaning system and variable output electronic ballasts. The UV system is to be complete and operational with all control equipment and accessories as shown and specified herein.

The equipment specified will be purchased from Trojan Technologies by the Contractor. The system to be installed by the Contractor and tested and commissioned by Trojan Technologies, as specified in this section.

1.2 SUBMITTALS

A. Submit for review, shop drawings showing the following:

1. Complete description in sufficient detail to permit an item comparison with the specification.
2. Dimensions and installation requirements.
3. Descriptive information including catalogue cuts and manufacturers' specifications for major components.
4. Electrical schematics and layouts.

1.4 GUARANTEE

A. Equipment:

The equipment furnished under this section will be free of defects in material and workmanship, including damages that may be incurred during shipping for a period of 12 months from date of start-up or 18 months after shipment, whichever comes first.

B. UV Lamps:

The UV lamps to be warranted for a minimum of 12,000 hours when operated in automatic mode, prorated after 9,000 hours. On/off cycles are limited to four (4) per day.

## 2.0 PRODUCTS

### 2.1 MANUFACTURER

- A. The existing system is a UV3000Plus™ System, as manufactured by Trojan Technologies, London, Ontario, Canada.

### 2.2 INSTALLATION AND MATERIALS

A. General:

1. Provide the services of a certified Trojan service technician onsite for a minimum of 8 hours in one trip. Service technician shall instruct laborers on the proper installation of the parts listed below. Service Technician shall also compile a list of any additional parts that should be considered for replacement but are not listed below as part of this contract.

B. Replacement Parts – Supply and Install

ITEM NUMBER	QUANTITY	DESCRIPTION
1	40	#794447-OYW - Lamps
2	40	#316135-078X Lamp Holders (Plugs)
3	36	#316136-004 - Sleeves
4	6	#327125-180PLGBOT - Wiper Canisters
5	6	#327125-180PLGTOP - Wiper Canisters
6	8	#327125-0255TDCYL -Wiper Canisters
7	8	#327125-180STDMID - Wiper Canisters
8	4	#327125-025STDCYL - Wiper Canisters
9	2	#327125-180PLGTOP - Wiper Canisters
10	4	#327125-180SNRMID - Wiper Canisters
11	2	#327125-180STDMID - Wiper Canisters
12	2	#327128-180PLGBOT - Wiper Canisters
13	6	#326411 Hydraulic Cylinder
14	2	#907632-04M066BL - Hydraulic Hoses sensor modules
15	2	#907632-04F145BL - Hydraulic Hoses sensor modules
16	4	#907632-04F071BK - Hydraulic Hose
17	4	#907632-04M150BK - Hydraulic Hose
18	2	#015229 - UV Sensors
19	1	#915851-070 - HMI
20	1	#915871-100 - HMI SD memory card
21	1	HMI Programming (CT129455)

- C. Training – Provide the services of a qualified Trojan representative to train the WWTP Operators on the proper use and maintenance of the Trojan equipment. The training shall include a minimum of 2 – 8-hour days onsite in 1 trip.

### 3.0 EXECUTION

#### 3.1 INSTALLATION

Install in accordance with contract drawings, manufacturers' shop drawings, instructions and installation checklist.

All labor, materials and test apparatus necessary for completing the installation shall be furnished by the Contractor at no additional cost to the Manufacturer.

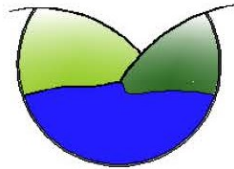
#### 3.2 PHASING

Only one bank shall be rehabilitated at a time with the other bank being left operable for wastewater effluent disinfection. For replacement of items requiring both banks to be inoperable and depowered, coordinate with the Owner to perform the work during low flow periods when effluent can be temporarily suspended.

MOUNTAIN VIEW  
WWTP IMPROVEMENTS

PROJECT #: 20-018

DESIGN CALCULATIONS



*CWB Engineers, Inc.*  
*-Designing a Better Arkansas-*



PROJECT NO. 20-018

MAY 2021



5-12-21



## Mt. View WWTP Final Clarifier Design Calculations

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### Existing Clarifier

Min. Flow            0.2 MGD  
Max. Flow            2.25 MGD

Design MLSS in Oxidation Ditch =        3,500.00 mg/L

Existing Clarifier Diameter =            55.00 ft  
Depth =                                        12.00 ft  
Volume =                                      213,254.45 gal  
Detention Time Min. =                    25.59 hours  
Detention Time Max. =                    2.27 hours

Min. SOR =                                  84.18 gpd/sf  
Max. SOR =                                  947.04 gpd/sf        10 SS requires < 1,000 gpd/sf for Extended Aeration

Min. SLR =                                  2.46 ppd/sf  
Max. SLR =                                  27.64 ppd/sf        10 SS requires < 35 ppd/sf for Extended Aeration

Min. WLR =                                  1,157.49 gpd/lf  
Max. WLR =                                  13,021.77 gpd/lf    10 SS requires < 20,000 for WWTP ADF < 1 MGD

### Proposed Clarifier

Min. Flow            0.2 MGD  
Max. Flow            1.25 MGD

Proposed Clarifier Diameter =            40.00 ft  
Depth =                                        12.00 ft  
Volume =                                      112,795.74 gal  
Detention Time Min. =                    13.54 hours  
Detention Time Max. =                    2.17 hours

Min. SOR =                                  159.15 gpd/sf  
Max. SOR =                                  994.72 gpd/sf        10 SS requires < 1,000 gpd/sf for Extended Aeration

Min. SLR =                                  4.65 ppd/sf  
Max. SLR =                                  29.04 ppd/sf        10 SS requires < 35 ppd/sf for Extended Aeration

Min. WLR =                                  1,591.55 gpd/lf  
Max. WLR =                                  9,947.18 gpd/lf    10 SS requires < 20,000 for WWTP ADF < 1 MGD

**Total Combined Max. Clarifier Capacity =        3.5 MGD**

Existing Effluent Box to Existing UV Channel

PIPE SIZE	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING VALVE	CHECK CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
0.5	0.22	9.2	1.48	0.08	-	0.49	0.81	0.43	0.43	0.54	1.62	2.7	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
0.75	0.2	8.5	1.38	0.08	-	0.45	0.75	0.4	0.4	0.5	1.5	2.5	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1	0.18	7.8	1.27	0.07	-	0.41	0.69	0.37	0.37	0.46	1.38	2.3	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.25	0.18	7.5	1.21	0.07	-	0.4	0.66	0.35	0.35	0.44	1.32	2.2	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.5	0.15	7.1	1.16	0.06	-	0.38	0.63	0.34	0.34	0.42	1.26	2.1	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2	0.15	6.5	1.05	0.06	0.86	0.34	0.57	0.3	0.3	0.38	1.14	1.9	2.3	2.3	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2.5	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
3	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
4	0.14	5.8	0.94	0.05	0.77	0.31	0.51	0.27	0.27	0.34	1.02	1.7	2	2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
6	0.12	5.1	0.83	0.05	0.68	0.27	0.45	0.24	0.24	0.3	0.9	1.5	1.8	1.8	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
8	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
10	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
12	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
14	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
16	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
18	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
20	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
24	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
30	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
36	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
42	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
48	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
QUANTITY	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING VALVE	CHECK CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
SUMMED K	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0.78	1	0	0	0	0	0	0

TOTAL K 2.4  
 DIAMETER: 14  
 C VALUE H 140  
 C VALUE L 100  
 LENGTH 110

Q GPM	Hh FEET	HLL FEET	V FPS	ML FEET	Total Loss
2431	1.115	0.598	5.067	0.957	2.072

UV WL = 602.5  
 Eff Box WL = 604.57  
 Top of Effluent Box = 605 0.52 ft. of freeboard @ 3.5 MGD flow

Existing Effluent Box to Proposed Final Clarifier

PIPE SIZE	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING VALVE	CHECK CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
0.5	0.22	9.2	1.48	0.08	-	0.49	0.81	0.43	0.43	0.54	1.62	2.7	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
0.75	0.2	8.5	1.38	0.08	-	0.45	0.75	0.4	0.4	0.5	1.5	2.5	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1	0.18	7.8	1.27	0.07	-	0.41	0.69	0.37	0.37	0.46	1.38	2.3	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.25	0.18	7.5	1.21	0.07	-	0.4	0.66	0.35	0.35	0.44	1.32	2.2	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.5	0.15	7.1	1.16	0.06	-	0.38	0.63	0.34	0.34	0.42	1.26	2.1	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2	0.15	6.5	1.05	0.06	0.86	0.34	0.57	0.3	0.3	0.38	1.14	1.9	2.3	2.3	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2.5	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
3	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
4	0.14	5.8	0.94	0.05	0.77	0.31	0.51	0.27	0.27	0.34	1.02	1.7	2	2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
6	0.12	5.1	0.83	0.05	0.68	0.27	0.45	0.24	0.24	0.3	0.9	1.5	1.8	1.8	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
8	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
10	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
12	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
14	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
16	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
18	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
20	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
24	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
30	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
36	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
42	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
48	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
QUANTITY	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING VALVE	CHECK CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
SUMMED K	0	0	0	0	0	0.23	0.39	0	0	0	0	0	0	0	3.12	4	0	0	0	0	0	0

TOTAL K 7.74  
 DIAMETER: 16  
 C VALUE H 140  
 C VALUE L 100  
 LENGTH 180

Q GPM	H <sub>L</sub> FEET	H <sub>LL</sub> FEET	V FPS	ML FEET	Total Loss
1042	0.199	0.107	1.663	0.332	0.531

Eff Box WL = 604.57  
 WL after FC weir = 605.10

Oxidation Ditch to Proposed Final Clarifier

PIPE SIZE	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	PIPE REDUCER D RATIO	REDUCER 0.8 D RATIO	REDUCER 0.5 D RATIO	REDUCER 0.2 D RATIO	ENLARGER 0.8 D RATIO	ENLARGER 0.5 D RATIO	ENLARGER 0.2 D RATIO
0.5	0.22	9.2	1.48	0.08	-	0.49	0.81	0.43	0.43	0.54	1.62	2.7	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
0.75	0.2	8.5	1.38	0.08	-	0.45	0.75	0.4	0.4	0.5	1.5	2.5	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
1	0.18	7.8	1.27	0.07	-	0.41	0.69	0.37	0.37	0.46	1.38	2.3	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
1.25	0.18	7.5	1.21	0.07	-	0.4	0.66	0.35	0.35	0.44	1.32	2.2	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
1.5	0.15	7.1	1.16	0.06	-	0.38	0.63	0.34	0.34	0.42	1.26	2.1	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
2	0.15	6.5	1.05	0.06	0.86	0.34	0.57	0.3	0.3	0.38	1.14	1.9	2.3	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
2.5	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
3	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
4	0.14	5.8	0.94	0.05	0.77	0.31	0.51	0.27	0.27	0.34	1.02	1.7	2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
6	0.12	5.1	0.83	0.05	0.68	0.27	0.45	0.24	0.24	0.3	0.9	1.5	1.8	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
8	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
10	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
12	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
14	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
16	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
18	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
20	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
24	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
30	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
36	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
42	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
48	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
QUANTITY SUMMED K	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0

TOTAL K 2.38

DIAMETER: 12  
 C VALUE H 140  
 C VALUE L 100  
 LENGTH 80

Q GPM	HLh FEET	HLl FEET	V FPS	ML FEET	Total Loss
1042	0.358	0.192	2.956	0.323	0.681

FC WL = 606.35  
 Weir 1 607.031121441411  
 WL in MLSS Splitter Box = 608.03 dist

Oxidation Ditch to Existing Final Clarifier

PIPE SIZE	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	PIPE REDUCER D RATIO	REDUCER 0.8 D RATIO	REDUCER 0.5 D RATIO	REDUCER 0.2 D RATIO	ENLARGER 0.8 D RATIO	ENLARGER 0.5 D RATIO	ENLARGER 0.2 D RATIO
0.5	0.22	9.2	1.48	0.08	-	0.49	0.81	0.43	0.43	0.54	1.62	2.7	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
0.75	0.2	8.5	1.38	0.08	-	0.45	0.75	0.4	0.4	0.5	1.5	2.5	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
1	0.18	7.8	1.27	0.07	-	0.41	0.69	0.37	0.37	0.46	1.38	2.3	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
1.25	0.18	7.5	1.21	0.07	-	0.4	0.66	0.35	0.35	0.44	1.32	2.2	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
1.5	0.15	7.1	1.16	0.06	-	0.38	0.63	0.34	0.34	0.42	1.26	2.1	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
2	0.15	6.5	1.05	0.06	0.86	0.34	0.57	0.3	0.3	0.38	1.14	1.9	2.3	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
2.5	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
3	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
4	0.14	5.8	0.94	0.05	0.77	0.31	0.51	0.27	0.27	0.34	1.02	1.7	2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
6	0.12	5.1	0.83	0.05	0.68	0.27	0.45	0.24	0.24	0.3	0.9	1.5	1.8	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
8	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
10	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
12	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
14	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
16	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
18	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
20	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
24	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
30	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
36	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
42	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
48	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13	
QUANTITY SUMMED K	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0

TOTAL K 2.17

DIAMETER: 14  
 C VALUE H 140  
 C VALUE L 100  
 LENGTH 55

Q GPM	HLH FEET	HL1 FEET	V FPS	ML FEET	Total Loss
1389	0.198	0.106	2.895	0.282	0.480
FC WL =			606.35		
Weir			1		606.830386542951
WL in MLSS Splitter Box =			607.83		

MLSB to Oxidation Ditch - Existing 16"

PIPE SIZE	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING VALVE	CHECK CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
0.5	0.22	9.2	1.48	0.08	-	0.49	0.81	0.43	0.43	0.54	1.62	2.7	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
0.75	0.2	8.5	1.38	0.08	-	0.45	0.75	0.4	0.4	0.5	1.5	2.5	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1	0.18	7.8	1.27	0.07	-	0.41	0.69	0.37	0.37	0.46	1.38	2.3	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.25	0.18	7.5	1.21	0.07	-	0.4	0.66	0.35	0.35	0.44	1.32	2.2	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.5	0.15	7.1	1.16	0.06	-	0.38	0.63	0.34	0.34	0.42	1.26	2.1	-	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2	0.15	6.5	1.05	0.06	0.86	0.34	0.57	0.3	0.3	0.38	1.14	1.9	2.3	2.3	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2.5	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
3	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
4	0.14	5.8	0.94	0.05	0.77	0.31	0.51	0.27	0.27	0.34	1.02	1.7	2	2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
6	0.12	5.1	0.83	0.05	0.68	0.27	0.45	0.24	0.24	0.3	0.9	1.5	1.8	1.8	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
8	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
10	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
12	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
14	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
16	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
18	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
20	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
24	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
30	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
36	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
42	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
48	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
QUANTITY	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING VALVE	CHECK CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
SUMMED K	0	0	0	0	0	0.23	0.39	0	0	0	0	0	0	0	0.78	1	0	0	0	0	0	0

TOTAL K 2.4  
 DIAMETER: 16  
 C VALUE H 140  
 C VALUE L 100  
 LENGTH 100

Q GPM	HLH FEET	HLL FEET	V FPS	ML FEET	Total Loss
2431	0.529	0.284	3.879	0.561	1.090

MLSB WL = 608.03  
 Ox Ditch Eff WL = 609.12

Scum Pump Discharge

PIPE SIZE	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
0.5	0.22	9.2	1.48	0.08	-	0.49	0.81	0.43	0.43	0.54	1.62	2.7	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
0.75	0.2	8.5	1.38	0.08	-	0.45	0.75	0.4	0.4	0.5	1.5	2.5	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1	0.18	7.8	1.27	0.07	-	0.41	0.69	0.37	0.37	0.46	1.38	2.3	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.25	0.18	7.5	1.21	0.07	-	0.4	0.66	0.35	0.35	0.44	1.32	2.2	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.5	0.15	7.1	1.16	0.06	-	0.38	0.63	0.34	0.34	0.42	1.26	2.1	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2	0.15	6.5	1.05	0.06	0.86	0.34	0.57	0.3	0.3	0.38	1.14	1.9	2.3	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2.5	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
3	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
4	0.14	5.8	0.94	0.05	0.77	0.31	0.51	0.27	0.27	0.34	1.02	1.7	2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
6	0.12	5.1	0.83	0.05	0.68	0.27	0.45	0.24	0.24	0.3	0.9	1.5	1.8	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
8	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
10	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
12	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
14	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
16	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
18	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
20	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
24	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
30	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
36	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
42	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
48	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13

QUANTITY	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
SUMMED K	0	0	0	0	0	0	4	4	0	0	0	0	0	1	1	0	0	0	0	0	0
	0	0	0	0	0	0	2.16	1.16	0	0	0	0	0	0.78	1	0	0	0	0	0	0

TOTAL K 5.1  
 DIAMETER 3  
 C VALUE H 140  
 C VALUE L 100  
 LENGTH 300

Q GPM	Hh FEET	Hl FEET	V FPS	ML FEET	Total Loss
50	4.144	2.224	2.270	0.408	4.552

Digester HWL = 630  
 Digester LWL = 620  
 Scum Beach HWL = 611  
 Scum Beach LWL = 609  
 LOW TDH = 11.63 ft  
 HIGH TDH = 23.63 ft

**Mt. View Existing Oxidation Ditch**

Flow 0.95 MGD  
BOD 200.00 mg/L  
TSS 200.00 mg/L  
TP 6.00 mg/L  
NH3 30.00 mg/L  
TKN 40.00 mg/L

Total Basin Volume 430,705.00 gal

Mass Load

BOD 1,584.60 ppd  
Organic Loading 27.52 ppd/mcf  
Hyd. Detention Time 10.88 hr

10 S.S. REQUIRES < 40 FOR CONVENTIONAL AERATION, SRT < 15 DAYS

Ynet 0.90  
Design MLSS 3,500.00 mg/L

SRT @ design flow 8.82 days

Washout SRT @ 10°C 4.30 days  
SF @0.95 MGD 2.05

from WERF Publication: Methods for Wastewater Characterization in Activated Sludge Modeling



THE FOLLOWING CALCULATIONS ARE  
THE ORIGINAL DESIGN  
CALCULATIONS FOR THE OXIDATION  
DITCH WHEN IT WAS INSTALLED -  
WITH DESIGN FLOW = 0.73 MGD.

**ORBAL DESIGN OUTLINE**

Project: Mt View - AR Orbal      Prepared: 07/18/2006  
Engineer: McClelland consulting engineer      Designer: Dennis Barnes

**Influent Characteristics**

Flow, MGD	0.73
BOD5, mg/L	200
TSS, mg/L	200
TP, mg/L	6
NH3-N, mg/L	40
TKN, mg/L	50

**Effluent Requirements**

BOD5, mg/L	10
TSS mg/L	15
TP, mg/L	1.5
NH3-N, mg/L	1.0
TN, mg/L	10.0

**Orbal Design Parameters**

Total Load, lb BOD5/day	1,218	MLSS, mg/L	3,470
Primary Clarifiers	NO	No. of Trains in Parallel	1
Organic Loading, lb/1000 cft/day	21.15	Solids under Aeration, Lbs.	12,466
Total Hydraulic Detention Time, Hr	14.2	Sludge Yield	0.85
		WAS per train, lb/day	1,039
		Sludge Age, days	12

**Basin Dimensions**

No. of Channels per Train	3	Wall Thickness, ft	1.00
Channel Depth, ft	12.00	Radius of Center Island, ft.	5.0
Channel Width, ft		Length of Short Axis Straight Section, ft.	0.0
Inner	10.00	Length of Long Axis Straight Section, ft.	14.0
Middle	10.00	Overall Width, ft.	76.0
Outer	10.00	Overall Length, ft.	90.0
		Volume per Train, cubic feet	57,581
		Volume per Train, gal	430,705

**Pumping Requirements**

RAS pumping rate at 150% of Q, (where Q is the average design flow rate)  
Pump MLSS containing Nitrates from Aerobic Inner channel to Anoxic Outer channel at 400% of Q

**Drives Recommendation**

Location	Channels spanned	Discs per aerator	Design rpm	Max. rpm	Quantity per train	HP
Outer	1	18	29	45	(2)	10.0
Center Island	2	36	43	55	(2)	30.0
Wall Pumps for Nitrate Recycle to Anoxic Outer Channel					1	5.6
Based on max. disc immersion of		21 inches	Installed HP per Train		86 HP	
Based on motor efficiency of		90%	Operating electrical Hp per Train		38 HP	
and design disc immersion of		14 inches				

Additional Costs	Concrete	Unit Price		Orbal Basin	
		Walls	\$550	Cubic Yards	\$176,000
		Floors	\$500	158	\$78,000
	Installation	Hourly Rate	Orbal	SmartBNR	
		\$55	130 man-hrs	100 man-hrs	\$13,000
<b>Total Additional Costs</b>					<b>\$267,000</b>

**Influent Characteristics**

	Ave. design flow, MGD	0.73		
BOD5, mg/L	200	NH3-N, mg/L	40	
TSS, mg/L	200	TKN, mg/L	50	TP, mg/L 6

**A) Determine Basin Volume**

Basin volume is determined by minimum sludge age required to maintain a healthy population of nitrifying organisms at the minimum wastewater temperature.  $\theta_{min} = 1 / (\mu_{max} * EXP(0.098 * (T_{min} - 15))) * TPF * SF$ , where:

Minimum wastewater temperature, $T_{min}$ =	53.6 degrees F
$\theta_{max}$ =	0.47 days <sup>-1</sup>
Diurnal Peak Factor, DPF =	1.2
Monthly Peak Factor, MPF =	1.3
DPF x MPF = Total Process Peak Factor, TPF =	1.56
Safety Factor, SF =	2.5
Minimum Solids Residence Time, $\theta_{min}$ =	11.1 days
Selected Solids Residence Time, $\theta_x$ =	12.0 days

Use McCarty kinetic equations to calculate basin volume required:

- 1) **Inert solids:**

$M_{i,IB} = (M_{o,TSS})(1 - f_{VSSo}) =$	
( 1218 lb/day influent TSS)(100 - 80% VSS) / (100%) =	244 lb/day
  
- 2) **Nonbiodegradable VSS:**

$M_{o,NS} = (M_{o,TSS})(f_{VSSo})(f_{NS}) =$	
( 1218 lb/day influent TSS)(80% VSS)(40% NBVSS) / (100%) =	390 lb/day
  
- 3) **Heterotrophic Kinetic Parameters**

Growth Rate, $Y_{true, 15} =$	0.6 lb VSS/lb BOD5
Decay rate, $b_{15} =$	0.06 days <sup>-1</sup>
BOD Half-saturation coefficient, $K_{BOD} =$	20 mg/l BOD
Adjusting for temperature, $b_T = b_{15}(1.04)^{(T-15)} =$	0.073 days <sup>-1</sup>
Maximum Growth Rate, $\mu_{MAX,H} =$	6

Estimate Effluent BOD<sub>5</sub>:

Soluble BOD, $S_e = [K_{BOD}(1+b_T \theta_x)] / [K_{BOD}(\mu_{MAX,H} \cdot b_T) - 1] =$	0.54 mg/l
Effluent VSS concentration, $f =$	40%
$BOD_{5, total} = S_e + (TSS \times f) =$	
0.54 + (10mg/l effluent TSS)(40% VSS) / (100%) =	4.54 mg/l

Observed yield of heterotrophs:

$Y_{OBS,H} = Y_{true} / (1 + b_T \theta_x) =$	0.32
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Heterotrophic Biomass Produced:

$M_H = (M_{o,BOD} - M_{o,BOD})(Y_{OBS,H}) =$	381 lb/day
--	------------
  
- 4) **Autotrophic Kinetic Parameters**

Growth Rate, $Y_{true, 15} =$	0.15 lb VSS/lb NH3-N
Decay Rate, $b =$	0.05 days <sup>-1</sup>
Ammonia half-saturation coefficient, $K_{am} =$	0.5 mg NH <sub>3</sub> -N/L
Oxygen half-saturation coefficient, $K_o =$	1 mg DO/L
$\theta_{max} =$	0.47 days <sup>-1</sup>
Adjusting for temperature: $\theta_{max T} = \theta_{max 15} e^{0.098(T-15)} =$	0.350 days <sup>-1</sup>
$b_T = b_{15}(1.04)^{(T-15)} =$	0.044 days <sup>-1</sup>

Calculate observed yield of autotrophs:

$Y_{OBS,A} = Y_{true} / (1 + b_T \theta_x) =$	0.098
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Nitrogen assimilated by heterotrophic biomass:

$$\begin{aligned} \text{Nitrogen content of biomass: } N_{cm} &= 12\% \\ \text{Nitrogen assimilated: } M_{NA-H} &= (M_H)(N_{cm}) = 46 \text{ lb/day} \end{aligned}$$

Nitrogen assimilated by autotrophic biomass (1st iteration):

$$\begin{aligned} \text{TKN oxidized: } M_{TKN-o} &= M_{o-TKN} - M_{NA-H} = 259 \text{ lb/day} \\ \text{Autotrophic Biomass Produced: } M_A &= (M_{TKN-o})(Y_{OBS A}) = 25 \text{ lb/day} \\ \text{Nitrogen assimilated by autotrophic biomass: } M_{NA-A} &= (M_A)(N_{cm}) = 3 \text{ lb/day} \end{aligned}$$

Nitrogen assimilated by autotrophic biomass (2nd iteration):

$$\begin{aligned} \text{TKN oxidized: } M_{TKN-o} &= M_{o-TKN} - M_{NA-H} - M_{NA-A} = 256 \text{ lb/day} \\ \text{Autotrophic Biomass Produced: } M_A &= (M_{TKN-o})(Y_{OBS A}) = 25 \text{ lb/day} \\ \text{Nitrogen assimilated by autotrophic biomass: } M_{NA-A} &= (M_A)(N_{cm}) = 3 \text{ lb/day} \\ \text{TKN oxidized: } M_{TKN-o} &= M_{o-TKN} - M_{NA-H} - M_{NA-A} = 256 \text{ lb/day} \\ \text{Oxidized TKN Concentration} &= (M_{TKN-o})(1000)/Q = 42 \text{ mg/l} \end{aligned}$$

5) **Total Solids Production Rate:**

$$\begin{aligned} P_x &= M_{o-BS} + M_{o-NS} + M_H + M_A = 1039 \text{ lb/day} \\ \text{Overall Yield: } Y_H &= P_x/M_{o-BOD} = 0.85 \\ \text{MLVSS: } (M_{o-NS} + M_H + M_A) / P_x &= 76.56\% \end{aligned}$$

6) **Orbal Basin Volume Calculations:**

Calculate required volume, based on MLSS concentration of 3500 mg/l

$$\begin{aligned} \text{Required Volume, } V &= (\theta_x)(P_x)(1,000,000)/8.34/\text{MLSS} = 427048 \text{ gallons} \\ \text{Selected Orbal basin volume} &= 430705 \text{ gallons} \\ \text{Actual MLSS: } X &= (\theta_x)(P_x)(1,000,000)/V/8.34 = 3470 \text{ mg/l} \end{aligned}$$

7) **Waste Activated Sludge:**

$$\begin{aligned} \text{WAS TSS: } X_{wv} &= (1 + F_R)(X)/(F_R) = 5784 \text{ mg/l} \\ \text{WAS Flow: } Q_W &= (P_x)(1000000)/(X_W)/8.34 = 21535 \text{ gal/day} \end{aligned}$$

**B. Determine Actual Oxygen Transfer Rate (AOTR) to be satisfied in Orbal**

1) **Carbonaceous O<sub>2</sub> demand**

$$\begin{aligned} \text{oxygen equivalent of cell mass, } B &= 1.42 \text{ lb O}_2/\text{lb VSS} \\ \text{Influent BOD}_{ULT}:\text{BOD}_5 \text{ RATIO:} &= 1.46 \\ \text{Effluent BOD}_{ULT}:\text{BOD}_5 \text{ RATIO:} &= 1.2 \\ \text{Carbonaceous oxygen demand design factor, } f_{c-o_2} &= 1.16 \end{aligned}$$

a) **Mass of BOD<sub>5</sub> O<sub>2</sub> demand equivalents entering the system:**

$$\begin{aligned} \text{lb BOD}_5/\text{d} \times \text{Influent BOD}_{ULT}:\text{BOD}_5 \text{ RATIO} &= \\ (1218 \text{ lb/day Influent BOD})(1.46) &= 1778 \text{ lb/day} \end{aligned}$$

b) **Mass of BOD<sub>5</sub> O<sub>2</sub> demand equivalents leaving the system:**

$$\begin{aligned} \text{lb BOD}_5/\text{day} \times \text{Effluent BOD}_{ULT}:\text{BOD}_5 \text{ RATIO} &= \\ (28 \text{ lb/day effluent BOD})(1.46) &= 33 \text{ lb/day} \end{aligned}$$

c) **Mass of O<sub>2</sub> equivalents leaving the system as biomass:**

$$\begin{aligned} \text{heterotrophic VSS/d} + \text{autotrophic VSS/d} \times \text{lb O}_2/\text{lb VSS} &= \\ (381 + 25.01)(1.42) &= 578 \text{ lb/day} \end{aligned}$$

d) **Carbonaceous O<sub>2</sub> demand (calc.):**  $f_{c-o_2}(a - b - c) = 1356 \text{ lb/day}$

e) **Carbonaceous O<sub>2</sub> demand (selected):** 1356 lb/day

2) **Nitrification oxygen demand:**

Nitrification oxygen equivalent: 4.6  
Denitrification oxygen credit: 2.9

Nitrification oxygen demand:  $\text{lb O}_2/\text{kg NH}_3\text{-N} \times \text{lb TKN oxidized}/\text{day} =$   
 $(256 \text{ lb}/\text{day TKN oxidized})(4.6) = 1176 \text{ lb}/\text{day}$

3) **Denitrification oxygen credit:**

As long as that the organic loading is high enough and the O<sub>2</sub> supply is distributed to multiple locations, the outer channel(s) of Orbal systems can be maintained in an anoxic state by limiting the percentage of the overall system AOR satisfied in each anoxic channel to a value close to the percentage of the overall system volume in that channel, resulting in simultaneous nitrification and denitrification. Ammonia oxidation will occur at a rate proportional to the percentage of AOR satisfied in each Orbal channel. With a strong oxygen deficit (DO = near zero mg/l), 100% of the ammonia oxidized will be denitrified. With a mild oxygen deficit condition (DO = near 0.5 mg/l), 65% of ammonia oxidized will be denitrified. Based on the process split listed in the table below, we can calculate the rate of denitrification for the Orbal system:

	Channel			Total
	1	2	3	
Volume Split	47.7%	33.3%	18.9%	100.0%
AOR Split	19.4%	44.2%	36.4%	100.0%
DO, mg/l	0.0	0.5	2.0	
Denite Rate	100%	65%	0%	

**Nitrogen Mass Balance**

Nitrogen components in clarifier return activated sludge, with RAS flow at 150% of design flow

Ammonia-N:  $M_{R-NH_3} = (C_e-NH_3)(Q)(RAS\%)(8.34) = 3 \text{ lb}/\text{day}$   
Nitrate-N:  $M_{R-NO_x} = (C_e-NO_x)(Q)(RAS\%)(8.34) = 32 \text{ lb}/\text{day}$   
Total-N:  $M_{R-TN} = (C_e-TN)(Q)(RAS\%)(8.34) = 52 \text{ lb}/\text{day}$

Nitrogen components in MLSS recycle stream, with internal recycle (IR) at 400% of design flow

Ammonia-N:  $M_{IR-NH_3} = (C_e-NH_3)(Q)(Recycle\%)(8.34) = 7 \text{ lb}/\text{day}$   
Nitrate-N:  $M_{IR-NO_x} = (C_e-NO_x)(Q)(Recycle\%)(8.34) = 86 \text{ lb}/\text{day}$   
Total-N:  $M_{IR-TN} = (C_e-TN)(Q)(Recycle\%)(8.34) = 140 \text{ lb}/\text{day}$

Nitrogen components in channel 1 influent:

Ammonia-N:  $M_{i-NH_3} = M_{e-NH_3} + M_{R-NH_3} + M_{IR-NH_3} = 266 \text{ lb}/\text{day}$   
Nitrate-N:  $M_{i-NO_x} = M_{e-NO_x} + M_{R-NO_x} + M_{IR-NO_x} = 118 \text{ lb}/\text{day}$

Nitrogen Components in Reactor 1 Effluent:

Ammonia-N:  $M_{1-NH_3} = M_{i-NH_3} - (M_{e-NH_3} - M_{e-NH_3})(f_{N1}) = 217 \text{ lb}/\text{day}$   
Nitrate-N:  $M_{1-NO_x} = (M_{i-NH_3} - M_{1-NH_3} + M_{i-NO_x})(1-f_{O1}) = 0 \text{ lb}/\text{day}$

Nitrogen Components in Reactor 2 Effluent:

$$\begin{aligned} \text{Ammonia-N: } M2\text{-NH3} &= M1\text{-NH3} - (M0\text{-NH3} - M0\text{-NH3})(fN2) = & 104 \text{ lb/day} \\ \text{Nitrate-N: } M2\text{-Nox} &= (M1\text{-NH3} - M2\text{-NH3} + N1\text{-NOx})(1-fD2) = & 39 \text{ lb/day} \end{aligned}$$

Nitrogen Components in Reactor 3 Effluent:

$$\begin{aligned} \text{Ammonia-N: } M3\text{-NH3} &= M2\text{-NH3} - (M0\text{-NH3} - M0\text{-NH3})(fN3) = & 5 \text{ lb/day} \\ \text{Nitrate-N: } M3\text{-NOx} &= (M2\text{-NH3} - M3\text{-NH3} + N2\text{-NOx})(1-fD3) = & 53 \text{ lb/day} \end{aligned}$$

Nitrogen Components in Clarifier Effluent:

$$\begin{aligned} \text{Ammonia-N: } M_{w\text{-NH3}} &= M_{w\text{-NH3}} - M_{R\text{-NH3}} = & 2 \text{ lb/day} \\ \text{Nitrate-N: } M_{e\text{-NOx}} &= M_{e\text{-NOx}} - M_{R\text{-NOx}} = & 21 \text{ lb/day} \\ \text{Effluent NH}_3\text{-N Concentration} &= (M_{w\text{-NH3}})(1000)/Q = & 0.3 \text{ mg/l} \\ \text{Effluent NO}_3\text{-N Concentration} &= (M_{e\text{-NOx}})(1000)/Q = & 3.5 \text{ mg/l} \end{aligned}$$

Denitrification oxygen credit:

$$\begin{aligned} &(\text{lb O}_2/\text{lb NO}_3\text{-N})(\text{lb TKN oxidized/d} - \text{lb effluent NO}_3\text{-N/day}) = \\ & (2.9)(258 - 21) = & 680 \text{ lb/day} \end{aligned}$$

4) Net oxygen demand, AOR:

$$\text{lb Carbonaceous O}_2/\text{d} + \text{lb Nitrogenous O}_2/\text{d} - \text{lb Denitrification Credit/day} = 1852 \text{ lb/day}$$

C) Determine Standard Oxygen Transfer Rate (SOTR) to be satisfied in Orbal

$$\text{SOTR} = \text{AOTR} / \text{FCF}$$

$$\text{FCF} = A \times (B \times \text{ACF} \times C_s - \text{DO}) \times \text{TCF} / 9.092$$

$$\begin{aligned} \text{Alpha, } A &= 0.95 & \text{Beta, } B &= 0.98 \\ \text{Elevation} &= 770 \text{ feet} & \text{Altitude Correction Factor (ACF)} &= 0.972 \\ \text{Design water temperature} &= 68\text{F} & \text{Temperature Correction Factor (TCF)} &= 1.000 \\ \text{Saturation Concentration of Oxygen at Design Water Temperature, } C_s &= & &= 9.09 \text{ mg/l} \end{aligned}$$

DO = Dissolved oxygen concentration in each reactor, mg/l

	Channel			
	1	2	3	Total
AOR, lb/hr	15	34	28	77
DO, mg/l	0.0	0.5	2.0	
FCF	0.905	0.853	0.696	
SOR, lb/hr	17	40	40	97

1) Calculate disc quantity required per channel # of discs required = SOTR / SOTR/disc

	Channel			
	1	2	3	
Design disc immersion (in.)	14.0	14.0	14.0	
Design disc speed (rpm)	29	43	43	
Design SOTR/disc lb/hr/disc	0.48	1.18	1.18	Total
Disc Quantity	36	36	36	108

2) Disc aerator drive selection

- (2) 10.0 Hp aerator(s) on periphery of basin, each turning 18 discs
- (2) 30.0 Hp aerator(s) on periphery of basin, each turning 36 discs

3) Check for adequate oxygen reserve capacity

	Channel		
	1	2	3
Max. disc immersion (in.)	21.0	21.0	21.0
Max. disc speed (rpm)	45	55	55
Max. SOTR/disc lb/hr/disc	1.80	2.50	2.50

RESERVE SOTR CAPACITY		
	All aerators in service	Largest aerator out
Maximum SOTR =	245 lb/hr	155 lb/hr
Reserve Over Design Load =	152%	80%

WITH LARGEST AERATOR OUT, CAPACITY = 0.73/0.6 = 1.2 MGD < 0.95 MGD PROPOSED DESIGN FLOW



1) Calculate disc quantity required per channel # of discs required = SOTR / SOTR/disc

	Channel			
	1	2	3	
Design disc immersion (in.)	15.0	16.0	16.0	
Design disc speed (rpm)	29	43	43	
Design SOTR/disc lb/hr/disc	0.54	1.32	1.32	Total
Disc Quantity	36	36	36	108

2) Disc aerator drive selection

- (2) 10.0 Hp aerator(s) on periphery of basin, each turning 18 discs
- (2) 30.0 Hp aerator(s) on periphery of basin, each turning 36 discs

80 Hp

3) Check for adequate oxygen reserve capacity

	Channel		
	1	2	3
Max. disc immersion (in.)	21.0	21.0	21.0
Max. disc speed (rpm)	45	55	55
Max. SOTR/disc lb/hr/disc	1.80	2.50	2.50

*Handwritten calculations:*  
 $1.8 \times 24 = 43.2 \frac{\text{lb}}{\text{hr}}$   
 $2.5 \times 24 = 60 \frac{\text{lb}}{\text{hr}}$   
 $2.5 \times 24 = 60 \frac{\text{lb}}{\text{hr}}$

**RESERVE SOTR CAPACITY**

All aerators in service  
 Maximum SOTR = 245 lb/hr  
 Reserve Over Design Load = 115%

Largest aerator out  
 155 lb/hr  
 36%

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transfer rate =  $\frac{2 \text{ lbs } O_2}{1 \text{ hp} \cdot \text{hr}}$

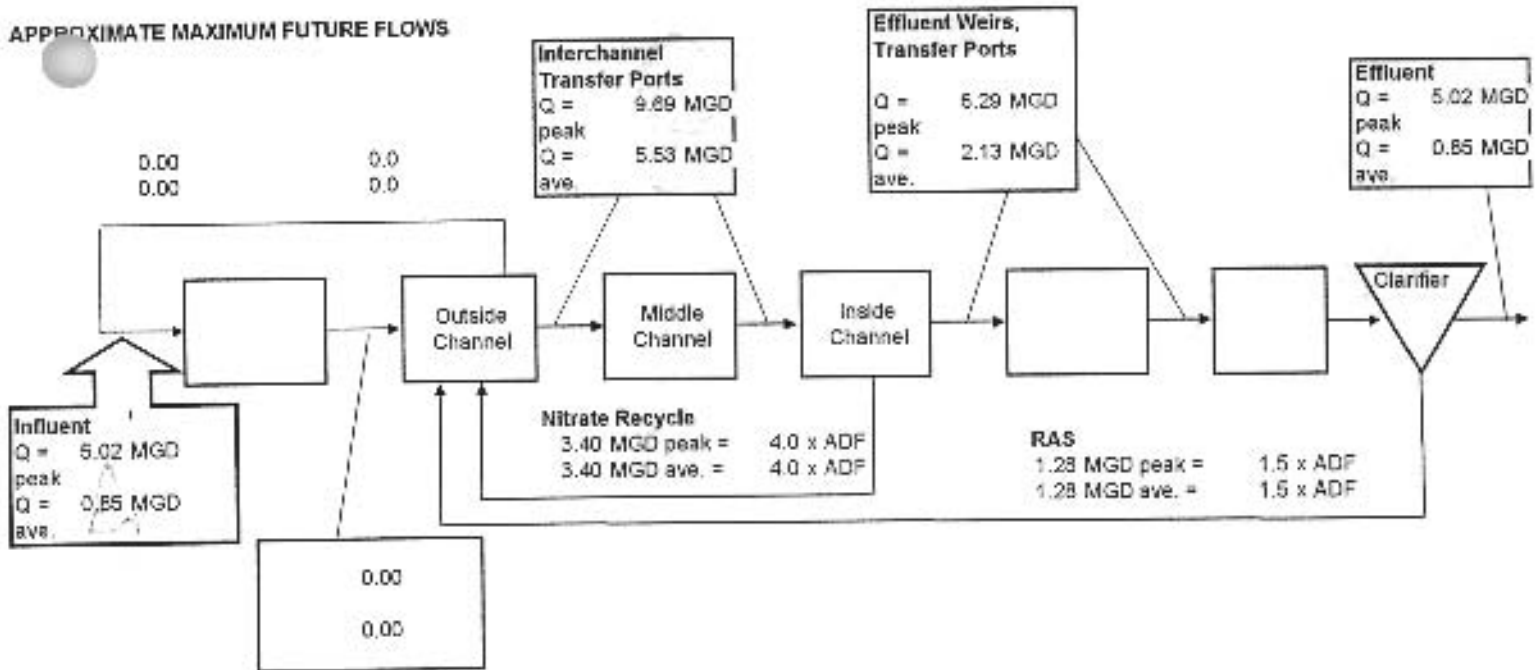
$$\frac{1 \text{ hp}}{2 \text{ lbs } O_2} = \frac{x \text{ hp}}{114 \text{ lb } O_2}$$

$$x = \frac{114 \text{ lb } O_2 \times 1 \text{ hp}}{2 \text{ lbs } O_2} = 57 \text{ hp}$$



Number of Channels in Orbal 3

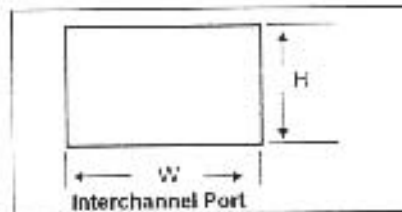
APPROXIMATE MAXIMUM FUTURE FLOWS



SUGGESTED SIZING FOR INTERCHANNEL TRANSFER PORTS  
(ports between outer, middle, and inner channels)

Maximum flow = 9.89 MGD = 5.02 MGD peak + 1.28 MGD RAS + 3.40 MGD SIM-PRE  
Limit headloss to 0.50 inches at peak flow

Headloss Calculations:  $h = 1.21 (Q/A)^2$   
where:  
h = headloss in inches  
Q = flow in MGD  
A = area in sq. ft.



Solving for A, we have:

$A = (1.21Q^2/h)^{1/2} = 15.07 \text{ sq. ft.}$

Recommended port opening size =

Actual hl at peak, inches =	0.444
Actual hl at peak, ft =	0.037

15.00 sq. ft. =	48 inch x	48 inch
Actual hl at average, inches =		0.144
Actual hl at average, ft =		0.012

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**SUGGESTED SIZING FOR EFFLUENT CONTROL STRUCTURE GATE**

(gate between inner channel and effluent weirs)

Maximum flow = 6 290 MGD = 5.015 MGD peak + 1.275 MGD RAS  
 Limit headloss to 1 inches at peak flow

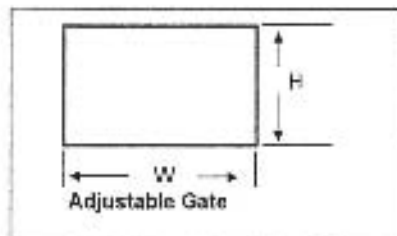
Headloss Calculations:  $h = 1.21 (Q/A)^2$

Where: h = headloss in inches  
 Q = flow in MGD  
 A = area in sq. ft.

Solving for A, we have:

$A = (1.21Q^2/h)^{1/2} = 6.919 \text{ sq. ft.}$

Recommended port opening size = 7.111 sq. ft. = 32 inch x 32 inch  
 Actual hl at peak, inches = 0.947  
 Actual hl at ave., ft = 0.079  
 Actual hl at average, inches = 0.1081  
 Actual hl at average, ft = 0.009



**HYDRAULIC CALCULATIONS FOR ORBAL SYSTEM**

**SUGGESTED SIZING FOR EFFLUENT WEIRS**

Maximum flow = 6 290 MGD = 5.015 MGD peak + 1.275 MGD RAS  
 Limit headloss to 3 inches at peak flow with adjustable gate at 100% closed

Headloss Calculations:  $h = (18.96Q/L)^{2/3}$

Where: h = headloss in inches  
 Q = flow in MGD  
 L = length of weir in feet

Solving for L, we have:

$(18.96Q/h^{3/2}) = 23.0 \text{ feet}$

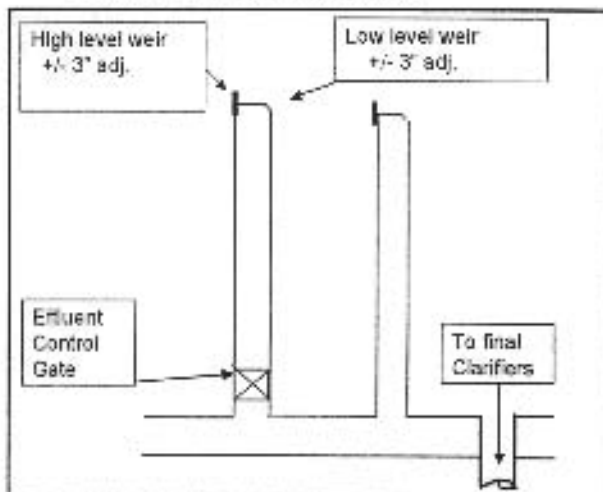
Recommended high weir length = 23 feet  
 Actual hl at peak, inches = 2.986  
 Actual hl at peak, ft = 0.250

Minimum recommended low weir length = 5.157 feet

Actual low weir length, feet = 6 feet  
 Actual hl at peak, inches = 7.338 inches  
 Actual hl at peak, ft = 0.611 feet

Maximum disc immersion = 21"  
 Minimum disc immersion = 9"  
 disc radius = 27"

Section view of Center Island Weirs



- Top of high level weir plate should

be placed - 6" +  $\frac{(18.96Q/h)^{2/3}}{12}$  +  $\frac{(18.96Q/h)^{2/3}}{12}$  below the centerline  
 of the shaft. Top of concrete weir support should be placed 3" below the high weir plate.

- Top of low level weir plate should be placed 18" below the center line of the shaft. Top of concrete weir support to be 21" below the centerline of the shaft.

With high level weir at 0.8236 feet below shaft centerline, max. disc immersion at average flow = 18.68 inches

If chamber between low weir and gate has a cross-sectional area = 2 sq. ft. average velocity = 0.658 fps  
 peak velocity = 3.88 fps

*Doc J*

