KENVIRONS INCORPORATED

KENVIRONS, INC.
452 Versailles Road
FRANKFORT, KENTUCKY 40601
(502) 695-4357

RECEIVED
APR 21 2015
PUBLIC SERVICE COMMISSION

LETTER OF TRANSMITTAL

DATE	04-21-15
JOB NO.	2012059
ATTENTION	Jeff Derouen, Exec Director
RE	Cumberland Falls Highway Water Dist.
	Case No. 2015-00115

TO KY Public Service Commission
211 Sower Blvd.
Frankfort, KY 40601

WE ARE SENDING YOU ☒ Attached ☐ Under separate cover via _____ the following items:

☐ Shop drawings ☐ Prints ☐ Plans ☐ Samples ☐ Specifications
☐ Copy of letter ☐ Change Order ☐ _____

COPIES	DATE	NO.	DESCRIPTION
1			CD – Stamped and Signed Construction Plans and
			Specifications PSC Case No. 2015-00115

THESE ARE TRANSMITTED as checked below:

☒ For approval ☐ Approved as submitted ☐ Resubmit _____ copies for approval
☒ For your use ☐ Approved as noted ☐ Submit _____ copies for distribution
☐ As requested ☐ Returned for corrections ☐ Return _____ corrected prints
☐ For review and comment ☐ _____
☐ FOR BIDS DUE _____ 20 ____ ☐ PRINTS RETURNED AFTER LOAN TO US

REMARKS The plans and specifications on the attached CD are being submitted to correct the deficiencies noted in the April 20, 2015 letter from Ms. Linda Faulkner to the Cumberland Falls Highway Water District regarding the above referenced case no. 2015-00115. Sorry for the inconvenience.

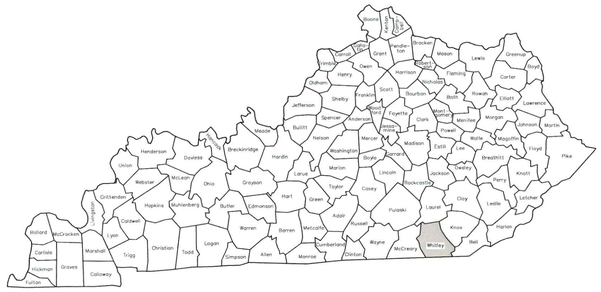
COPY TO Randy Jones; CFHWD

thank you

SIGNED: Ken Taylor PE
Ken Taylor, P.E.

If enclosures are not as noted, kindly notify us at once.

CUMBERLAND FALLS HIGHWAY WATER DISTRICT
US 25W TRANSMISSION MAIN & PUMP STATION
WHITLEY COUNTY, KENTUCKY



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Prepared By:

KENVIRONS, INC.

FRANKFORT, KENTUCKY

STATE OF KENTUCKY
CARLOS F. MILLER
17384
LICENSED PROFESSIONAL ENGINEER
12/23/14

QA/QC: _____ DATE: _____

N:\PJO\2012059\Plans\00-COVER.dwg, 12/1/2014 1:14:37 PM, HP Designjet T2500 HPGL2.pc3

GENERAL NOTES

1. Stations shown on the water line are for reference only and do not reflect the actual linear lengths of pipe required for construction.
2. The Contractor shall be responsible for coordinating all construction work with local utility companies and other concerned parties.
3. Existing buried utilities are shown on the drawings in their general location utilizing the best available information. Before construction begins near or through existing utilities (i.e. Gas Co., Telephone Co., etc.) each utility company shall be notified, a request for the exact location of the utility shall be made, and permission to proceed with construction obtained. The utility shall be given at least one week advance notice for location verification. BUD provides a clearinghouse service for member utilities relative to underground utilities location. The Contractor shall contact BUD at telephone no. 1-800-752-6007 or 811.
4. Before construction begins through any property, the Contractor shall make himself aware of the exact location of construction through the property and the bounds of the permanent and temporary construction easements.
5. The Contractor shall have on hand at the job site 11 1/4°, 22 1/2°, 45° and 90° bends for use where necessary for proper installation.
6. Pipe joint deflection shall not exceed 2°. Bending of PVC pipe will not be allowed.
7. At some locations, the Contractor may be required to provide extra cover over line. Cost of extra cover is to be included in unit price bid for line installation and no separate payment will be made for such extra cover. All such locations are shown on the plans.
8. Connecting new lines to existing lines or to work in other contracts is subsidiary to the contract unless specifically itemized in the Bid Schedule. It includes fittings, sleeves, etc., but does not include gate valves, which are an extra pay item.
9. All fittings, thrust restraint and appurtenances to construct the pipelines as shown shall be included in the unit cost for the pipe and are not separate pay items.
10. The pipe lengths have been estimated as close as possible. The Contractor shall be responsible for ordering pipe quantities necessary for installation to the limits as shown on the Drawings unless otherwise instructed. Any left-over pipe quantities shall be the property of the Contractor unless other arrangements are made. The Owner shall not be responsible for re-stocking or other charges associated with the left over pipe.
11. Ductile iron pipe shall be installed in accordance with Standard AWWA C150/ANSI A21.50 Laying Condition Type 3 unless otherwise noted.
12. All driveways that are cut shall be backfilled with KTC #8 or 9-M and shall be included in the unit price for pipe installation.
13. All open cut streets and roads and trenches cut in existing pavements shall be backfilled with compacted crushed stone or DGA in accordance with the miscellaneous details drawings.
14. Paved driveways shall be free-bored. Free bore unit prices are contained in Bid Schedule. The material in which the free bore is made is unclassified.
15. It is the responsibility of the Contractor to comply with all regulations regarding the effect on the environment from the discharge of chlorinated water. See Technical Specification 15103 Subsection 3 for methods of sterilization and for disposing of heavily chlorinated water.
16. The time period for pressure testing in this project shall be 6 hours.
17. Final cleanup is a separate pay item in the Bid Schedule which includes seeding and straw mulch along the entire length of the pipeline trench. A power landscape rake shall be used for seedbed preparation. See the Specifications for specific requirements.
18. Tracer tape and wire shall be installed with the PVC pipe. See Technical Specification 15100, and the miscellaneous details drawings.
19. During the process of tapping asbestos concrete mains, the contractor shall conform to OSHA regulations governing the handling of hazardous waste. Pieces of asbestos concrete resulting from the tap shall be double bagged, placed in a rigid container and disposed of in an approved landfill.
20. **Distribution pipelines and customer service lines exist along the entire route of the transmission pipeline to be installed in this project. Attention is directed specifically to Note 3 of these General Notes.**
21. Final Cleanup payment is for transmission and distribution pipelines only. It does not include service lines.
22. Locations where pipeline is to be installed on state road right-of way are approximately delineated on the drawings. The Contractor, along with the Engineer's Representative, shall determine, precisely, the field locations for transitions between private easements, and state and county road rights-of-way.
23. All pipelines installed in the ditchline on state or county rights-of-way shall have 42" minimum cover over top of pipe.
24. The pipeline trench width will be strictly enforced. See Technical Specification 15100 for trench width requirements.
25. The GENERAL CERTIFICATION - NATIONWIDE PERMIT #12 - UTILITY LINE BACKFILL AND BEDDING is contained in the Specifications. The Contractor shall read, understand and comply with the requirements and procedures. All crossings of streams that appear as a blue line on a USGS 7.5 minute topographical map shall be accomplished in accordance with: PERMIT #12, UTILITY LINE BACKFILL AND BEDDING. It is the intent of the plans to identify a stream crossing at each blue line stream. Small creek crossings, less than 15 feet measured from top of bank to top of bank, may be accomplished by trenching when the stream is in a no-flow condition. If the stream is in a flow condition, the crossing shall be accomplished by directional boring or other method that complies with the General Certification and is approved by the Engineer. Specific details for stream crossings are contained in the Miscellaneous Details. Bid items for specific stream crossings may be contained in the Bid Schedule with the type of crossing shown on the Plan Sheets. Payment shall be "Each" for directional bores of small stream crossings. All small stream crossings in the project shall be considered the same regardless of width (up to 15 L.F.) or depth. It is the responsibility of the Contractor to determine an average unit price that will be used for payment for each instance a blue line stream is crossed. Stream crossings may be added, for extended lines beyond those shown on the plans, at the same unit price providing the crossings are reasonably similar to those in the initial project. Stream crossings may be deleted, without effecting the unit price, if a line is deleted or shortened. Payment for specific bid item directional bored stream crossings shall be "Lump Sum".
26. Rough cleanup is included in the unit price for pipe installation and must be done before payment for pipe will be approved.
27. Do not cut fences except where specifically shown and noted.
28. The Contractor shall obtain and pay for all grading, storm water, etc. permits, if any required to complete the work. The contractor shall maintain compliance with all conditions, limitations and stipulations of all permits. The contractor shall not commence work, except mobilization, until he has obtained all required permits for said work. The contractor shall supply the owner with copies of all permits within 24 hours of receipt. A KPDES Storm Water Discharge Permit will be required for this project. The contractor shall fill out, sign and submit the Notice of Intent (NOI) and the Notice of Termination (NOT). The Notice to Proceed will not be issued until the Permit has been provided.
29. All work shall be provided in accordance with all terms of the General Construction Permit and the Floodplain Construction Permit as issued for the Project by the Kentucky Department for Environmental Protection, Division of Water. The Owner will secure said Construction Permits and deliver a copy of each to the Contractor, to be maintained on-site at all times during construction.

GENERAL NOTES (CONT.)

30. All work shall be provided in compliance with all applicable local, state and national building codes.
31. All work shall be executed in compliance with the current workplace safety regulations of the U.S. Department of Labor, Occupational Safety and Health Administration (O.S.H.A.).
32. The Contractor shall restrict all construction activities to within the limits of the public right-of-way and the private easements and fee parcels unless otherwise approved by the Owner in writing. The Contractor shall be solely liable for any and all Work he performs outside of the boundaries of the public road right-of-way and the private easements and fee parcels provided by the Owner.
33. The Contractor is solely responsible for determination of the existence and location of any and all other buried utilities in the vicinity of his Work. Utilities shown on the Project Drawings are purported to be approximate only and not warranted to be complete nor accurately located. Additional buried utility lines, other than as shown on the Project Drawings, may exist in the vicinity of the Project work. The Contractor shall contact local utilities and/or locating service at least 48 hours prior to commencing work on the Project.
34. The Contractor shall be responsible for all traffic control measures necessary to the safe execution of his work, including but not limited to flaggers, traffic signage, barricades, construction fencing and nighttime warning lights. Traffic safety provisions shall be employed by the Contractor in accordance with the Standards of the appropriate State and local public highway authorities.
35. All excavation and all boring shall be considered unclassified excavation and unclassified boring. No additional payment shall be due and payable to the Contractor for dewatering of pipe trenches/excavations or for excavation and removal of rock or for boring casing through rock.
36. All water main fittings shall be ductile iron, mechanical joint compact fittings for water service complying with AWWA Standard C153. Unless otherwise specifically shown or noted, no PVC fitting, other than in-line repair couplings, will be accepted.
37. All water main fittings shall be anchored with poured concrete thrust blocks as shown in the miscellaneous details drawings. Wrap fittings in minimum 5-mil plastic (PVC) wrap prior to forming and pouring the block.
38. Prior to cutting existing driveways, the Contractor shall notify the property owner/occupant at least 24 hours in advance and shall schedule his Work such to restrict access to not more than 2 hours in one (1) day.
39. The Contractor shall repair/replace any and all existing utility lines and equipment damaged by the Contractor's Work, to the satisfaction of the damaged utility and at no additional cost to the Owner.
40. The Contractor shall protect all drainage culverts in the vicinity of his work and shall repair or replace all culverts damaged by his Work and at no additional cost to the Owner. All existing culverts may not be shown/noted on the Project Drawings.
41. Existing utility lines may be cathodically protected. The installation of all ductile iron pipe, fittings and appurtenances within 100' of cathodically protected utility lines shall comply with AWWA Standard C105 (Polyethylene Encasement), latest revision, and at no additional cost to the Owner. This requirement will be specifically applicable to all new iron pipe located within 100' of the cathodically protected new primary booster station.
42. There are no sanitary sewers or drains known to exist in the vicinity of the proposed new water main. If unforeseen sewer or other sanitary facility is encountered, the Engineer shall direct the relocation of the water main to provide separation and/or other protection of the water main in accordance with terms of the Kentucky Department for Environmental Protection, Division of Water Construction Permit. The Contractor shall provide relocation of the water main as directed by the Engineer and the Contract Price adjusted only by/to the number of Bid Item units actually provided.
43. No water service shall be activated until the new work has been completed, sterilized, and tested in accordance with the Contract Documents and accepted in writing by the Owner.

ENVIRONMENTAL NOTES

1. When crossing all streams, silt barriers, ie. straw bales or silt fences, shall be put in place to prevent sediment runoff into stream. Conventional stream crossings shall be accomplished during low flow periods. Stream banks shall be reseeded with native vegetation beneficial to wildlife immediately following completion of the stream crossing. Disturbed surfaces shall be restored to original contours and excess materials removed to a properly confined area.
2. If the removal of any trees greater than (6) inches in diameter at breast height is required, The tree removed shall be accomplished between October 15 and March 31.
3. Any excavation by the Contractor that uncovers a historical or archaeological artifact shall be immediately reported to the Owner and Engineer. Construction shall be temporarily halted pending the notification process and further directions after consultation with the State Historic Preservation Officer (SHPO).

HIGHWAY DEPARTMENT NOTES

1. Underground utilities installed inside state right of way shall be located within 3-5 feet from the edge of the right of way unless otherwise shown on the plans.
2. Underground utilities installed in KDOT right-of-way in Whitley County may be installed with a minimum depth of cover of 30 inches except in the ditchline where the depth of cover shall be 42 inches.
3. Underground utilities crossing any paved driveway inside state right of way shall be installed by boring unless written permission to open cut is obtained from the property owner.
4. Underground utilities shall not be installed in embankment fills or between edge of pavement and ditchline unless specifically noted on permitted plans.
5. Fire Hydrants or utility service boxes should be located within 2 feet from the edge of right of way line, or off right of way.
6. Contact KTC-DOH District prior to beginning work.
7. All effected KYTC ditchlines shall remain free of excess silt or erosion and constructed to the normal typical section of the roadway with a minimum depth of 18 inches from the shoulder break point.
8. All necessary steps shall be taken to prevent erosion or siltation of the public right-of-way, adjoining property and waterways.

GENERAL NOTES

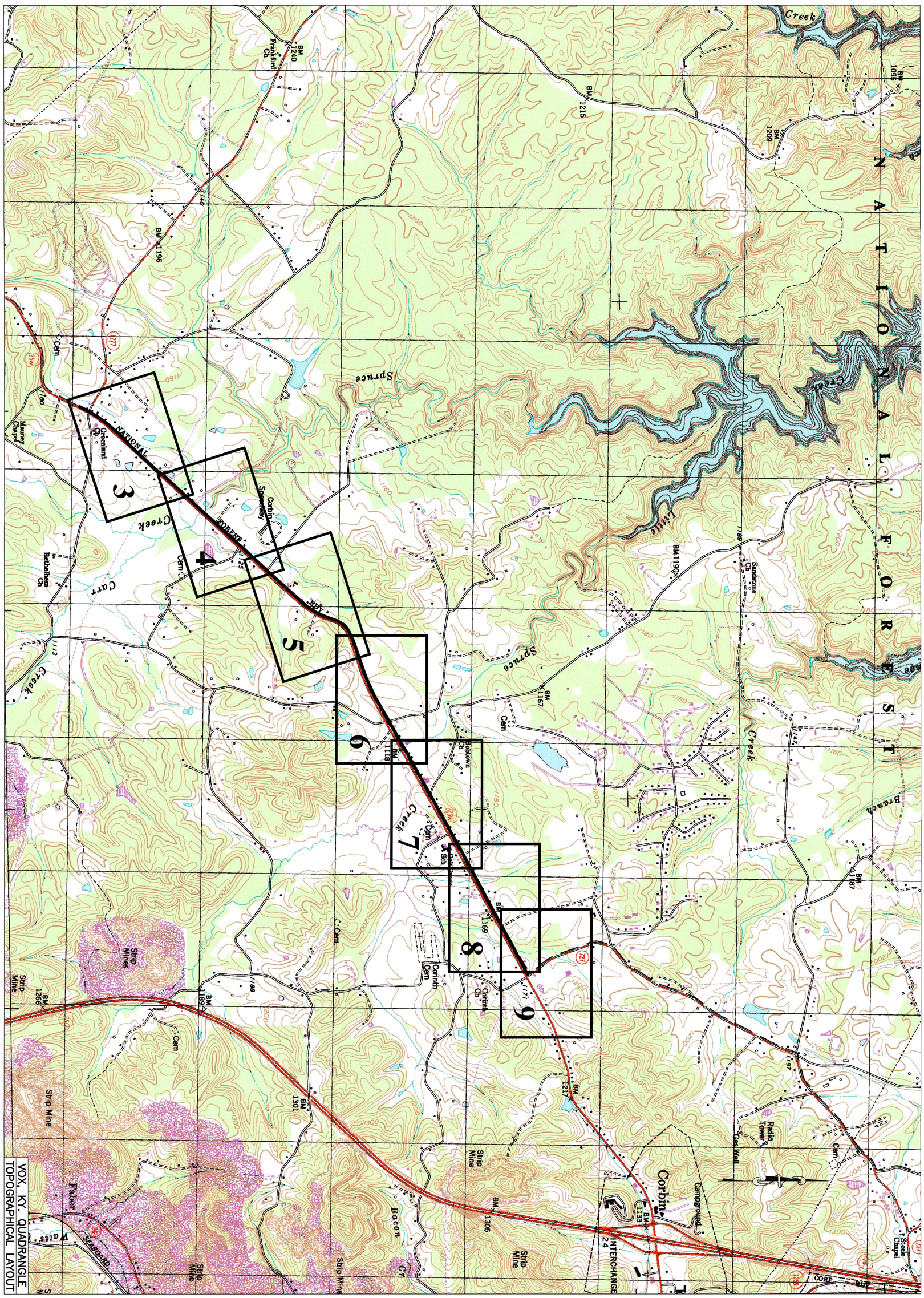
CUMBERLAND FALLS HIGHWAY WATER DISTRICT
US 25W TRANSMISSION MAIN
WHITLEY COUNTY, KENTUCKY

DRAWN BY: JKP/PTH
CHECKED BY: CFM
CHECKED BY:
DATE: April 2014
SCALE: 1"=100'
REVISIONS

KENVIRONS, INC.
FRANKFORT, KENTUCKY

PROJECT NO.
2012059

SHEET NO.
1



VOX, KY. QUADRANGLE
TOPOGRAPHICAL LAYOUT

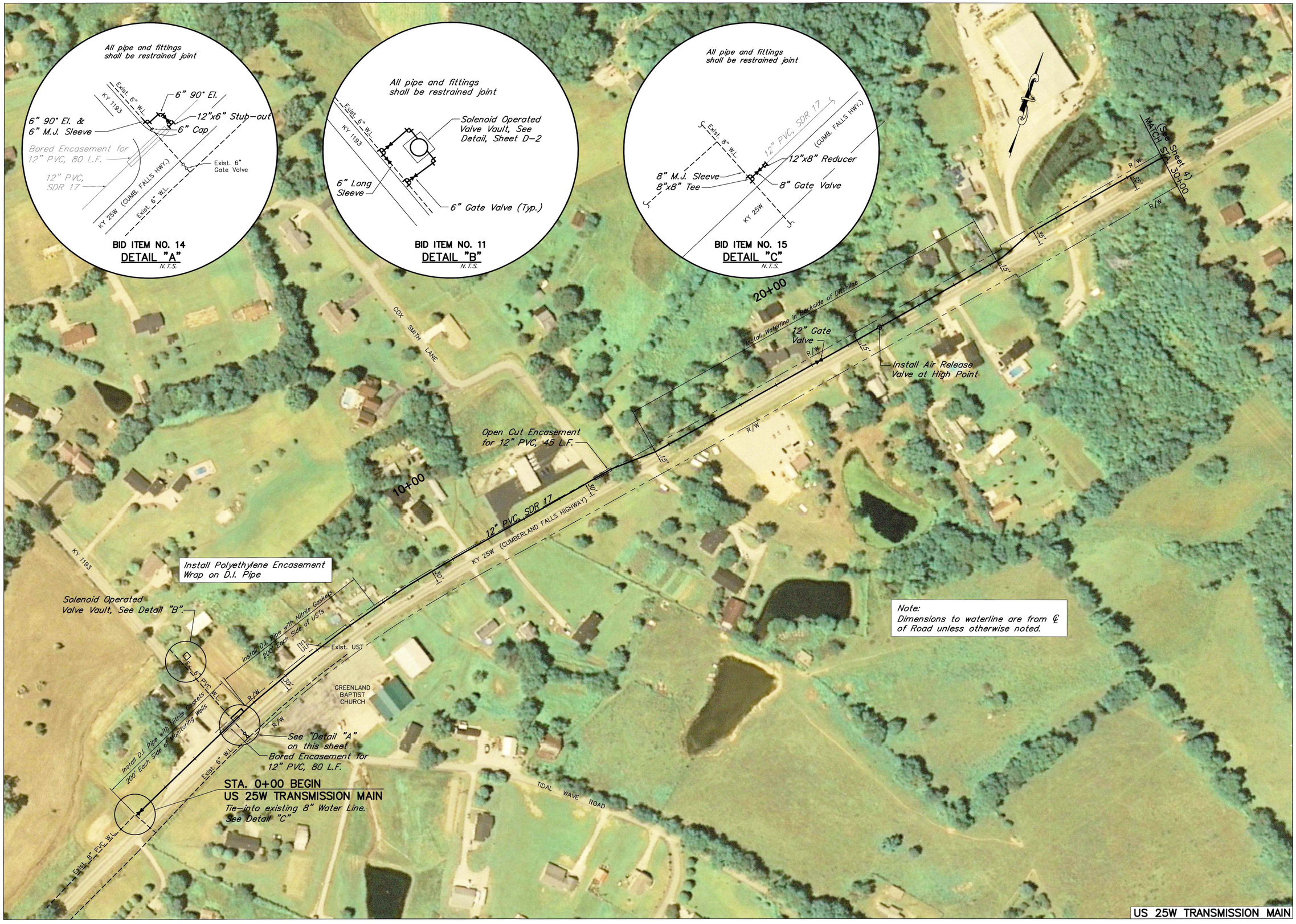
DRAWN BY:	JKP/PTH
CHECKED BY:	CFM
CHECKED BY:	
DATE:	Apr. 2012
SCALE:	1"=1,000'
REVISIONS	

STATE OF KENTUCKY
CARLOS F. MILLER
7384
LICENSED PROFESSIONAL ENGINEER
12-23-14

KENVIRONS, INC.
FRANKFORT, KENTUCKY

PROJECT NO. 2012059
SHEET NO. 2

CUMBERLAND FALLS HIGHWAY WATER DISTRICT
US 25W TRANSMISSION MAIN
WHITLEY COUNTY, KENTUCKY



CUMBERLAND FALLS HIGHWAY WATER DISTRICT
US 25W TRANSMISSION MAIN
WHITLEY COUNTY, KENTUCKY

STATE OF KENTUCKY
CARL C. MILLER
7384
LICENSED PROFESSIONAL ENGINEER

DRAWN BY:	JKP/PTH
CHECKED BY:	CFM
CHECKED BY:	
DATE:	April 2014
SCALE:	1"=100'
REVISIONS	

KENVIRONS, INC.
FRANKFORT, KENTUCKY

PROJECT NO.
2012059

SHEET NO.
3

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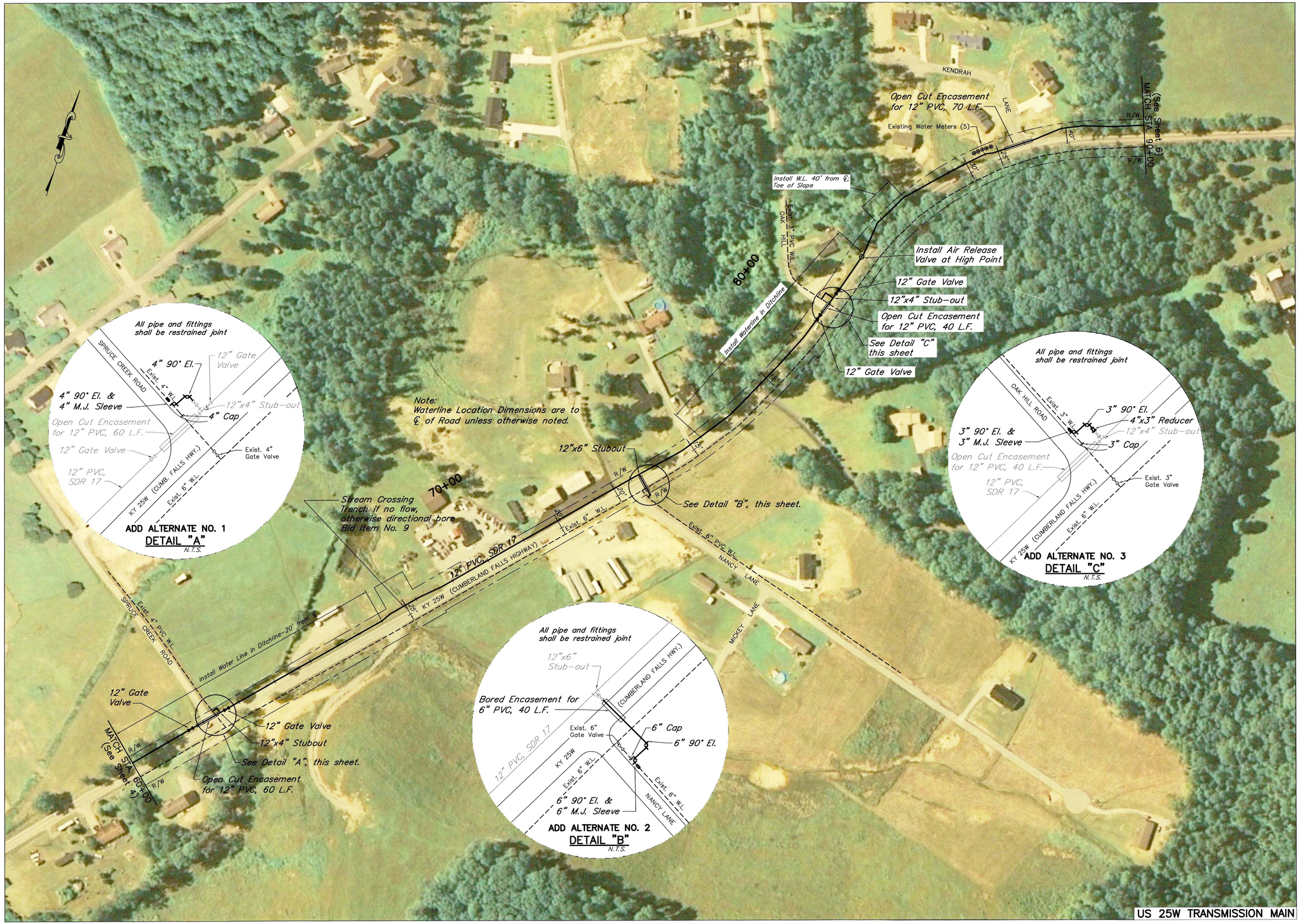
US 25W TRANSMISSION MAIN

SHEET NO. 4	PROJECT NO. 2012059	KENVIRONS, INC. FRANKFORT, KENTUCKY	DRAWN BY: JKP/PTH CHECKED BY: CFM CHECKED BY: DATE: April 2014 SCALE: 1"=100' REVISIONS	STATE OF KENTUCKY CARLOS F. MILLER 7384 LICENSED PROFESSIONAL ENGINEER

CUMBERLAND FALLS HIGHWAY WATER DISTRICT
US 25W TRANSMISSION MAIN
WHITLEY COUNTY, KENTUCKY

CUMBERLAND FALLS HIGHWAY WATER DISTRICT
US 25W TRANSMISSION MAIN
WHITLEY COUNTY, KENTUCKY



STATE OF KENTUCKY — LICENSED PROFESSIONAL ENGINEER — CARLOS F. MILLER 19864

DRAWN BY:	HKP/PTH
CHECKED BY:	CFM
CHECKED BY:	CFM
DATE:	April 2014
SCALE:	1"=100'
REVISIONS	

KENVIRONS, INC.
FRANKFORT, KENTUCKY

PROJECT NO.
2012059

SHEET NO.
5

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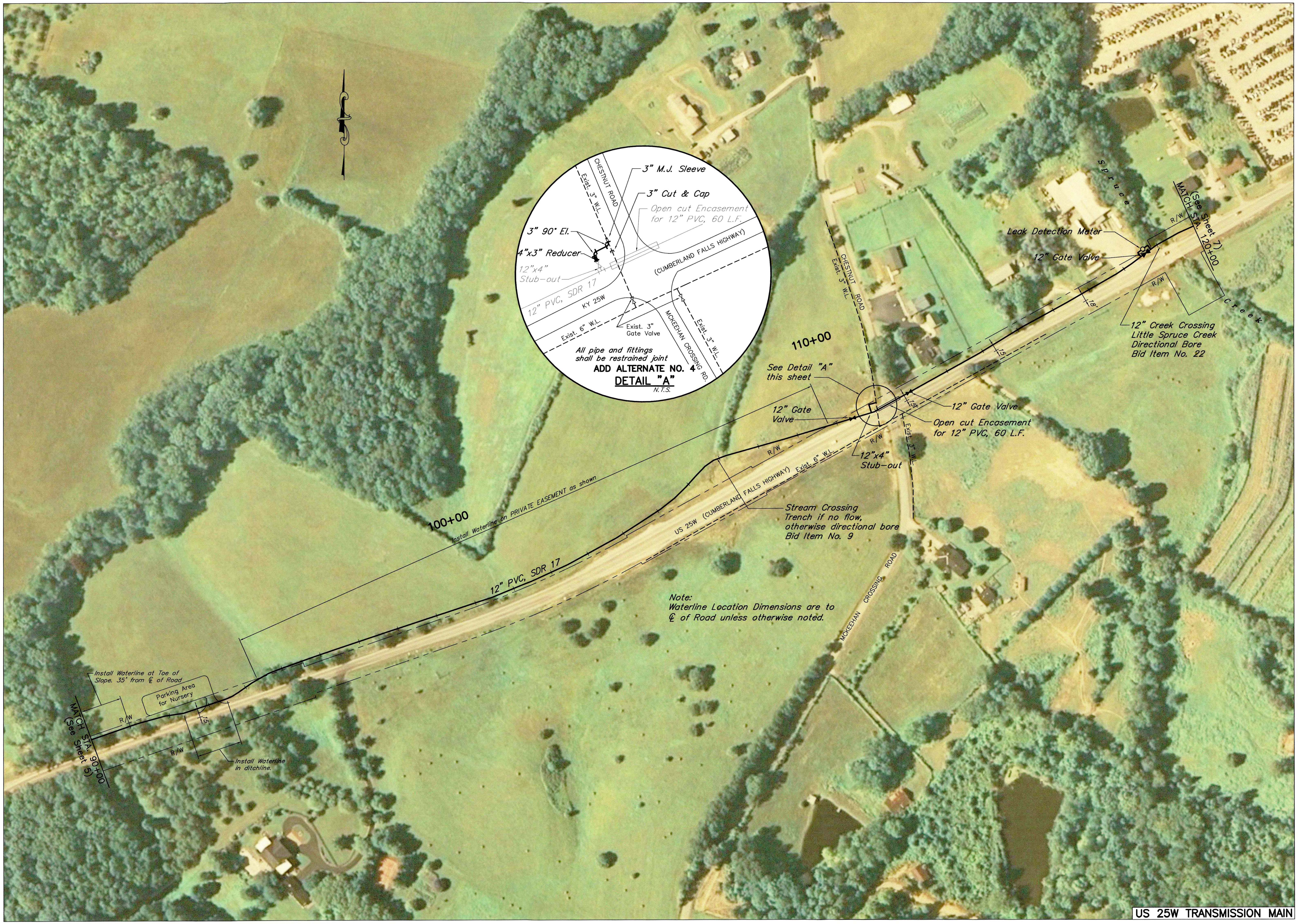


US 25W TRANSMISSION MAIN

CUMBERLAND FALLS HIGHWAY WATER DISTRICT
US 25W TRANSMISSION MAIN
WHITLEY COUNTY, KENTUCKY

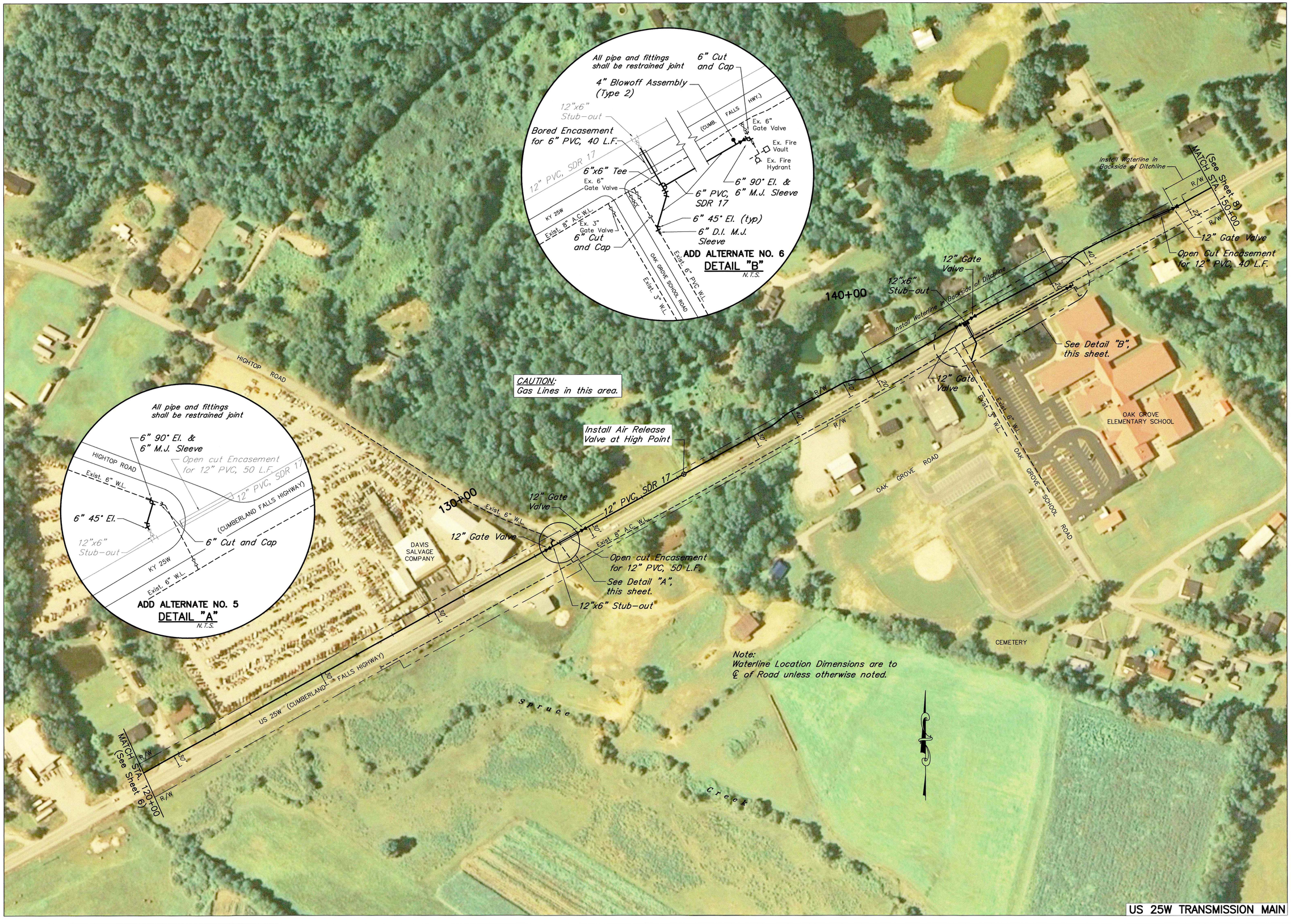
DRAWN BY: JKP/PTH
CHECKED BY: CFM
CHECKED BY:
DATE: April 2014
SCALE: 1"=100'
REVISIONS

KENVIRONS, INC.
FRANKFORT, KENTUCKY

PROJECT NO.
2012059

SHEET NO.
6

CUMBERLAND FALLS HIGHWAY WATER DISTRICT
US 25W TRANSMISSION MAIN
WHITLEY COUNTY, KENTUCKY



US 25W TRANSMISSION MAIN

DRAWN BY: JKP/JPH
CHECKED BY: CPM
CHECKED BY:
DATE: April 2014
SCALE: 1"=100'
REVISIONS

KENVIRONS, INC.
FRANKFORT, KENTUCKY

PROJECT NO.
2012059

SHEET NO.
7

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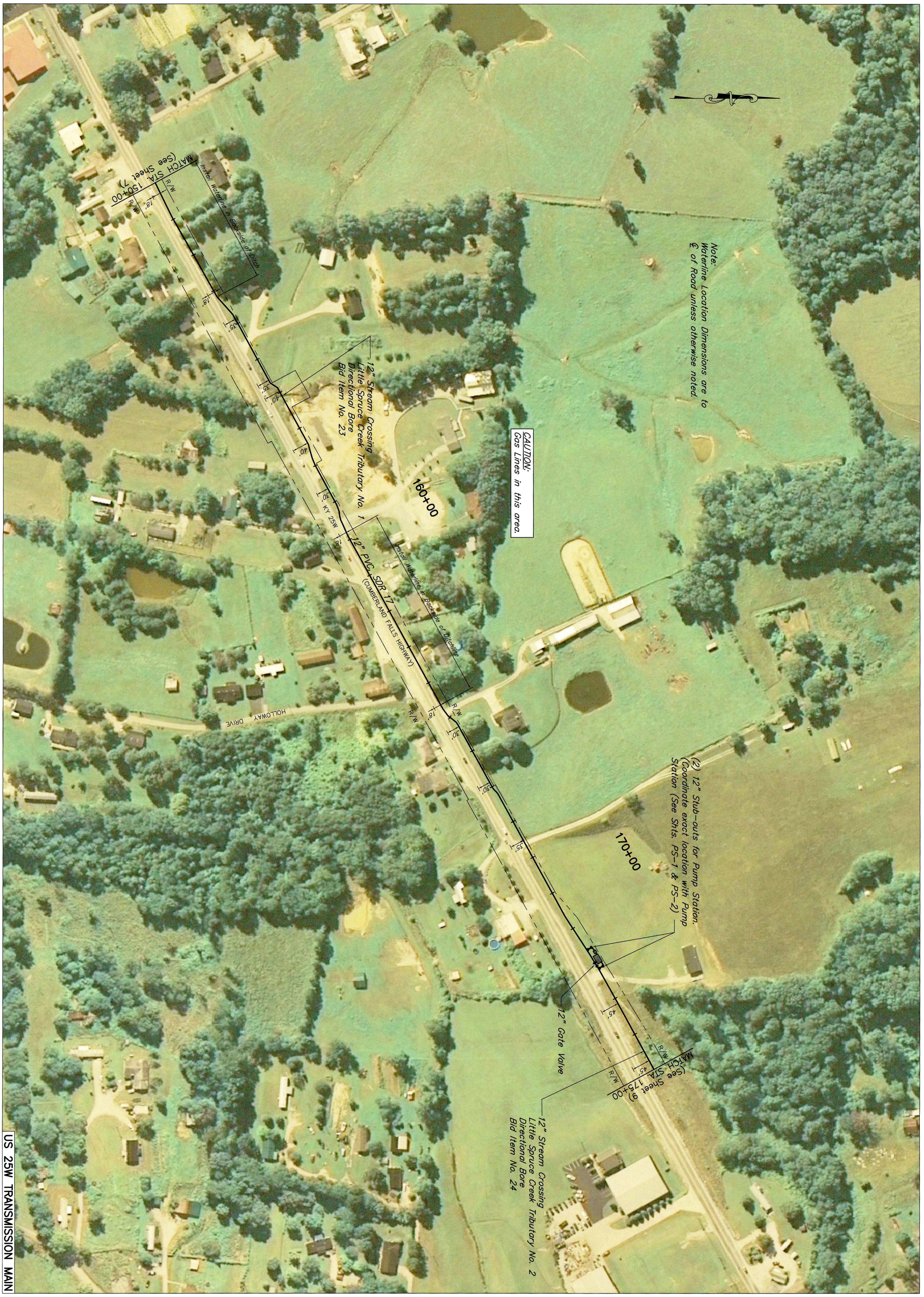
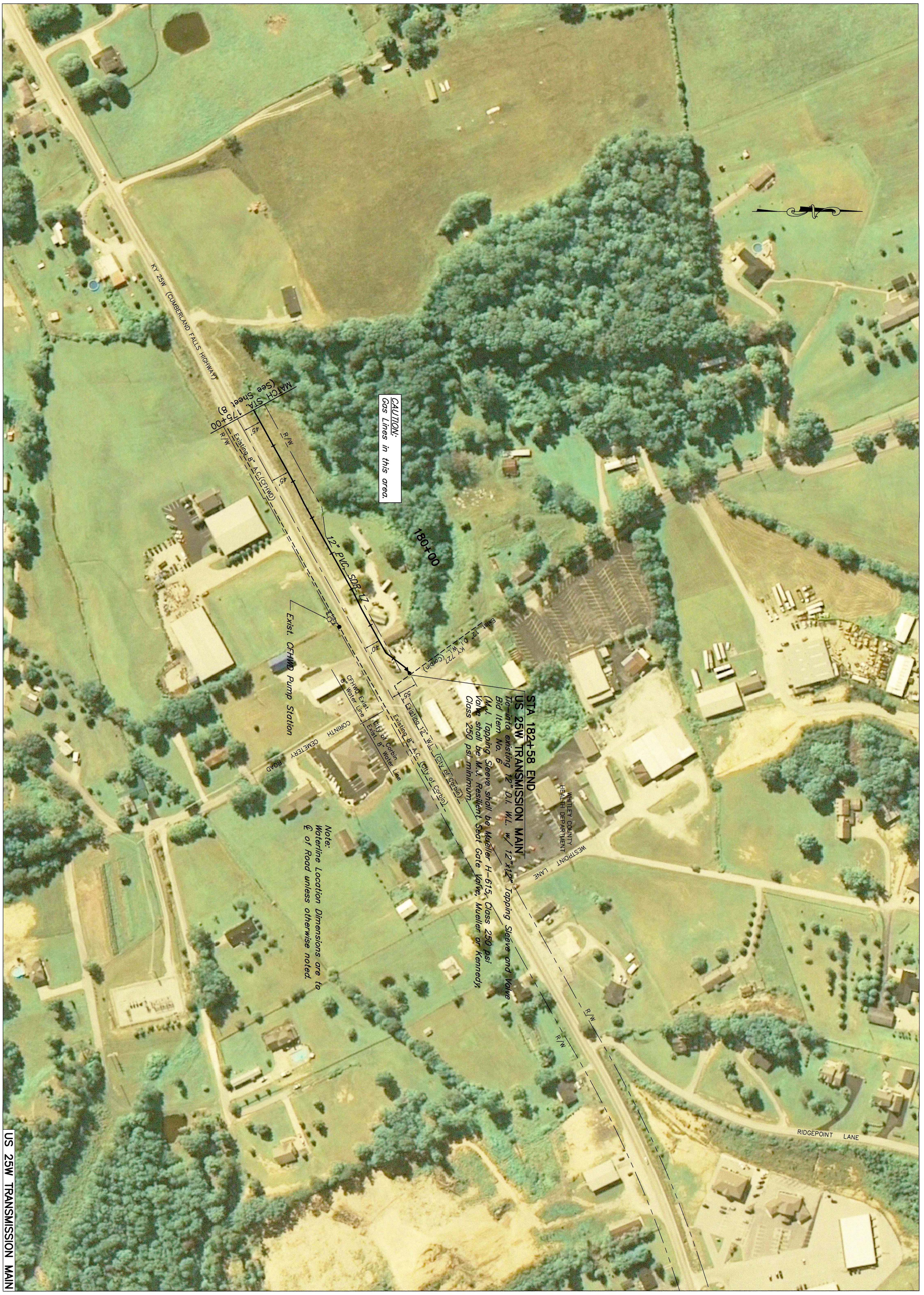


US 25W TRANSMISSION MAIN

SHEET NO. 8	PROJECT NO. 2012059	**KENVIRONS, INC.** FRANKFORT, KENTUCKY	DRAWN BY: JKP/PTH CHECKED BY: CFM CHECKED BY: DATE: April 2014 SCALE: 1"=100' REVISIONS	STATE OF KENTUCKY CARLOS F. MILLER LICENSED PROFESSIONAL ENGINEER	**CUMBERLAND FALLS HIGHWAY WATER DISTRICT** **US 25W TRANSMISSION MAIN** **WHITLEY COUNTY, KENTUCKY**



US 25W TRANSMISSION MAIN

SHEET NO. 9	PROJECT NO. 2012059	KENVIRONS, INC. FRANKFORT, KENTUCKY	DRAWN BY: JKP/PTH CHECKED BY: CFM CHECKED BY: DATE: April 2014 SCALE: 1"=100' REVISIONS

STATE OF KENTUCKY
CARLOS F. MILLER
7384
LICENSED PROFESSIONAL ENGINEER
12-2-14

CUMBERLAND FALLS HIGHWAY WATER DISTRICT
US 25W TRANSMISSION MAIN
WHITLEY COUNTY, KENTUCKY

CUMBERLAND FALLS HIGHWAY WATER DISTRICT
US 25W TRANSMISSION MAIN
WHITLEY COUNTY, KENTUCKY

NOTES:

1. *Bid Item No. 12 shall include the underground pump station, underground back-flow preventer vault, piping, valves, electrical work and all appurtenances from the 12"x12" Stub-outs north.*
2. *All field pipe joints shall be restrained with Locking Gaskets, EBBA Iron Mega Lug or approved equal.*

Exist. R/W (N48° 54' 13" E – 62.2')
Exist. R/W Marker
Exist. R/W (N 58° 01' 44" E – 201.8'±)
Back-flow Preventer Vault, See Detail, Sht. D-3
Underground Pump Station, See Sht. PS-2
3'
5'
12"x6" Reducer
12"x10" Reducer
Bid Item No. 12
Fire Hydrant
12" D.I.
8"x6" Reducer
12" Gate Valve
12" PVC, SDR 17
12"x12" Stub-out
28.5'
29.5'
Exist. 24" CMP
Exist. Drive
Exist. R/W Marker
Exist. R/W (N 59° 57' 00" E)
1150
1155
1160
Exist. 15" CMP
BM #1
Exist. Guardrail
KY 25W (CUMBERLAND FALLS HIGHWAY)
BM #2

BM #1:
Elev. 1159.76
R.R. Spike in edge of Gravel Drive

BM #2:
Elev. 1162.03
P.K. Nail at edge of pavement 6' from end of guardrail

10 0 5 10 20 40
(SCALE IN FEET)
1 inch = 10 ft.

Exist. Headwall
Exist. Culvert

PUMP STATION SITE PLAN

STATE OF KENTUCKY
CARLOS F. MILLER
25864
LICENSED PROFESSIONAL ENGINEER

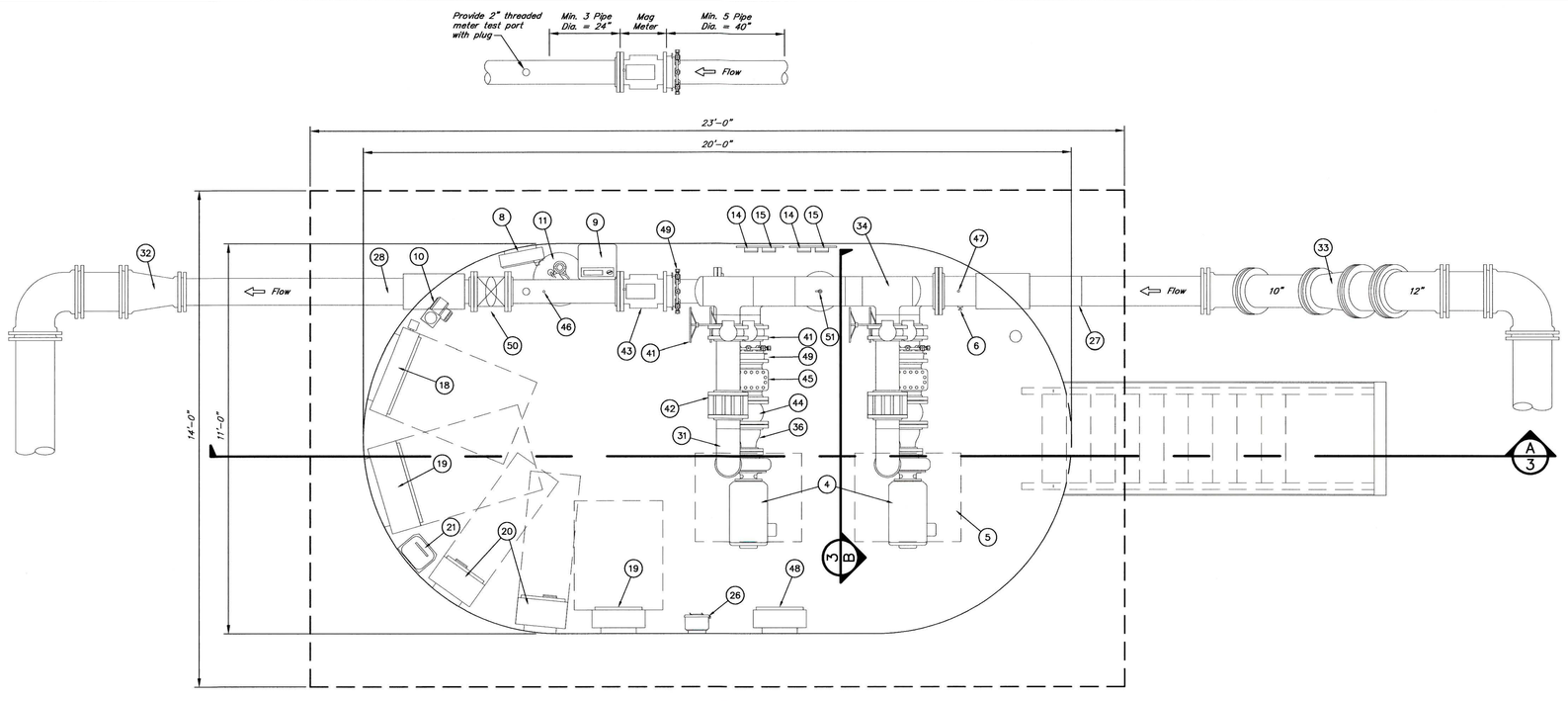
DRAWN BY: JKP
CHECKED BY: CFM
CHECKED BY:
DATE: August 2014
SCALE: As Noted
REVISIONS

KENVIRONS, INC.
FRANKFORT, KENTUCKY

PROJECT NO.
2012059

SHEET NO.
PS-1

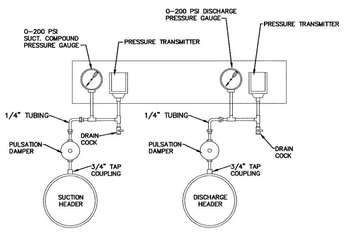
N:\P\2012059\Plans\PS-1 Pump Station Site Plan.dwg 2/12/2015 9:43:46 AM, JKP



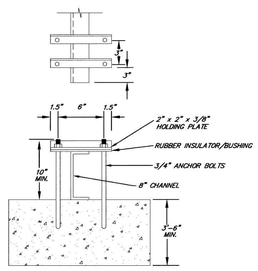
PUMP STATION PLAN

Scale: 1/2"=1'-0"

ITEM	QUANITY	DESCRIPTION
1	1	STEEL CHAMBER – 3/8" PLATE TOP, BOTTOM, SIDES AND ENDS W/ 8" TOP REINF,
	–	6" SIDE REINF, AND 8" BOTTOM REINF
2	1	BILCO L–50 ALUMINUM ENTRANCE
3	1	ENTRANCE STAIR ASSEMBLY
4	2	PUMPS & MOTORS , 30 HP, 1800 RPM, 480V/3PH/60HZ
		CONDITIONS – 800 GPM @ 101' TDH
5	2	BILCO S–50 EQUIPMENT HATCH (CENTERED OVER PUMPS)
6	1	HOSE BIBB
7	5	FLOURSCENT LIGHTS
8	1	3000 WATT HEATER
9	1	DEHUMIDIFIER (DRAIN TO SUMP)
10	1	VENTILATION BLOWER W/ VENT PIPING
11	1	SUMP WELL W/ SUMP PUMP AND 1–1/4" PVC DISCHARGE PIPING
12	1	8" BACKFLOW PREVENTER, AMES COMPANY SERIES 2000SS OR EQUAL
13	1	DRY WELL FLOAT
14	2	PRESSURE GAUGES
15	2	PRESSURE TRANSMITTERS
16	2	1" AIR RELEASE VALVE WITH ISOLATION VALVE (PIPE TO SUMP)
17		NOT USED
18	1	CONTROL PANEL
19	1	POWER DISTRIBUTION / LOAD CENTER PANEL
20	2	VARIABLE SPEED DRIVES
21	1	SINGLE PHASE TRANSFORMER
22		NOT USED
23	–	FUSION BONDED INTERNAL PIPE COATING
24	–	DEVOE / SHERWIN WILLIAMS PAINT COATINGS
25	6	CATHODIC PROTECTION
26	1	ANODE TEST BOX – CATHODIC PROTECTION
27	1	10" PLAIN END SUCTION PIPE
28	1	8" PLAIN END DISCHARGE PIPE
29		NOT USED
30		NOT USED
31	3	8" WELD ELBOWS
32	1	12"X8" M.J. REDUCER
33	1	12"X10" M.J. REDUCER
34	5	10"X10"X8" WELD TEE
35		NOT USED
36	2	8"X5" ECN WELD REDUCERS
37	2	8"X4" CONC WELD REDUCERS
38	2	8" FLANGED COUPLING ADAPTOR
39		NOT USED
40	1	10" BUTTERFLY VALVE W/ GEAR OPERATOR
41	4	8" BUTTERFLY VALVES W/ GEAR OPERATORS
42	2	8" FLANGED GLOBE STYLE SILENT CHECK VALVES
43	1	8" MAGNETIC FLOW METER
44	2	8" RESTRAINED METRASPHERE COUPLINGS
45	2	8" PLATE STRAINER
46	1	COMMON DISCHARGE PRESSURE TAP
47	1	COMMON SUCTION PRESSURE TAP
48	1	TELEMETRY PANEL
49	3	RESTRAINED FLANGED COUPLING ADAPTOR
50	1	8" GATE VALVE
51	1	MANUAL AIR RELEASE VALVE
52	1	LOW PRESSURE SWITCH, CIRCUIT, LIGHTS & SCADA CONTACTS AT EACH PUMP

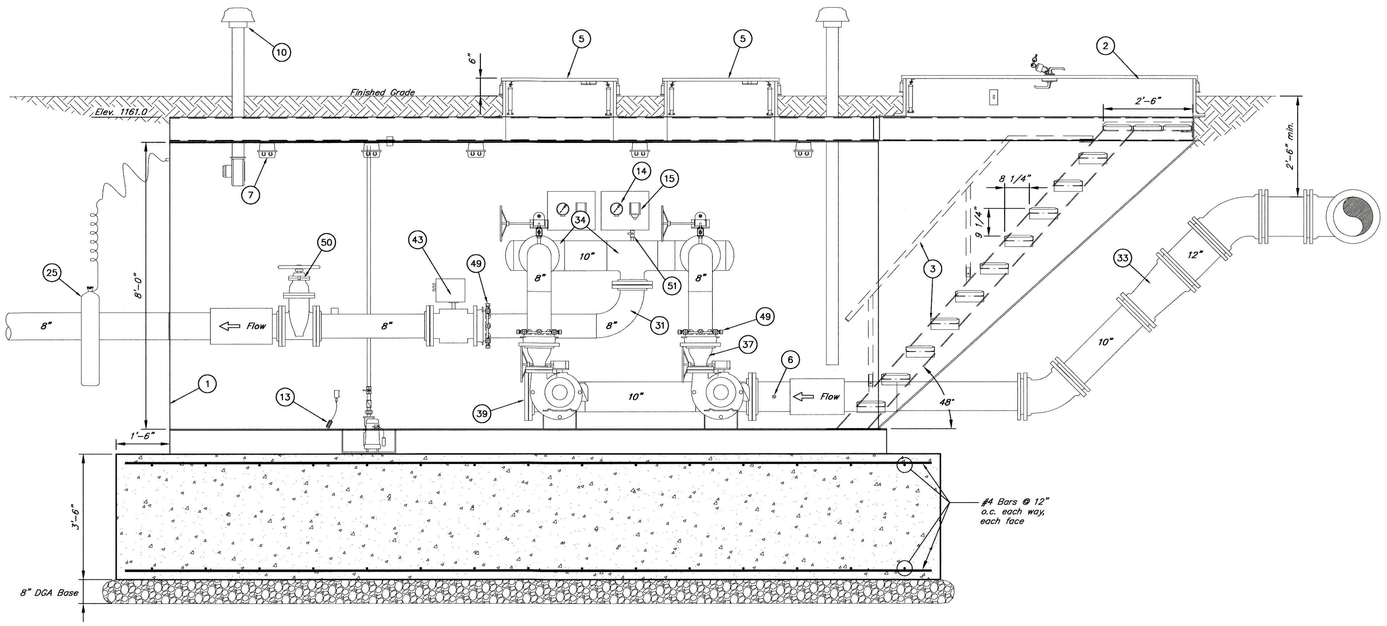


SUCTION/DISCHARGE PRESSURE GAUGE/TRANSMITTER DETAIL



ANCHOR DETAIL

N.T.S.

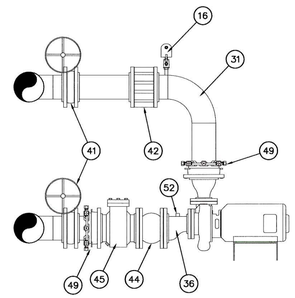


A/4 SECTION

Scale" 1/2"=1'-0"

NOTES:

1. All joints within the pump station shall be flanged or restrained for 200 psi minimum.
2. Gaskets for flanged pipe shall be full face gaskets equal to TORUSEAL by American Cast Iron Pipe Co.



SECTION B/4

Scale" 1/2"=1'-0"

PUMP STATION PLAN AND SECTIONS

CUMBERLAND FALLS HIGHWAY WATER DISTRICT
US 25W TRANSMISSION MAIN
WHITLEY COUNTY, KENTUCKY

STATE OF KENTUCKY — CARLOS F. MILLER — 28284 — LICENSED PROFESSIONAL ENGINEER

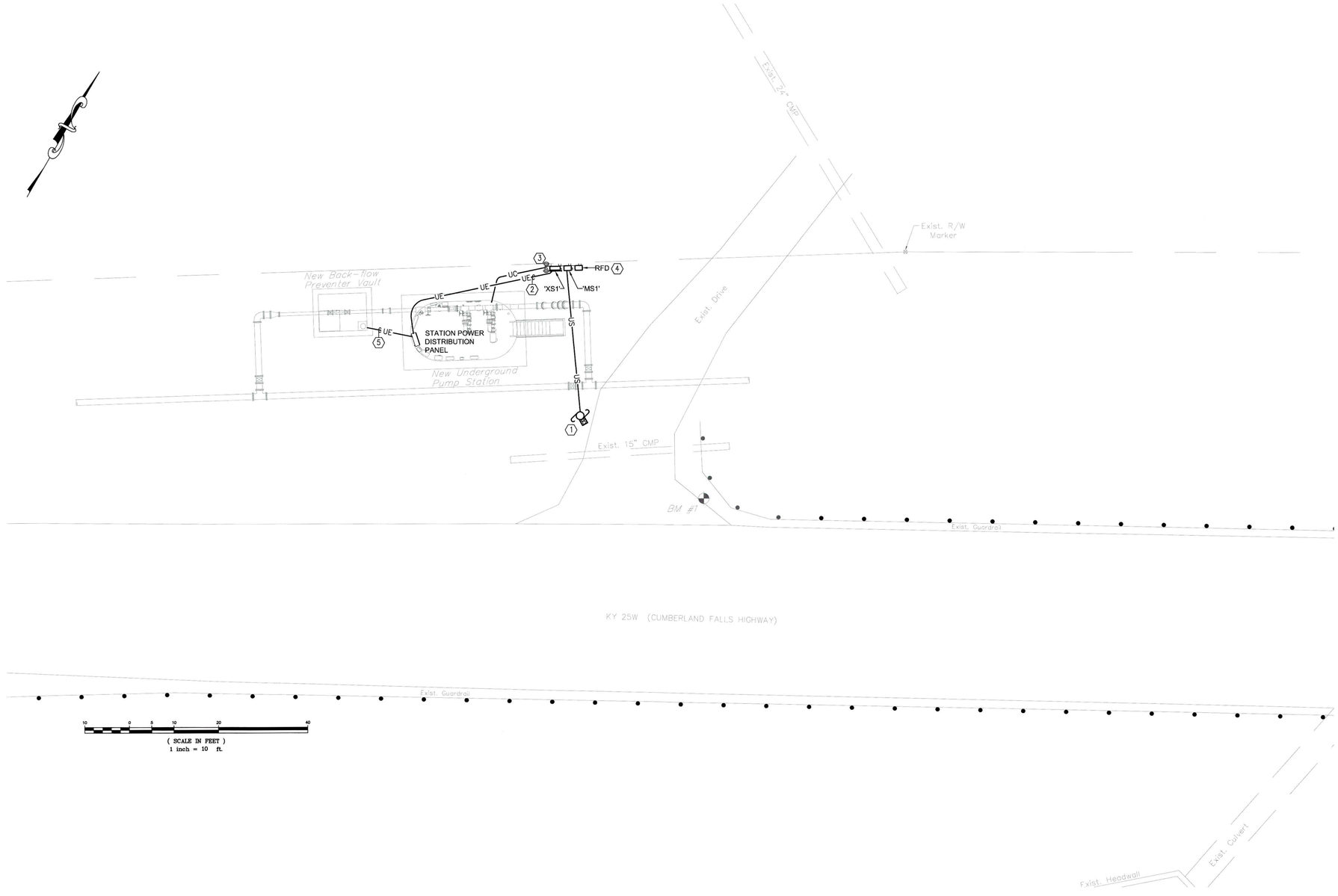
DRAWN BY: JKP
CHECKED BY: CFM
CHECKED BY:
DATE: August 2014
SCALE: As Noted
REVISIONS

KENVIRONS, INC.
FRANKFORT, KENTUCKY

PROJECT NO.
2012059

SHEET NO.
PS–2

N:\P\2012059\Plans\PS-2 Pump Station.dwg, 2/12/2015 4:49:56 PM, KP



SITE PLAN - ELECTRICAL

SCALE: 1" = 10'

SHEET NOTES

1. FURNISH AND INSTALL NEW SECONDARY SERVICE DROP. SEE RISER DIAGRAM FOR METERING AND CONDUIT REQUIREMENTS. COORDINATE EXACT POLE LOCATION AND NEW SERVICE INSTALLATION WITH POWER CO. AND OWNER IN FIELD.
2. NEW UNDERGROUND SECONDARY SERVICE TO NEW MAIN SWITCH 'MS1'. SEE ONE LINE RISER ON SHEET E-2.
3. NEW TELEMETRY SYSTEM ANTENNA. COORDINATE LOCATION AND SUPPORT WITH SYSTEM SUPPLIER.
4. NEW REMOTE FLOW DISPLAY. SEE RISER, SHT.E-2.
5. POWER TO VAULT SUMP PUMP. SEE RISER, SHT E-2.

GENERAL NOTES

1. ALL CONDUIT, ABOVE EXTERIOR GRADE TO 18" BELOW GRADE SHALL BE RIGID ALUMINUM UNLESS OTHERWISE NOTED.
2. ALL ELECTRICAL EQUIPMENT, WIRE AND CONDUIT REMOVED DURING CONSTRUCTION OF THIS PROJECT SHALL BECOME THE PROPERTY OF THE OWNER AND SHALL BE STORED AS DIRECTED.
3. THE EXISTING CONDITIONS AS SHOWN ON THESE PLANS HAVE BEEN FORMULATED THROUGH REVIEW OF OLD PLANS, DISCUSSIONS WITH CITY PERSONNEL AND DATA GATHERED BY FIELD SURVEYS.
4. THE CONTRACTOR SHALL VERIFY EXISTING AND FINAL CONTOURS AND ELEVATIONS.
5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR LOCATING AND VERIFYING ALL EXISTING LINES, ELECTRICAL CONDUITS AND ANY OTHER ITEMS THAT WILL BE EFFECTED BY THE CONSTRUCTION OF ELECTRICAL SYSTEMS FOR THIS PROJECT.
6. CONTRACTOR SHALL FURNISH AND INSTALL PULL BOXES, BOTH INTERIOR AND EXTERIOR INCLUDING GRADE MOUNT, AS REQUIRED FOR ALL POWER AND CONTROL CIRCUITS.
7. CONTRACTOR SHALL REFER TO OTHER DRAWINGS AND SPECIFICATIONS FOR ADDITIONAL ELECTRICAL REQUIREMENTS.

AFA ENGINEERING, LLC
CONSULTING ENGINEERS
HVAC – PLUMBING – ELECTRICAL
706 WESTLAND DRIVE
LEXINGTON, KENTUCKY 40504
PHONE (859) 255-4437

SITE PLAN – ELECTRICAL

CUMBERLAND FALLS HIGHWAY WATER DISTRICT
US 25W TRANSMISSION MAIN
WHITLEY COUNTY, KENTUCKY

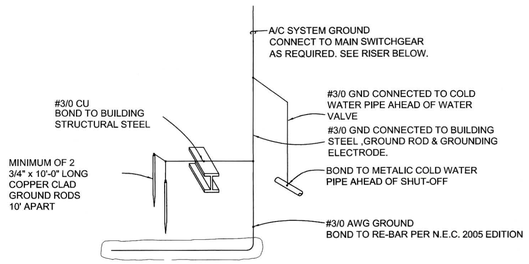
STATE OF KENTUCKY
THOMAS B. WILSON, JR. 9017
LICENSED PROFESSIONAL ENGINEER

DRAWN BY:
CHECKED BY:
CHECKED BY:
DATE: December 2014
SCALE: As Noted
REVISIONS

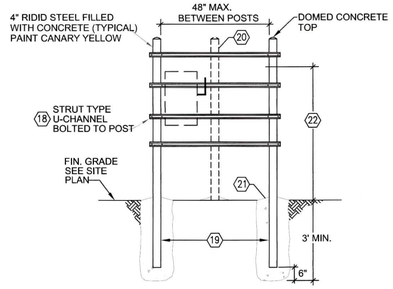
KENVIRONS, INC.
FRANKFORT, KENTUCKY

PROJECT NO.
2012059

SHEET NO.
E-1



MAIN SERVICE AC SYSTEM GROUND
SCALE: NTS



TYPICAL EQUIPMENT SUPPORT DETAIL
SCALE: NTS

ELECTRICAL LEGEND

- LIGHT SWITCH – SINGLE POLE, 3–WAY, 4–WAY, KEY OPERATED
- MANUAL MOTOR STARTER SWITCH
- FAN SPEED CONTROL
- DUPLEX RECEPTACLE
- SINGLE RECEPTACLE
- DUPLEX G.F.I. RECEPTACLE
- JUNCTION BOX
- THERMOSTAT : HUMIDISTAT
- DISCONNECT SWITCH
- EXPLOSION PROOF DISCONNECT SWITCH
- COMBINATION MOTOR STARTER
- VFD VARIABLE FREQUENCY DRIVE
- EQUIPMENT CONNECTION
- MOTOR CONNECTION
- CONDUIT CONCEALED BELOW SLAB OR GRADE
- CONDUIT SEAL – CLASS 1 DIVISION 1
- CONDUIT TURNED UP
- CONDUIT TURNED DOWN
- CORD & PLUG CONNECTION TO RECEPTACLE
- CONDUIT CONCEALED IN WALL OR CEILING
  NO. SLASHES EQUALS NO. CONDUCTORS – MIN. #12 AWG
  WIRE SIZE IF OTHER THAN #12
  NO. ARROWS EQUALS NO. CIRCUITS
  1,3,5 – INDICATES POLE POSITIONS
  A – INDICATES PANEL NO.
  (A-133)
- TI TRANSFORMER
- BC BATTERY CHARGER
- MPZ COMBINATION TRANSFORMER/PANEL (SQUARE D MINI POWER–ZONE OR EQUAL)
- UTILITY CO. POWER POLE
- UTILITY CO. METER
- PT PRESSURE TRANSDUCER
- TELEMETRY ANTENNA
- TELEMETRY ANTENNA SUPPORT POLE/ TOWER
- STATION DOOR OPEN–CLOSED STATUS CONTACTS
- M MOTORIZED DAMPER
- C CONTACTS
- E CONCRETE PULL BOX – FIN. GRADE MOUNTED
- I_M INTERCOM SYSTEM MASTER WITH KEYPAD
- I_R INTERCOM SYSTEM REMOTE
- I_B INTERCOM SYSTEM BUZZER
- R RELAY
- 3 #3/0 T/S TWISTED SHIELDED PAIR CABLE NUMBER = NO. CABLES IF MORE THAN ONE
- MANUAL TRANSFER SWITCH
- EQUIPMENT SUPPORT
- G GENERATOR
- FOT FUEL OIL TANK
- TVSS TYPE 1 SURGE PROTECTIVE DEVICE (TRANSIENT VOLTAGE SURGE SUPRESSOR) TYPE AS NOTED
- SCADA SYSTEM ANTENNA, INSTALL WITH COAXIAL CABLE IN 1 1/4"C. PER SYSTEM SUPPLIER
- RFD REMOTE FLOW DISPLAY
- OP — OVERHEAD PRIMARY
- UP — UNDERGROUND PRIMARY
- OS — OVERHEAD SECONDARY
- US — UNDERGROUND SECONDARY
- OT — OVERHEAD TELEPHONE
- UT — UNDERGROUND TELEPHONE
- UE — UNDERGROUND ELECTRIC
- UC — UNDERGROUND CONTROL

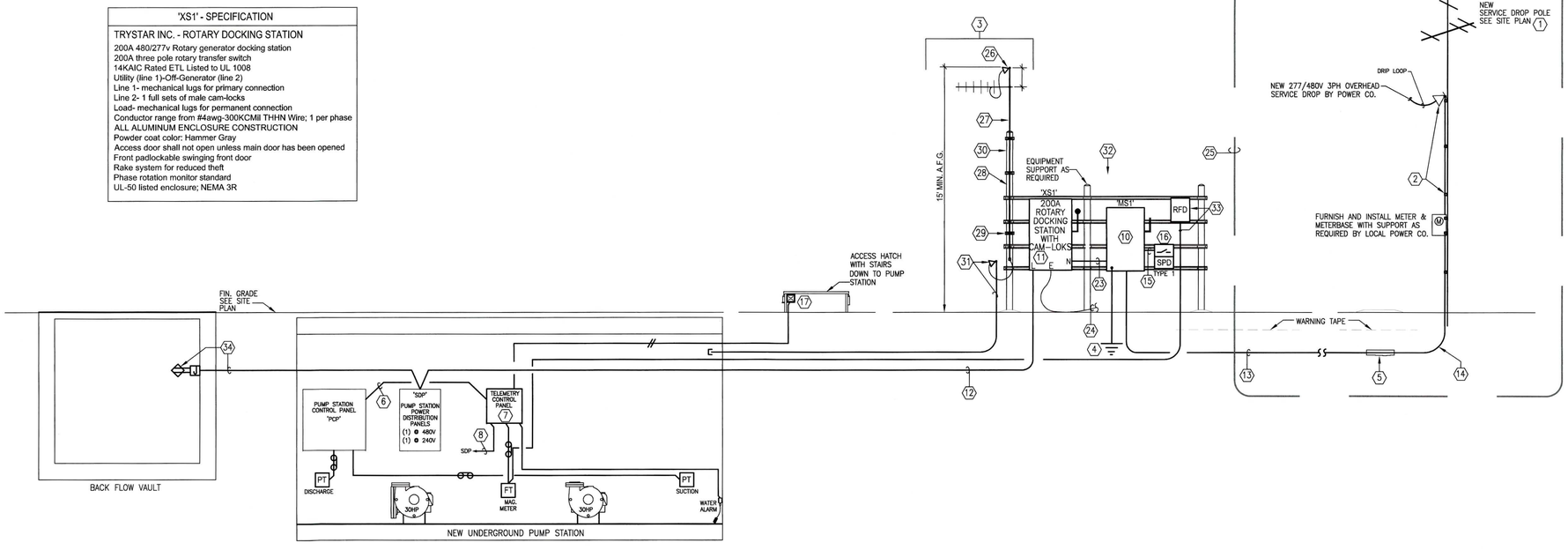
C.	CONDUIT
W	WIRE
PH	PHASE
EC	ELECTRICAL CONTRACTOR
CKT	CIRCUIT
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
WP	WEATHERPROOF
WPI	WEATHERPROOF IN–USE TYPE COVER
FUT.	FUTURE
OHS	OVERHEAD SECONDARY SERVICE
OHP	OVERHEAD PRIMARY
US	UNDERGROUND SECONDARY SERVICE
UP	UNDERGROUND PRIMARY
OHT	OVERHEAD TELEPHONE SERVICE
UT	UNDERGROUND TELEPHONE SERVICE
S.E.	SERVICE ENTRANCE
TYP.	TYPICAL
N,L,E,C,	TRANSFER SWITCH – NORMAL, LOAD, EMERGENCY, CONTROL
GRD	GROUND

XP	EXPLOSION PROOF
SV	SOLENOID VALVE
MV	MOTORIZED VALVE
CR	CORROSION RESISTANT
ENCL	ENCLOSURE
CB	CIRCUIT BREAKER
SWD	SWITCHING DUTY
EUH	ELECTRIC UNIT HEATER
S.S.	STAINLESS STEEL
RTU	REMOTE TERMINAL UNIT
MCP	MAIN CONTROL PANEL
FCC	FILTER CONTROL CONSOLE
GRS	GALVANIZED RIGID STEEL
RAC	RIGID ALUMINUM CONDUIT
CP	CONTROL PANEL
PCP	PUMP CONTROL PANEL
LCP	LEVEL CONTROL PANEL
E.T.	ELAPSED TIME

SHEET NOTES

1. VERIFY EXACT POLE LOCATION WITH POWER CO. IN FIELD.
2. FURNISH AND INSTALL RISER WITH WEATHERHEAD TO HEIGHT AS REQUIRED BY LOCAL POWER CO. SECURE TO POLE AS REQUIRED.
3. VERIFY EXACT ANTENNA INSTALLATION REQUIREMENTS (YAGI/VERTICAL ANTENNA & POLE/TOWER MOUNT) WITH TELEM. SYSTEM SUPPLIER PRIOR TO BID AND FURNISH AND INSTALL COMPLETE SUPPORT SYSTEM AS REQUIRED.
4. FURNISH AND INSTALL AC SYSTEM GROUND PER 2014 N.E.C. SEE DETAIL THIS SHEET FOR ADDITIONAL REQUIREMENTS.
5. CONCRETE ENCASE CIRCUITS MIN. 6" ALL AROUND WHERE RUN BELOW DRIVES/ROADWAYS.
6. FURNISH AND INSTALL WIRE AND SHIELDED CABLES AS REQUIRED IN (2) 1"C FOR TELEMETRY CONTROL SIGNALS TO/FROM 'PCP'.
7. FURNISH AND INSTALL NEW TELEM. SYSTEM RTU AS REQUIRED.
8. 3 #12, 1 #12GRD., 1"C.; 120VAC FOR TELEM. PANEL POWER.
9. VERIFY TELEMETRY ANTENNA SUPPORT (PIPE MAST, POLE OR TOWER) FOR THIS LOCATION WITH TELEMETRY EQUIPMENT SUPPLIER AND INSTALL PER MFGR. INSTRUCTIONS. INSTALL STEEL REINFORCED CONCRETE BASE WHERE TOWER INSTALLATION IS REQUIRED.
10. FURNISH AND INSTALL 200A, 3P, 600V, NEMA 4, S.E. RATED FUSIBLE MAIN DISCONNECT SWITCH. FUSE AT 200A WITH TYPE 'R' FUSE FOR 100,000 A.I.C. RATING.
11. FURNISH AND INSTALL 200A, 277/480V, NEMA 3R COMBINATION ROTARY TRANSFER SWITCH/DOCKING STATION. ALUMINUM ENCLOSURE. SEE SPEC, THIS SHEET.
12. 4 #3/0, 1 #6GRD., 2"C.
13. 4 #3/0, 2"C.
14. INSTALL LONG RADIUS ELLS, TYPICAL.
15. 5 #6, 1 1/4"C.
16. FURNISH AND INSTALL SURGE PROTECTOR IN NEMA 4 ENCLOSURE WITH INTEGRAL DISCONNECT SWITCH.
17. FURNISH AND INSTALL DOOR CONTACTS/LIMIT SWITCH AS REQUIRED FOR HATCH STATUS INDICATION THRU TELEMETRY SYSTEM.
18. FURNISH AND INSTALL MINIMUM (4) U-CHANNEL SPANS BETWEEN POSTS AND ADD ADDITIONAL AS REQUIRED FOR SUPPORT OF EQUIPMENT AND CONDUITS.
19. PAINT RGS POSTS WITH MIN. 2 COATS OF BITUMASTIC WHERE IN CONTACT WITH CONCRETE.
20. FURNISH AND INSTALL ADDITIONAL SUPPORT POST WITH CONCRETE BASE WHERE SPAN EXCEEDS 48" AND ADDITIONAL POSTS AS REQUIRED SUCH THAT NO SPAN BETWEEN POSTS EXCEEDS 48".
21. FURNISH AND INSTALL 18" DIAMETER BY 30" DEEP CONCRETE BASE FOR EACH SUPPORT POST REQUIRED. BASES SHALL BE A SINGLE HOMOGENEOUS CONCRETE POUR.
22. 6'-6" MAXIMUM HEIGHT TO TOP OF ELECTRICAL EQUIPMENT.
23. 4 #3/0, 1 #4GRD., 2"C.
24. CABLES FROM PORTABLE GENSET.
25. FURNISH AND INSTALL NEW 120/240V, 1PH SERVICE WITH SIMILAR POLE, METERING, SECONDARY SERVICE AND NEMA 3R, 120/240V, 1PH, S.E. RATED, 100A MAIN BREAKER PANEL WITH 12 SPACES AND (4) 20A, 1P BRANCH BREAKERS AT INSTALLATION OF NEW SOLENOID VALVE VAULT WITH SUMP PUMP AT EXIST. PUMP STATION TO BE REMOVED. SEE OTHER DRAWINGS ASSOCIATED WITH THIS CONTRACT FOR LOCATION AND ADDITIONAL REQUIREMENTS. NEW SEC. SERVICE TO PANEL SHALL BE 3 #1, 1 #6 GRD., 2"C. COORDINATE WITH G.C. & LOCAL POWER CO. INSTALL POWER CIRCUITS FROM NEW PANEL USING 2 #10, 1 #10GRD., 1"C. TO SOLENOID VALVE AND TO VAULT SUMP PUMP AS REQUIRED.
26. FURNISH AND INSTALL WEATHERHEAD ON TOP OF PIPE MAST FOR COAXIAL CABLE.
27. FURNISH AND INSTALL 2" RGS CONDUIT MAST FOR INSTALLATION OF COAXIAL CABLE AND ANTENNA SUPPORT. COORDINATE INSTALLATION WITH TELEMETRY SYSTEM SUPPLIER.
28. MIN. 4' OVERLAP OF SUPPORT MAST WITH BLACK STEEL PIPE EQUIPMENT SUPPORT POST REQUIRED.
29. SECURE ANTENNA MAST TO EQUIPMENT SUPPORT POST U-CHANNEL AT MINIMUM 4 LOCATIONS.
30. CONTRACTOR MAY AT HIS OPTION EXTEND LENGTH OF OF EQUIPMENT SUPPORT POST MAX. OF 48" TO ALLOW FOR INSTALLATION OF ANTENNA MAST.
31. FURNISH AND INSTALL WEATHERHEAD AND 1 1/2"C. WITH COAXIAL CABLE TO TELEMETRY (RTU) SYSTEM ANTENNA. COORDINATE WITH OWNER AND TELEM. EQUIPMENT SUPPLIER.
32. ALL EQUIPMENT CABINETS ON THIS SUPPORT STRUCTURE SHALL HAVE LOCKABLE COVERS.
33. FURNISH AND INSTALL NEMA 4 STAINLESS STEEL ENCLOSURE FOR HOUSING REMOTE FLOW TOTALIZER DISPLAY. SIZE AS REQUIRED. FURNISH AND INSTALL WIRE/CABLE IN 1"C. AS REQUIRED.
34. FURNISH AND INSTALL GFCI TYPE RECEPTACLE WITH WEATHERPROFF IN-USE COVER AS HIGH AS POSSIBLE IN VAULT FOR SUMP PUMP CONNECTION. CIRCUIT USING 2 #12, 1"C. TO STATION POWER PANEL.

'XS1' - SPECIFICATION
TRYSTAR INC. - ROTARY DOCKING STATION
200A 480/277v Rotary generator docking station
200A three pole rotary transfer switch
14KAIC Rated ETL Listed to UL 1008
Utility (line 1)-Off-Generator (line 2)
Line 1- mechanical lugs for primary connection
Line 2- 1 full sets of male cam-locks
Load- mechanical lugs for permanent connection
Conductor range from #4awg-300KCMil THHN Wire; 1 per phase
ALL ALUMINUM ENCLOSURE CONSTRUCTION
Powder coat color: Hammer Gray
Access door shall not open unless main door has been opened
Front padlockable swinging front door
Rake system for reduced theft
Phase rotation monitor standard
UL-50 listed enclosure; NEMA 3R



ONE LINE POWER RISER
SCALE: NTS

AFA ENGINEERING, LLC
CONSULTING ENGINEERS
HVAC – PLUMBING – ELECTRICAL
706 WESTLAND DRIVE
LEXINGTON, KENTUCKY 40504
PHONE (859) 255-4437

RISER & DETAILS – ELECTRICAL

CUMBERLAND FALLS HIGHWAY WATER DISTRICT
US 25W TRANSMISSION MAIN
WHITLEY COUNTY, KENTUCKY

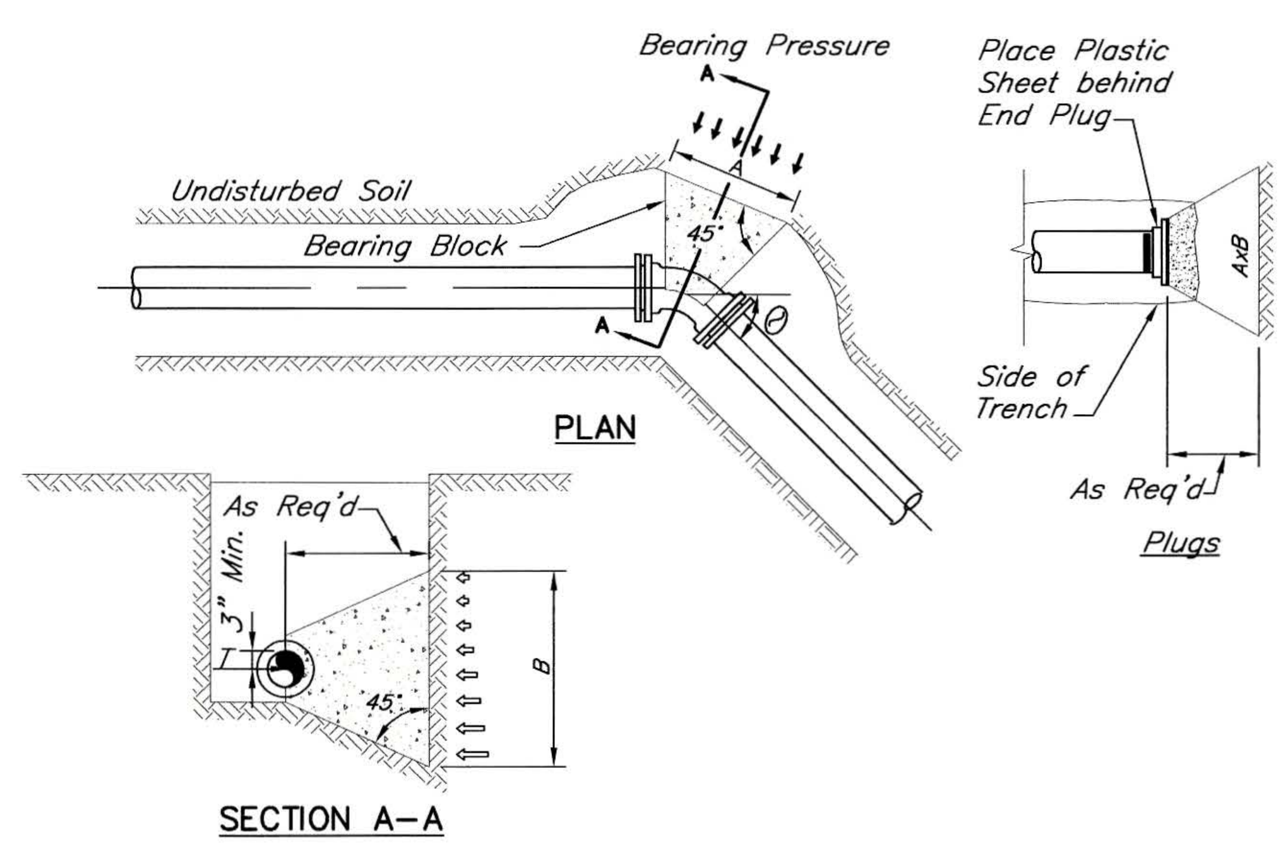
STATE OF KENTUCKY
THOMAS B. WILSON, JR.
#017
LICENSED
PROFESSIONAL ENGINEER

DRAWN BY: TN
CHECKED BY: TW
DATE: December 2014
SCALE: As Noted
REVISIONS

KENVIRONS, INC.
FRANKFORT, KENTUCKY

PROJECT NO.
2012059

SHEET NO.
E–2



NOTES:

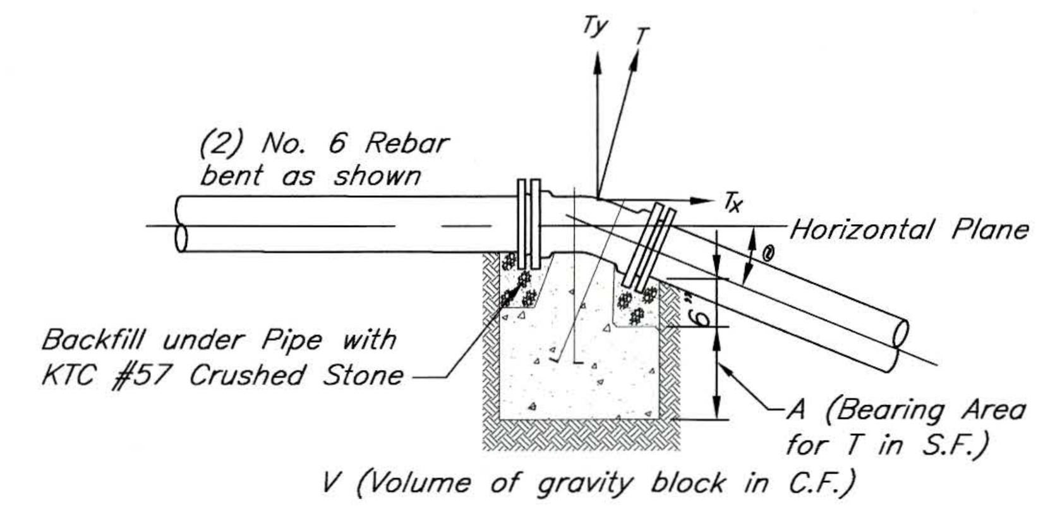
1. Thrust restraint table is based on pipeline pressure of 200 psi and earthbearing capacity of 1500 psf. During construction, the specific soil type may be evaluated and concrete thrust block size revised at the discretion of the engineer.
2. On large diameter pipes where space limitations or constuction difficulties render concrete thrust blocks not feasible or impractical, joint system may be used. This restrained joint system must be approved by the Engineer.
3. Concrete shall be 3000 psi minium conforming to KTC Specifications 601.
4. Accessibility to fittings and bolts must be maintained.
5. Wrap fittings in plastic prior to placing concrete.

HORIZONTAL THRUST BLOCK SCHEDULE

PIPE SIZE (INCHES)	90° BEND		45° BEND		22 1/2° BEND		11 1/4° BEND		TEE, DEAD END	
	A	B	A	B	A	B	A	B	A	B
3 & 4	3'–3"	1'–8"	2'–4"	1'–2"	1'–8"	1'–0"	1'–0"	1'–0"	2'–8"	1'–4"
6	4'–8"	2'–4"	3'–5"	1'–8"	2'–6"	1'–3"	1'–6"	1'–0"	3'–10"	2'–0"
8	6'–0"	3'–0"	4'–5"	2'–3"	3'–2"	1'–7"	2'–3"	1'–2"	5'–0"	2'–6"
10	7'–6"	3'–9"	5'–5"	2'–9"	3'–10"	2'–0"	2'–9"	1'–5"	6'–3"	3'–2"
12	8'–10"	4'–5"	6'–6"	3'–3"	4'–8"	2'–4"	3'–4"	1'–8"	7'–5"	3'–9"
14	10'–3"	5'–2"	7'–6"	3'–9"	5'–4"	2'–8"	3'–10"	2'–0"	8'–8"	4'–4"
16	11'–8"	5'–10"	8'–7"	4'–4"	6'–1"	3'–0"	4'–4"	2'–2"	9'–9"	4'–11"
18	13'–0"	6'–6"	9'–7"	4'–9"	6'–10"	3'–5"	4'–10"	2'–5"	11'–0"	5'–6"
20	14'–5"	7'–3"	10'–7"	5'–4"	7'–7"	3'–9"	5'–4"	2'–8"	12'–2"	6'–1"
24	17'–3"	8'–8"	12'–8"	6'–4"	9'–0"	4'–6"	6'–5"	3'–3"	14'–6"	7'–3"

HORIZONTAL THRUST BLOCK

July, 2011 — Scale: 3/8"=1'–0"



NOTES:

1. Thrust restraint table is based on pipeline pressure of 200 psi and earth bearing capacity of 1500psf. During construction, the specific soil type may be evaluated and concrete thrust block size revised at the discretion of the engineer.
2. On large diameter pipes where space limitations or constuction difficulties render concrete thrust blocks not feasible or impractical, joint system may be used. This restrained joint system must be approved by the Engineer.
3. Concrete shall be 3000 psi minium conforming to KTC Specifications 601.
4. Accessibility to fittings and bolts must be maintained.
5. Wrap fittings in plastic prior to placing concrete.

VERTICAL THRUST BLOCK SCHEDULE

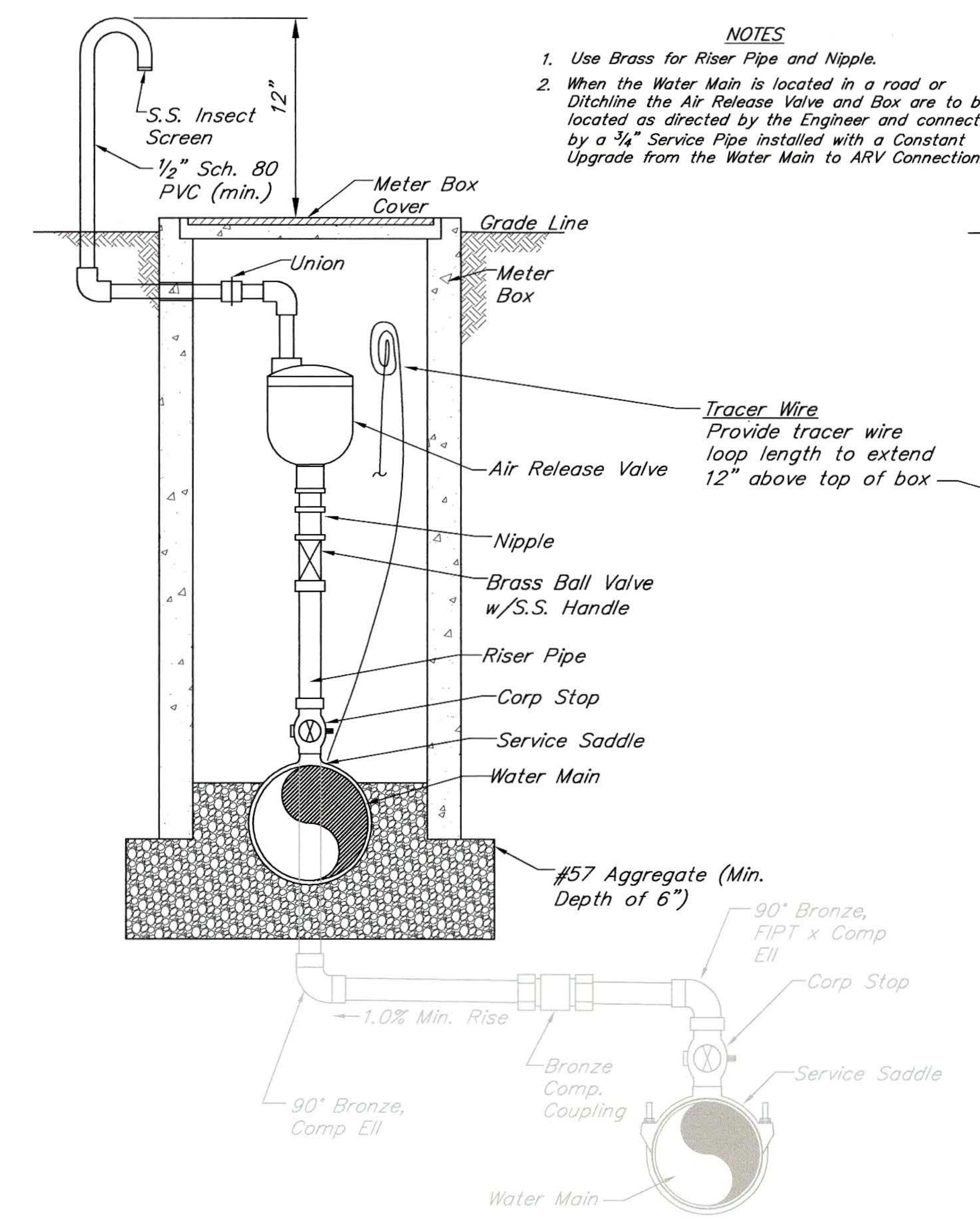
PIPE SIZE (INCHES)	90° BEND		45° BEND		22 1/2° BEND		11 1/4° BEND	
	V	A	V	A	V	A	V	A
3 & 4	29	2	20	1	11	1	6	1
6	64	5	46	2	25	1	13	1
8	114	8	81	4	43	1	23	1
10	174	12	123	5	66	2	35	1
12	248	17	176	8	95	2	50	1
14	337	23	238	10	128	3	67	1
16	439	29	311	13	167	4	88	1
18	555	37	393	16	211	5	111	1
20	685	46	484	20	260	6	137	2
24	985	66	696	29	374	8	197	2

VERTICAL THRUST BLOCK

July, 2011 — Scale: 1/2"=1'–0"

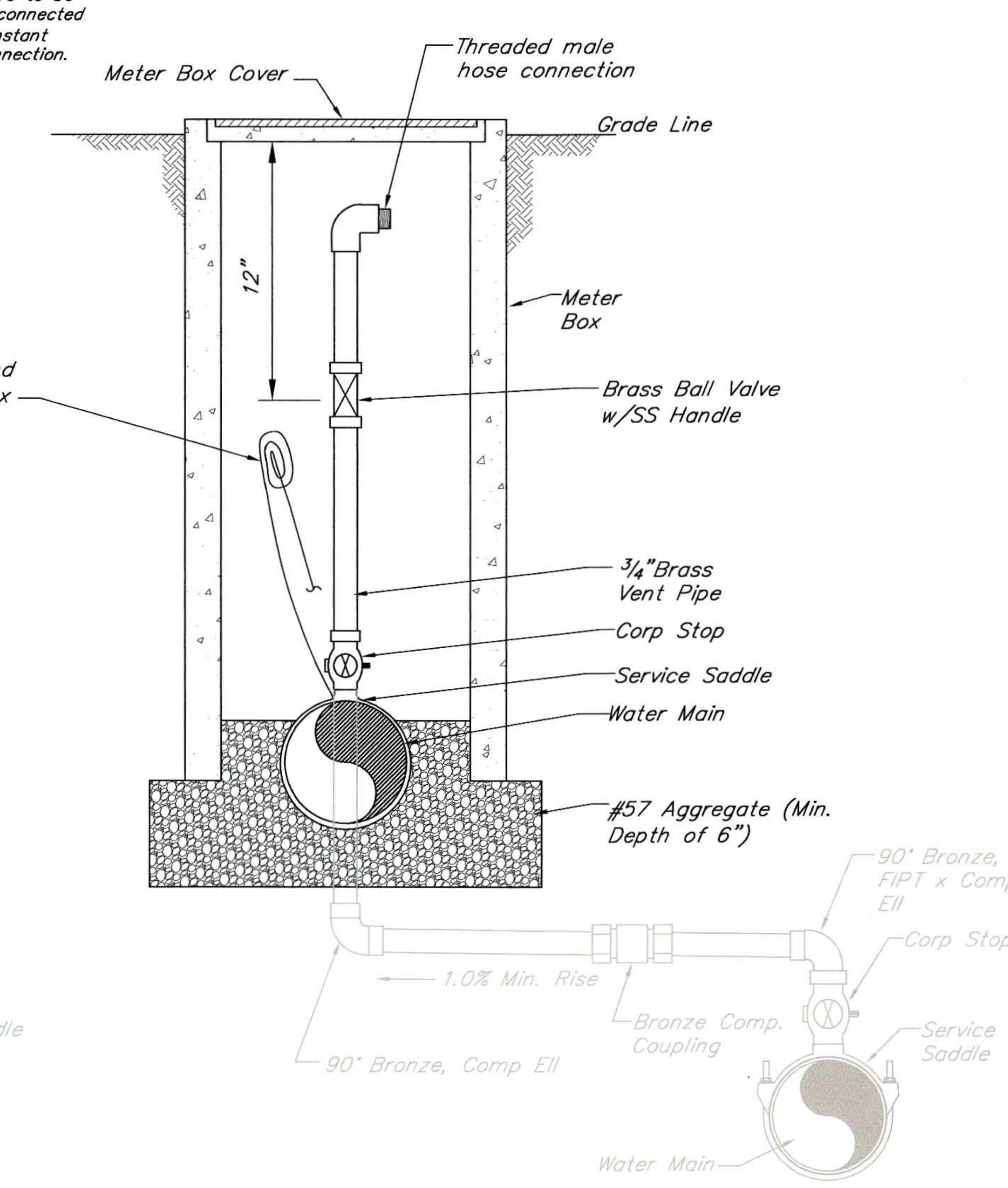
NOTES

1. Use Brass for Riser Pipe and Nipple.
2. When the Water Main is located in a road or Ditchline the Air Release Valve and Box are to be located as directed by the Engineer and connected by a 3/4" Service Pipe installed with a Constant Upgrade from the Water Main to ARV Connection.



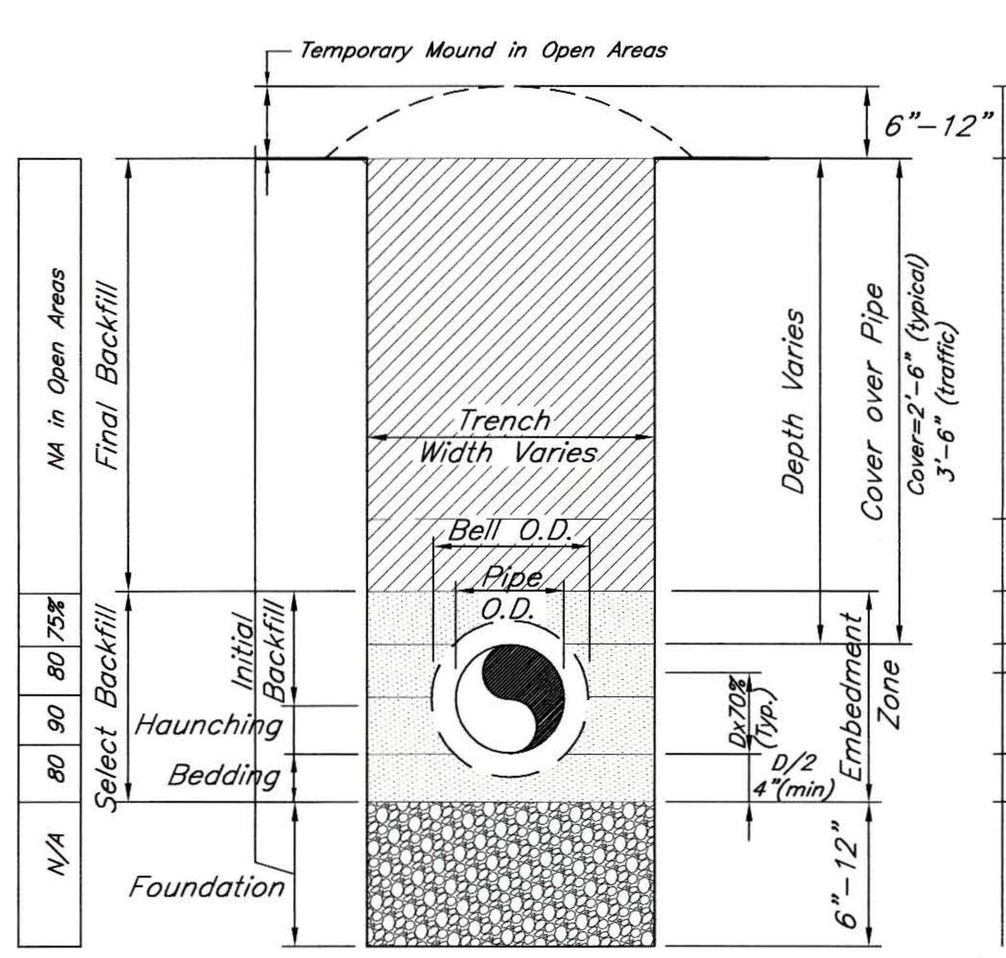
AUTOMATIC AIR VALVE INSTALLATION

Dec., 2010 — N.T.S.



MANUAL AIR VALVE INSTALLATION

Dec., 2010 — N.T.S.



Typically, open areas are final graded, dressed and seeded following two soaking rains...excluding KYTC road ROW's

Unless otherwise specified, material excavated from trench may be used for final backfill provided it is relatively free of large rock (>8"), or mixed with sufficient dirt to minimize voids and settlement, and free of other unsuitable materials... as approved by the Engineer

The Engineer may require selective placement of an extra buffer layer for extremely rocky backfill to prevent migration

Select backfill, lightly compacted (bucket shaping) using suitable on–site material, or dumped sand.

Sand or very select material, hand tamped

Haunching to be carefully placed – Sand or sandy/clay soil. No. 9's may be required if weak foundation is encountered

Bedding to be sand or approved equivalent, (except No. 57's may be required if weak foundation encountered) hand placed and smoothed to uniform grade for support of pipe

In soft, wet, muddy or otherwise yielding foundation conditions, undercutting and replacement with No. 2 Stone and/or Class II channel lining, or equivalent, will be required. Objective is to provide a trench bottom free of large stones, clods, frozen material, etc. which is unyielding.

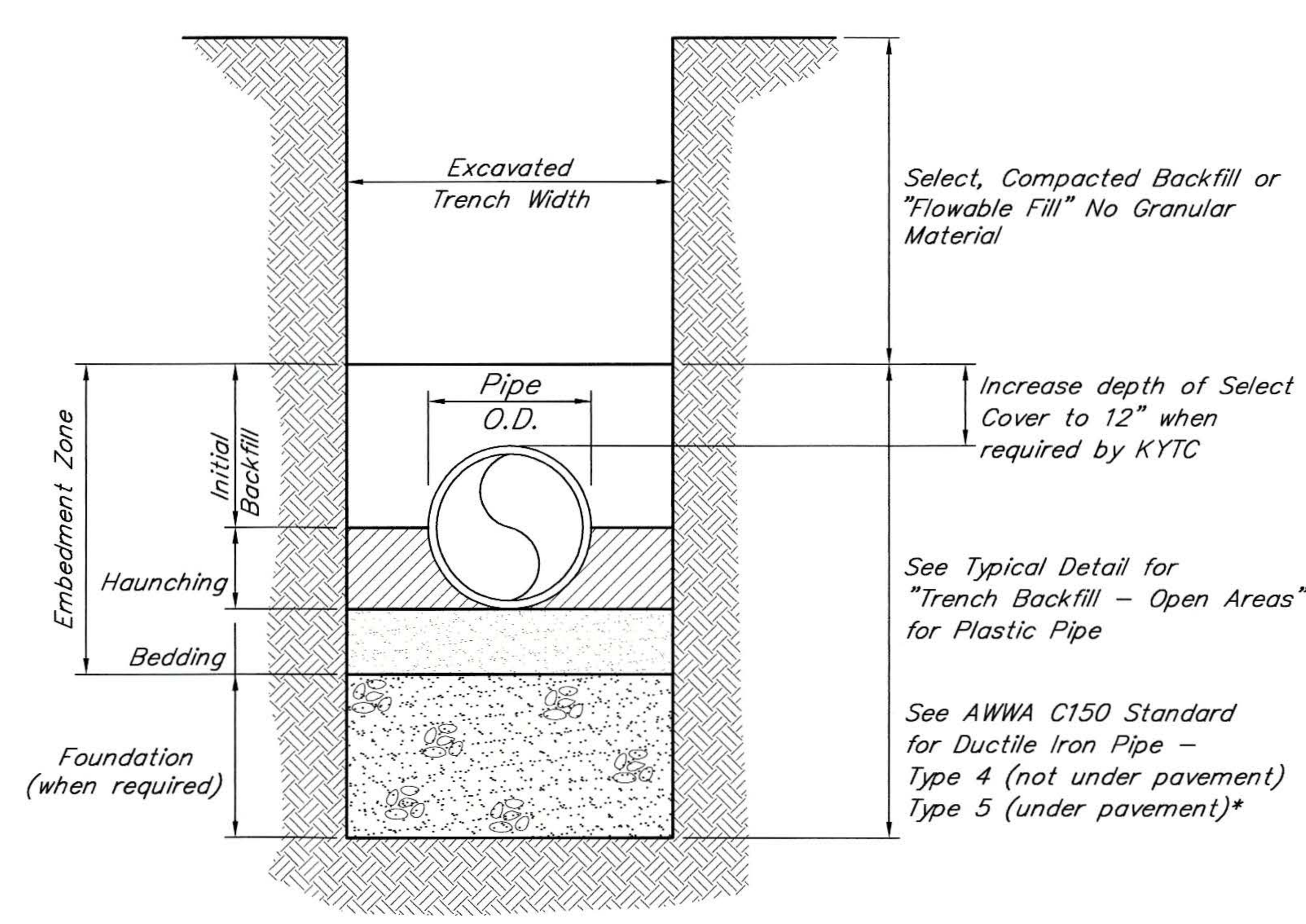
NOTES: No rocks larger than 1–1/2" allowed in embedment zone.

Typical desired densities in open areas are depicted above in the boxes to the left of the figure. In other laying situations, more stringent selection, placement and compaction will be required.

Trench width should be no wider than necessary for adequate work room and to assure safe working conditions. Nominal outside diameter (O.D.) pipe plus 6" on each side is typically considered minimal, with 8" minimum on each side for gravity sewer installation. For gravity sewer, pipe to be bedded on No. 9 stone and remainder of embedment zone to be backfilled with sand.

TRENCH BACKFILL OPEN AREAS – PLASTIC PIPE

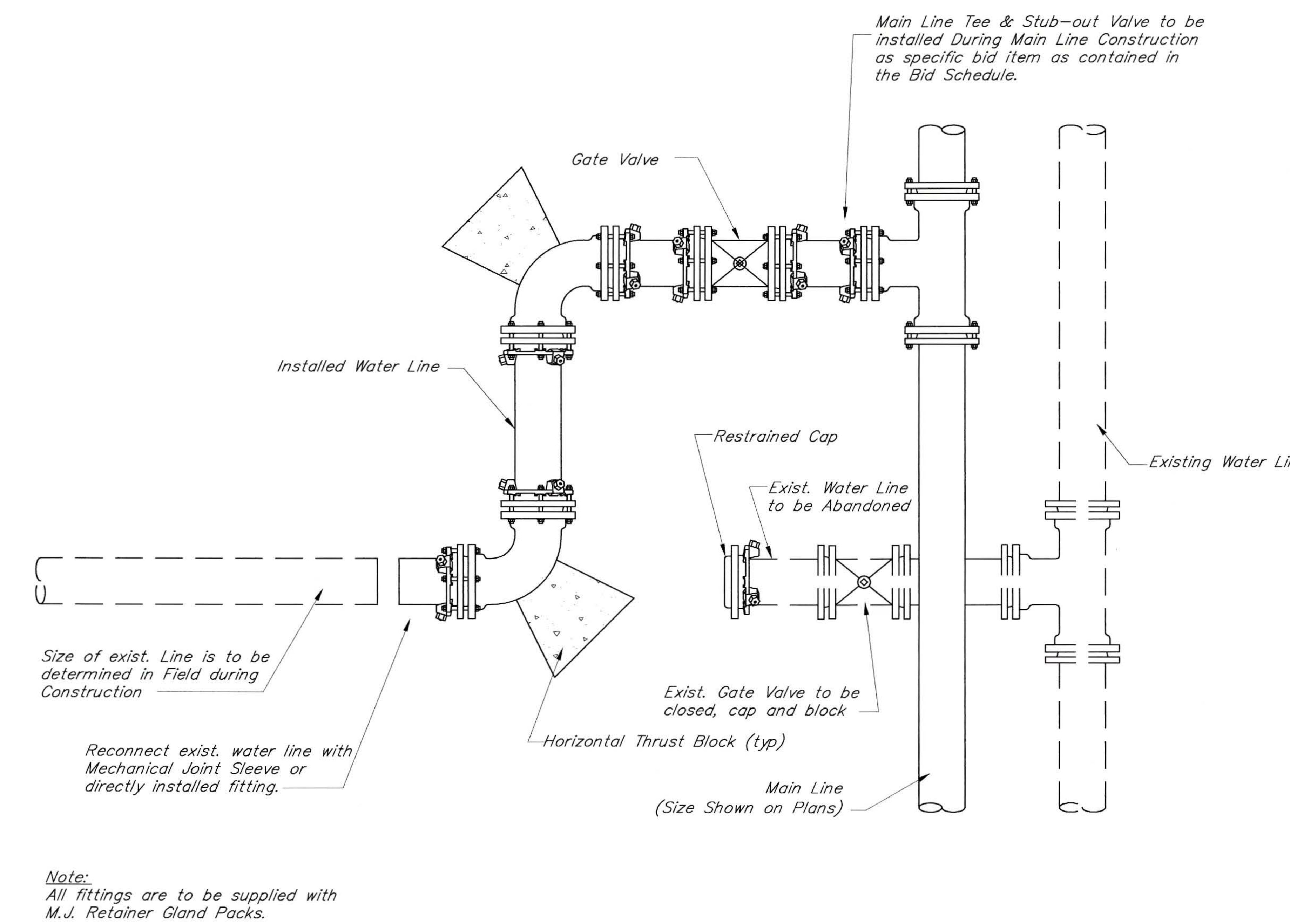
Mar., 2011 — Scale: 3/4"=1'–0"



* When "Open–cutting" of State Highway is permitted, pipe laying, encasement requirements, backfill placement, pavement replacement, etc. shall be as required by the encroachment permit issued by the Kentucky Transportation Cabinet (KYTC). By reference, such permit(s) shall become part of the contract. It shall be the CONTRACTOR'S responsibility to maintain a copy of KYTC permit(s) on the job site at all times.

TRENCH BACKFILL ON HIGHWAY ROW

Dec., 2010 — N.T.S.



Note:
All fittings are to be supplied with M.J. Retainer Gland Packs.

TYPICAL TIE–IN

Scale: 3/4"=1'–0"

MISCELLANEOUS DETAILS

CUMBERLAND FALLS HIGHWAY WATER DISTRICT
US 25W TRANSMISSION MAIN
WHITLEY COUNTY, KENTUCKY

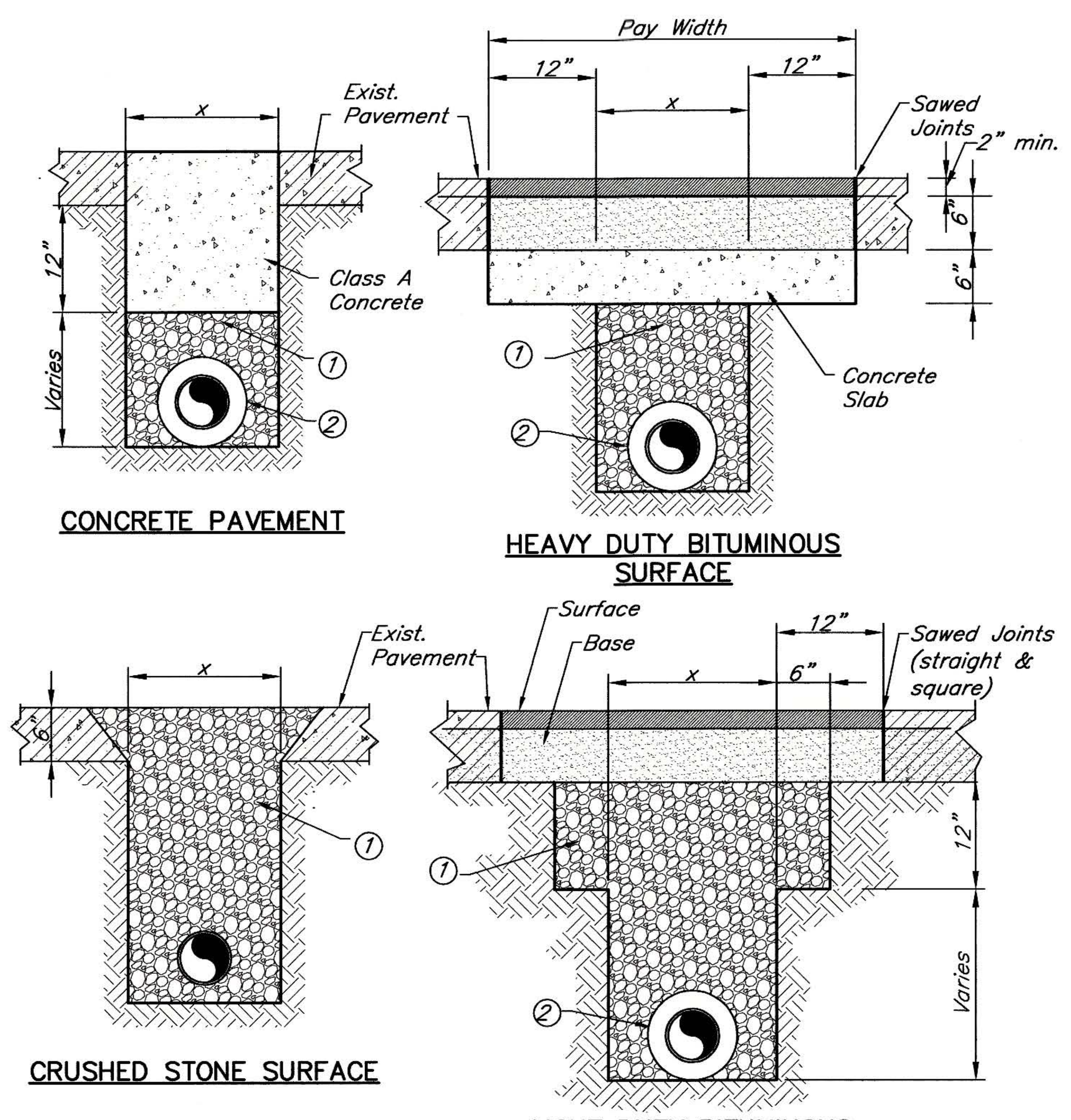
STATE OF KENTUCKY — CARLOS F. MILLER — 7384 — LICENSED PROFESSIONAL ENGINEER

DRAWN BY: JKP/PTH
CHECKED BY: CFM
CHECKED BY:
DATE: April 2014
SCALE: As Noted
REVISIONS

KENVIRONS, INC.
FRANKFORT, KENTUCKY

PROJECT NO. 2012059

SHEET NO. D–1



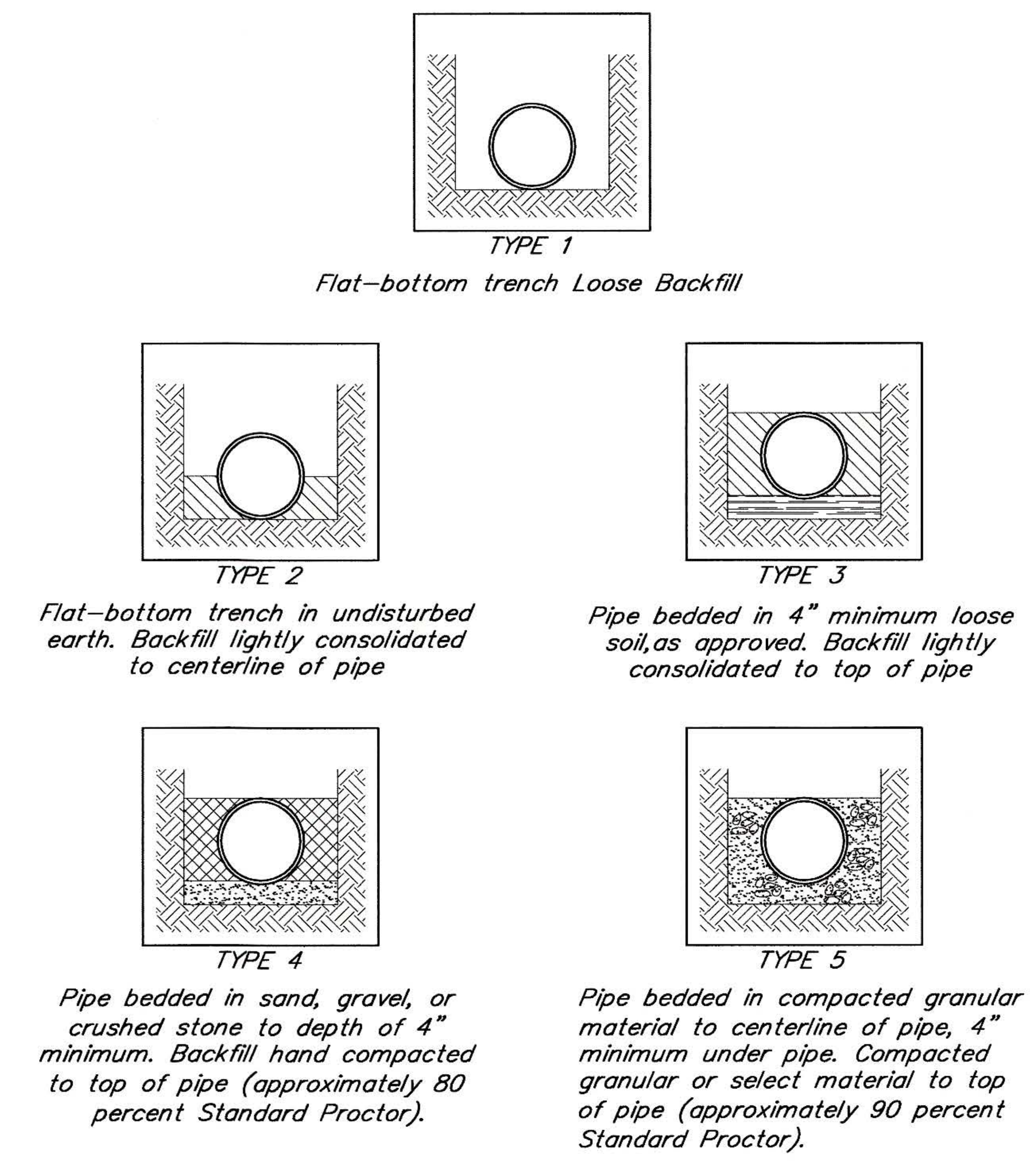
NOTES:
1. The max. allowable distance for dimension "X" shall be calculated as follows: X= 24" + Pipe Dia.
2. Concrete slab under Bituminous surface to extend 12-inches on each side to trench
3. Replace Concrete or Bit. Pavement with new pavement same thickness as existing pavement.
4. Casing Pipe is not required under private driveways.

① Mechanically tamped #57 crushed stone aggregate in layers not to exceed 6".

② Casing pipe to be 4" in diameter greater than the greatest dimension of the carrier pipe.

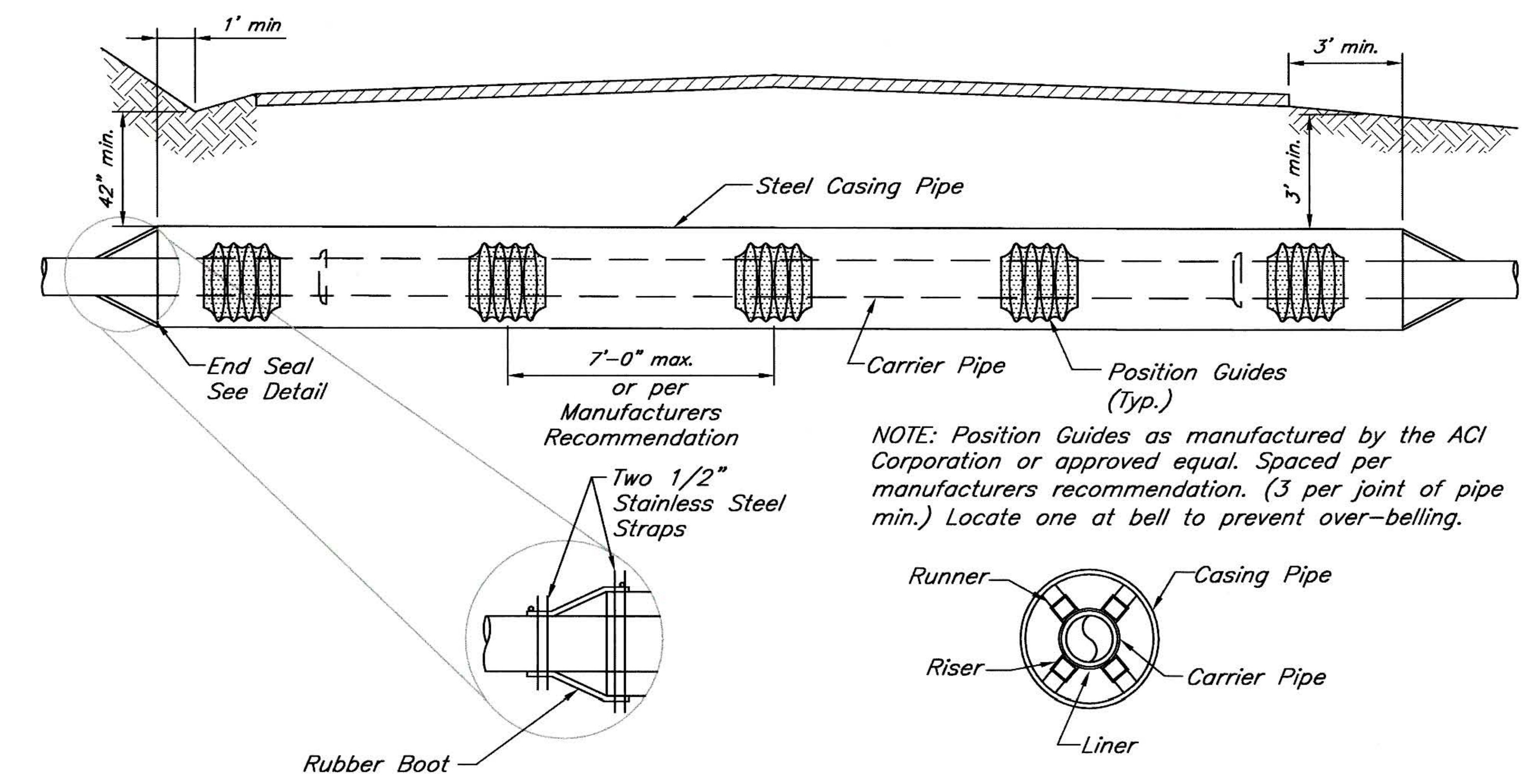
PAVEMENT REPLACEMENT

Mar., 2011 Scale: 3/4"=1'-0"



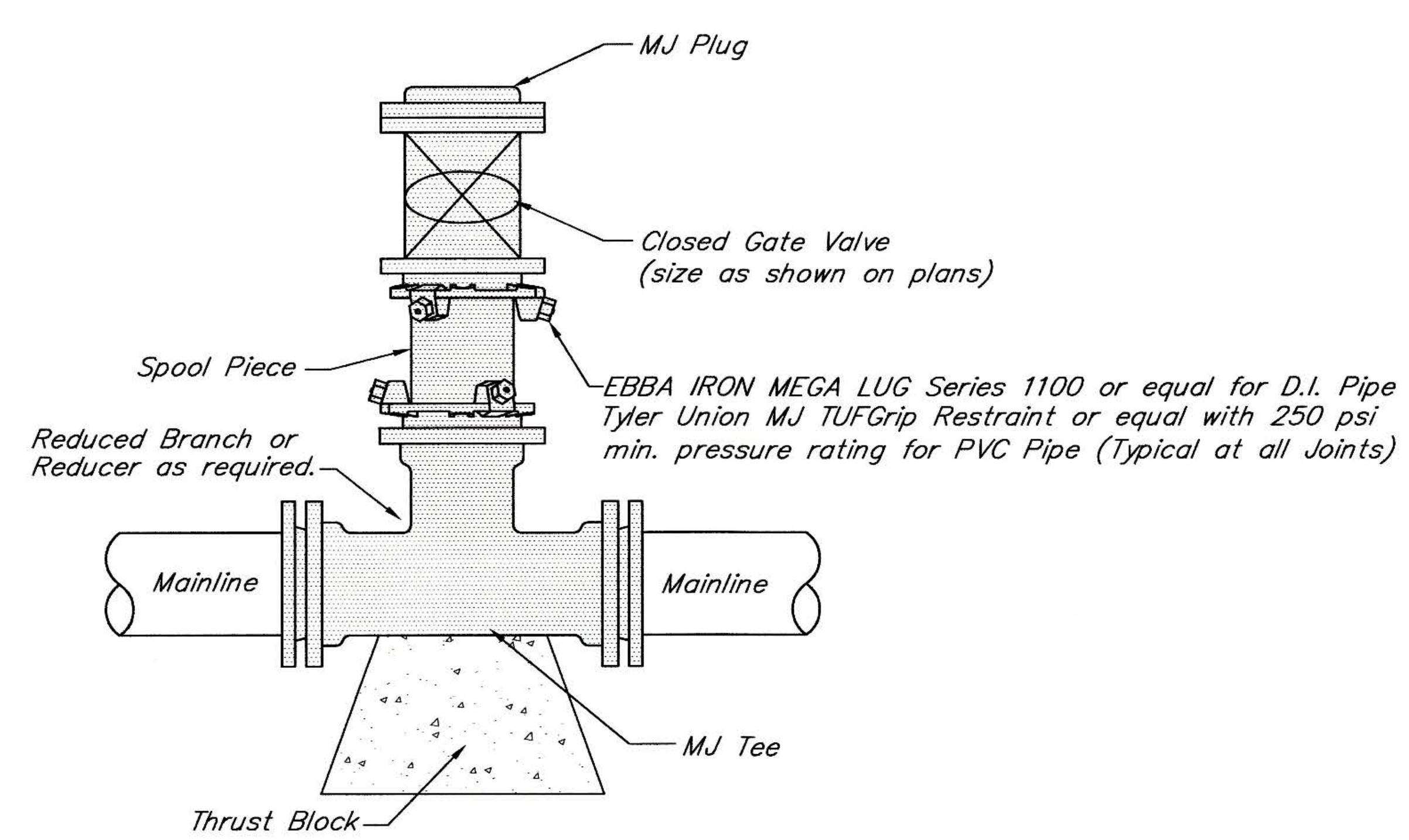
LAYING CONDITIONS FOR DUCTILE IRON PIPE

Dec., 2010 N.T.S.
Ref. AWWA C150



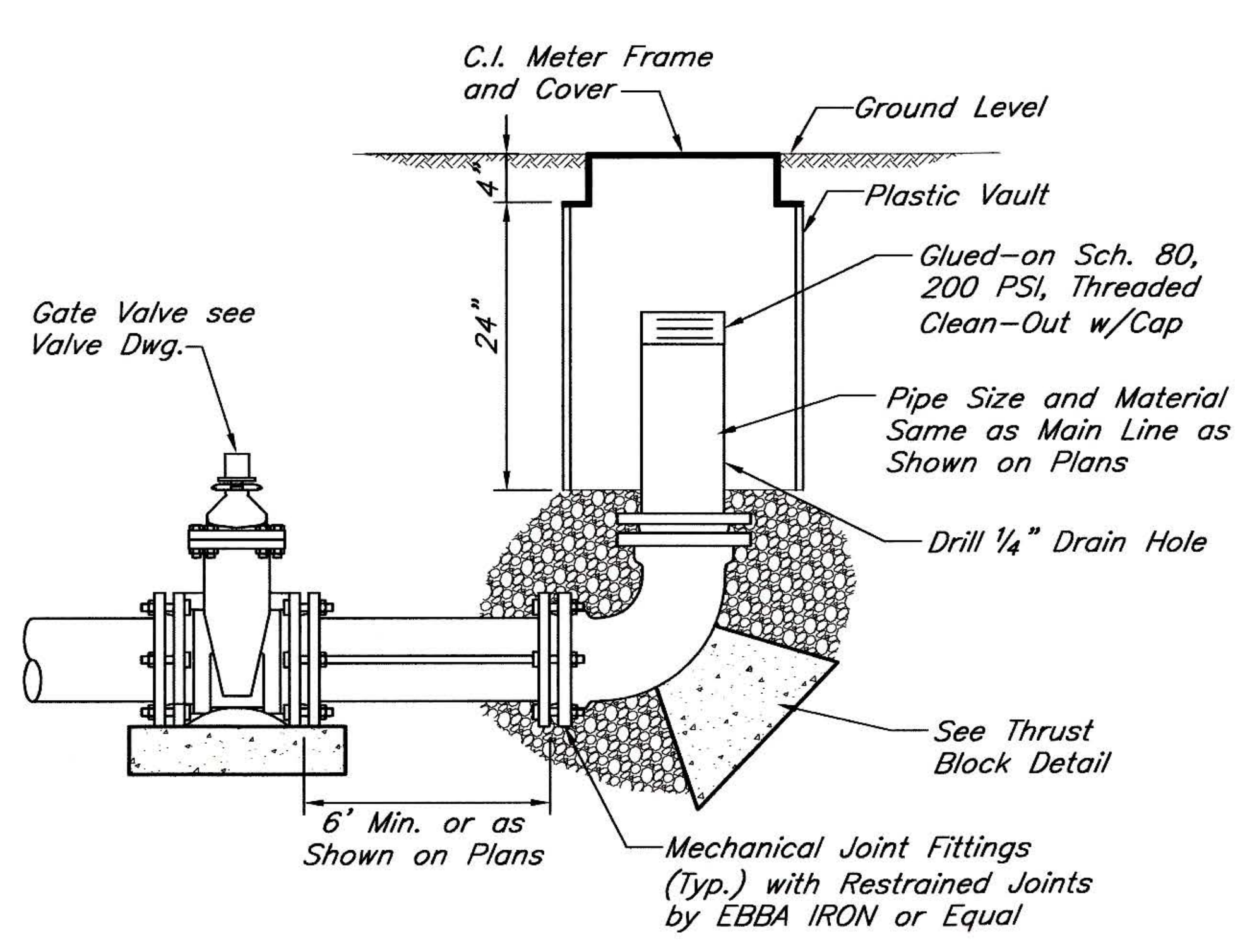
ROADWAY CROSSING INSTALLATION

Dec., 2010 Scale: 1/4"=1'-0"



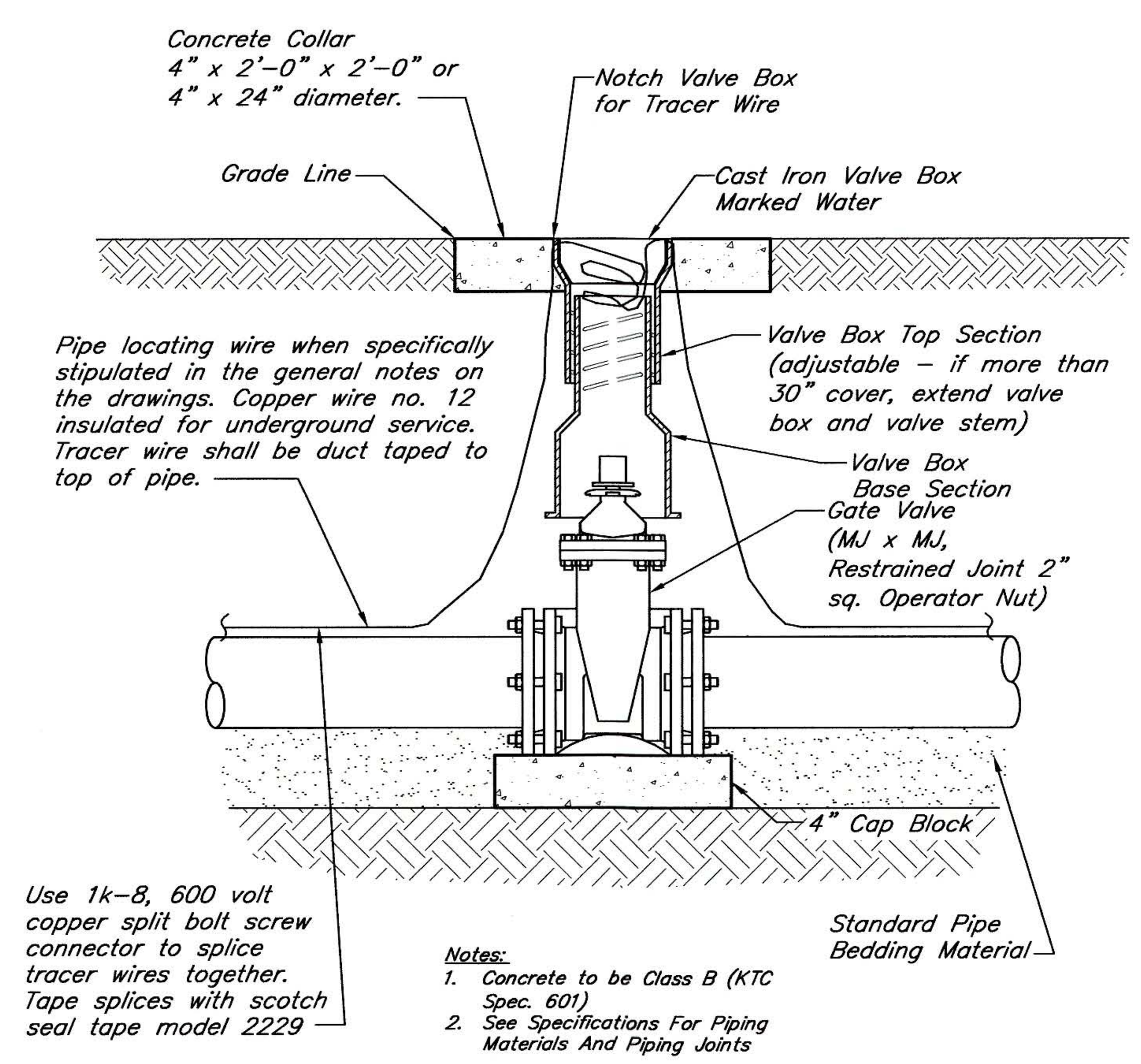
STUB-OUT DETAIL

Jan., 2011 N.T.S.



BLOWOFF ASSEMBLY DETAIL (TYPE 2)

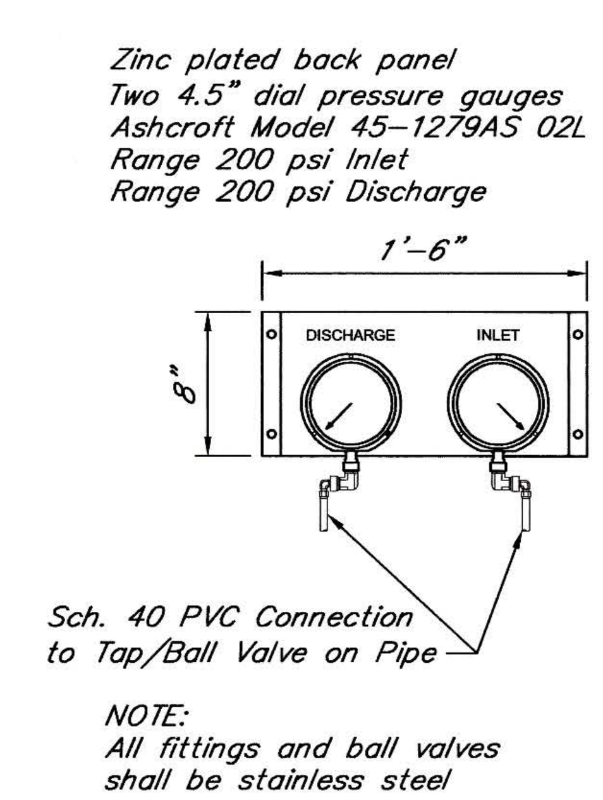
Mar., 2011 Scale: 3/4"=1'-0"



Notes:
1. Concrete to be Class B (KTC Spec. 601)
2. See Specifications For Piping Materials And Piping Joints

VALVE BOX INSTALLATION

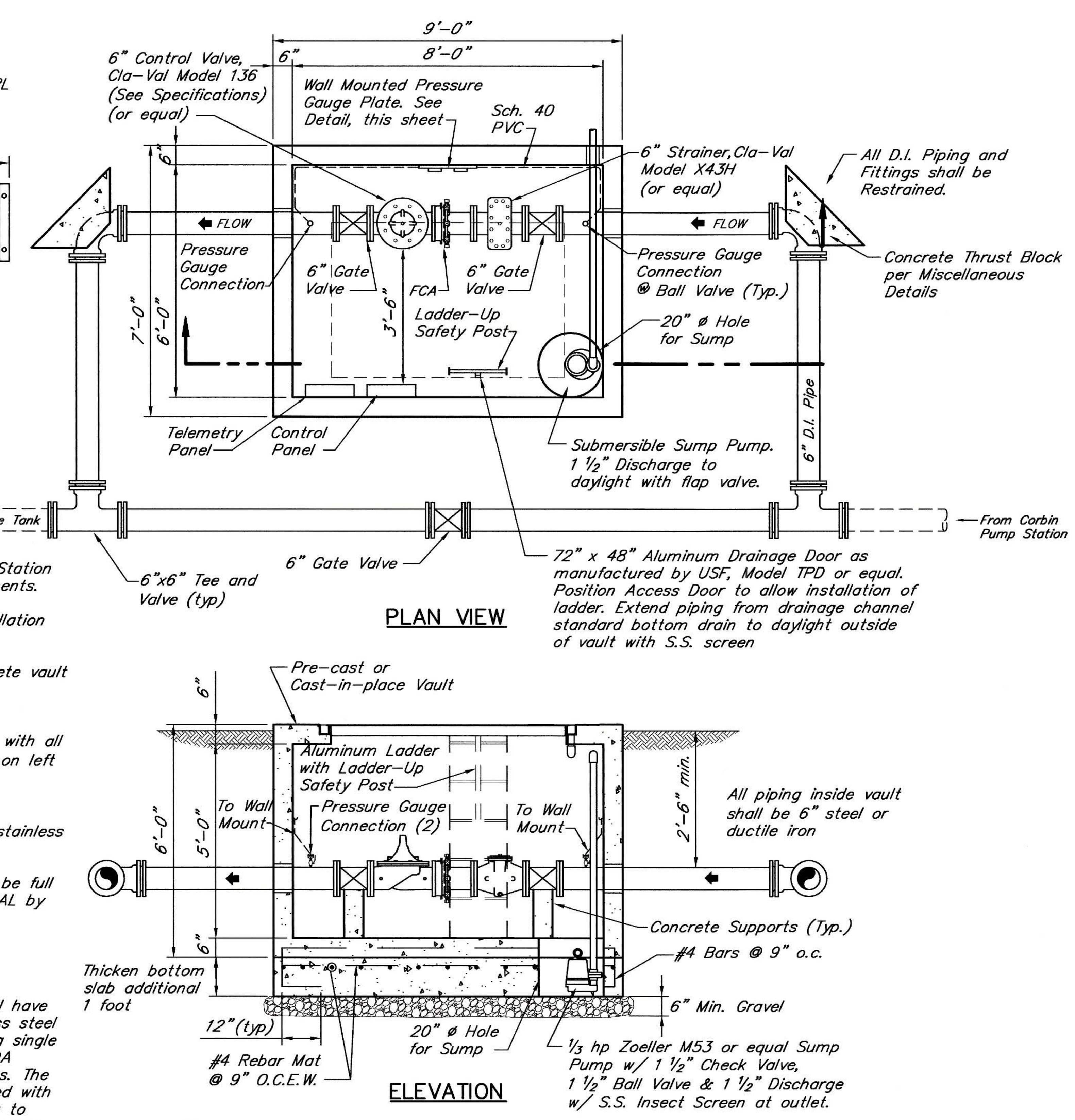
Mar., 2011 Scale: 1"=1'-0"



NOTE:
All fittings and ball valves shall be stainless steel

NOTES

1. See Specifications Section 13105-Solenoid/Control Valve Station for additional specific requirements.
2. Telemetry equipment and installation to be provided by others.
3. Provide conduit through concrete vault walls for electrical power and telemetry connections.
4. Control Valve shall be ordered with all operating valve/pilots/ tubing on left side of valve as viewed from inlet/strainer end.
5. All pipe flange bolts shall be stainless steel.
6. Gaskets for flanged pipe shall be full face gaskets equal to TORUSEAL by American Cast Iron Pipe Co.
7. Provide stainless bolts/nuts assembled with anti-seize.
8. The solenoid control valve shall have fusion bonded coating, stainless steel tubing, Nema 4 solenoid and a single limit switch to allow the SCADA system to monitor valve status. The solenoid valve shall be equipped with check valve in the pilot tubing to prevent any backflow from the Bee Creek tank to the Corbin tank.



6" SOLENOID CONTROL VALVE STATION

3/8"=1'-0"

MISCELLANEOUS DETAILS

CUMBERLAND FALLS HIGHWAY WATER DISTRICT
US 25W TRANSMISSION MAIN
WHITLEY COUNTY, KENTUCKY

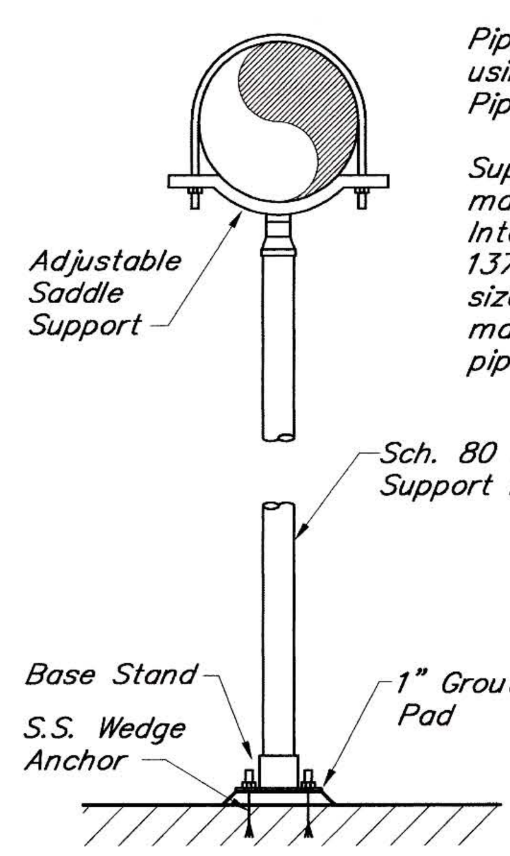
STATE OF KENTUCKY
CARLOS F. MILLER
7384
LICENSED PROFESSIONAL ENGINEER
4-23-14

DRAWN BY: JKP/PTH
CHECKED BY: CFM
CHECKED BY:
DATE: April 2014
SCALE: As Noted
REVISIONS

KENVIRONS, INC.
FRANKFORT, KENTUCKY

PROJECT NO.
2012059

SHEET NO.
D-2



Piping shall be Supported using Adjustable U-Bolt Saddle Pipe Stands.

Support to be as manufactured by Anvil International, or equal, Fig. 60, 137, 199, 264, 265, 590. Rod sizes to be determined by manufacturer according to pipe size.

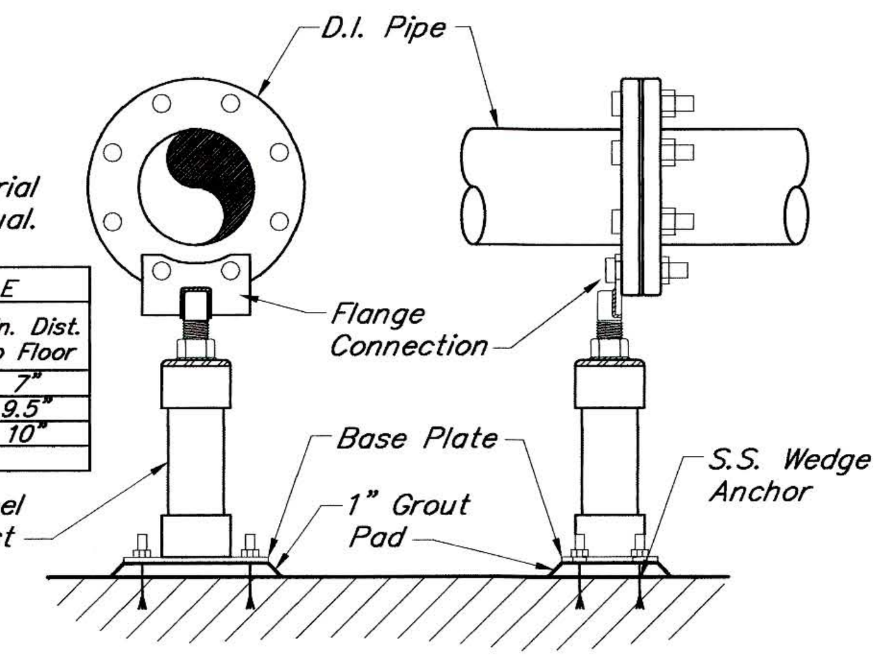
SUPPORT POST SCHEDULE	
Pipe Size	Support Post Size
less than 4"	2 1/2"
4" to 12"	3"
14" to 16"	4"
18" to 36"	6"

PIPE SADDLE DETAIL

N.T.S.

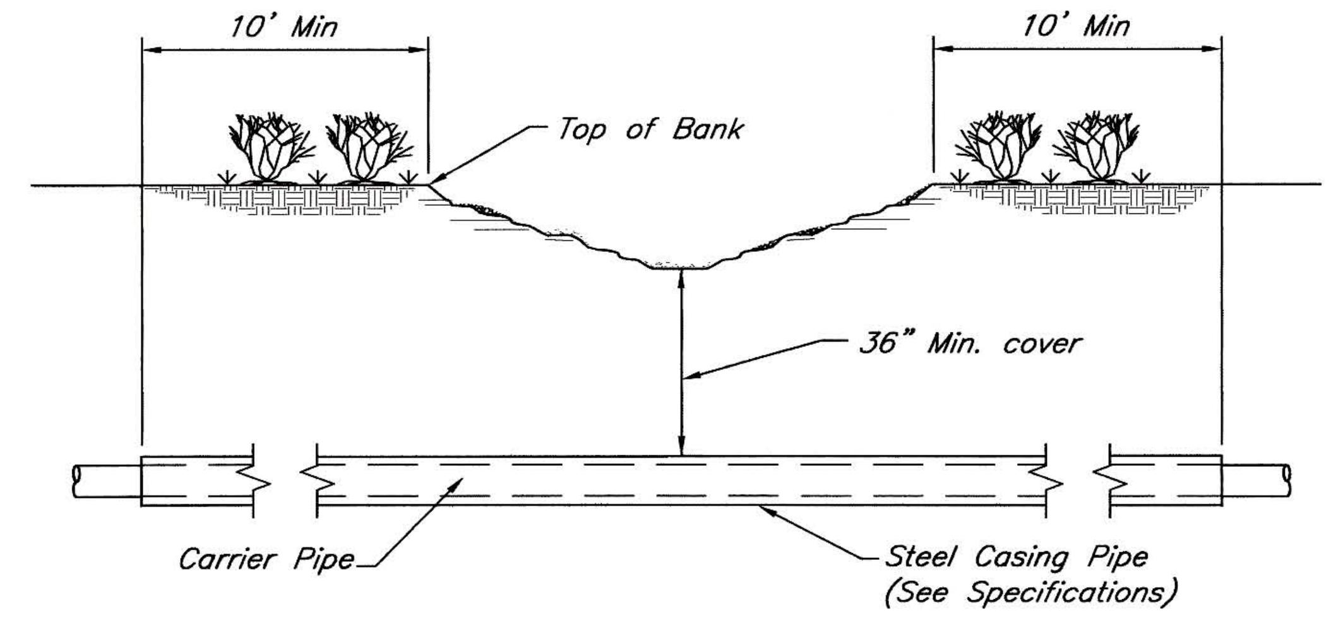
Support to be as manufactured by Material Resources, Inc., or equal.

SUPPORT POST SCHEDULE		
Pipe Size	Support Post Size	Min. Dist. to Floor
less than 12"	2"	7"
14" to 16"	3"	9.5"
18" to 24"	4"	10"



FLANGED PIPE SUPPORT

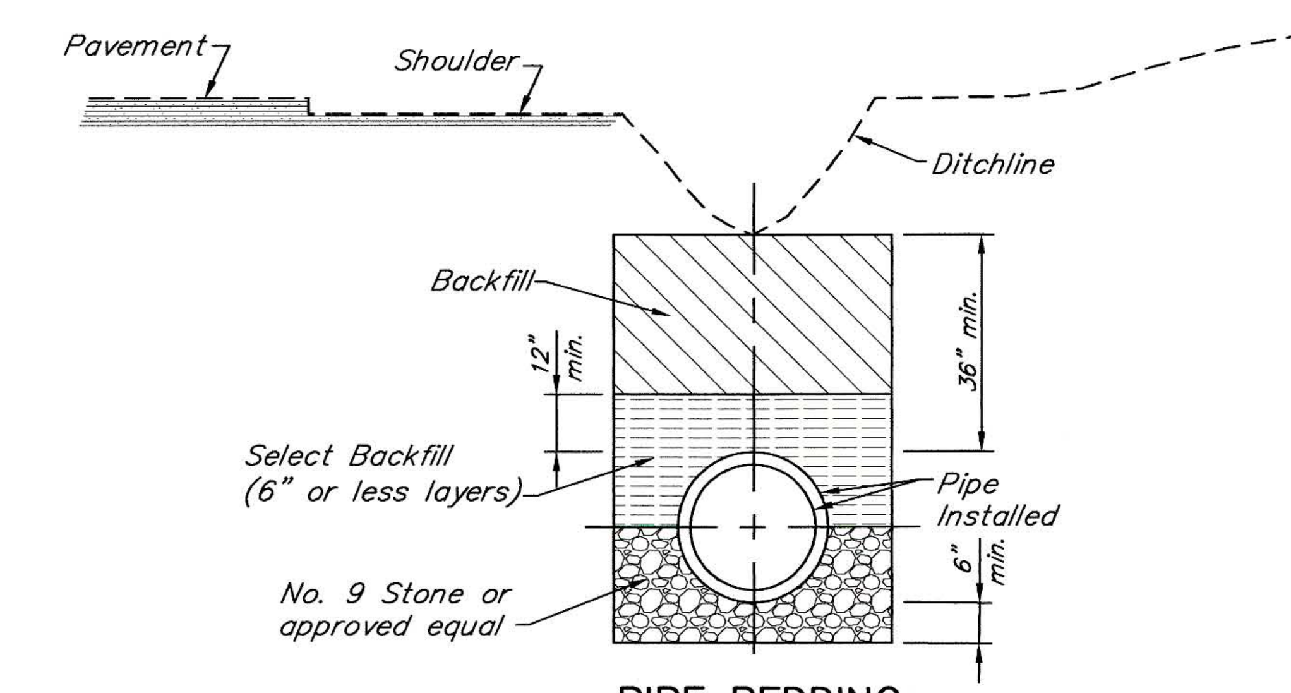
N.T.S.



Note: This Crossing Shall Be Made With Appropriate fittings to prevent Excess Joint Deflection. Normally Four (4) Fittings will be required. The Contractor, at his option, may provide extra approach Trench Depth to avoid use of Bends. Allowable Deflection of Pipe may not be exceeded under any situation. See typ. Roadway Crossing Installation Detail for Insulator placement.

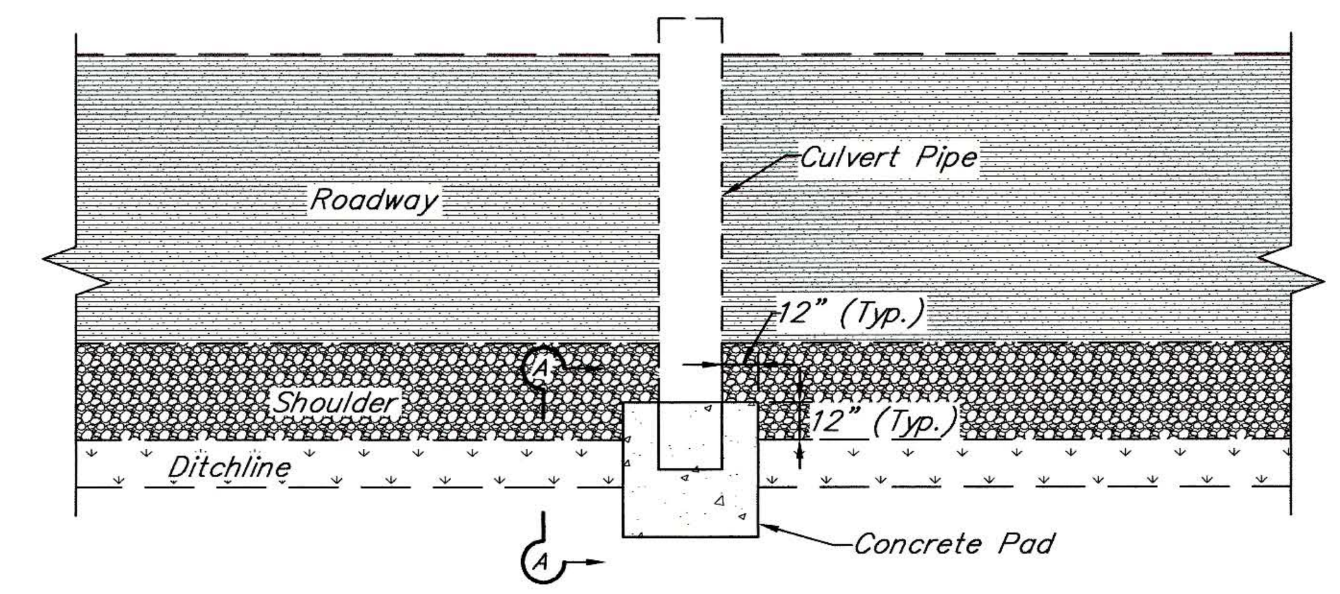
SPECIAL STREAM CROSSING IN EARTH (TYPE A)

Dec., 2010 N.T.S.



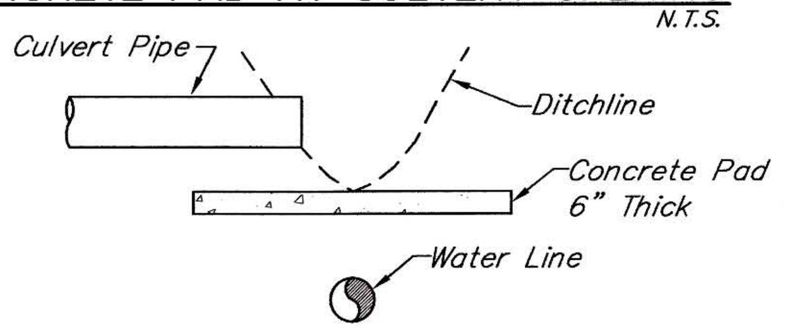
PIPE BEDDING

N.T.S.



CONCRETE PAD AT CULVERT OPENING

N.T.S.

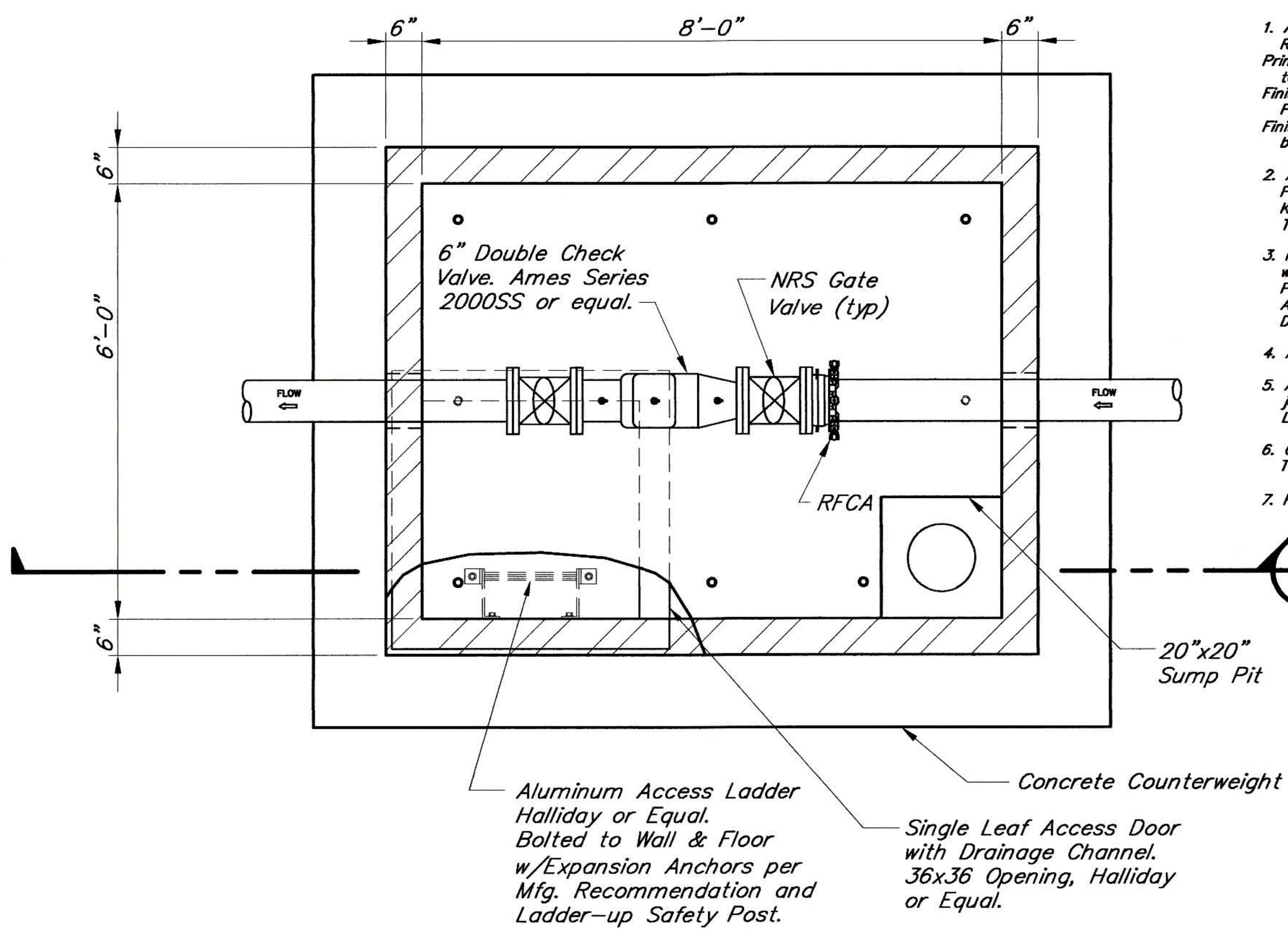


SECTION A–A

N.T.S.

DITCHLINE DETAIL

Dec., 2010 N.T.S.

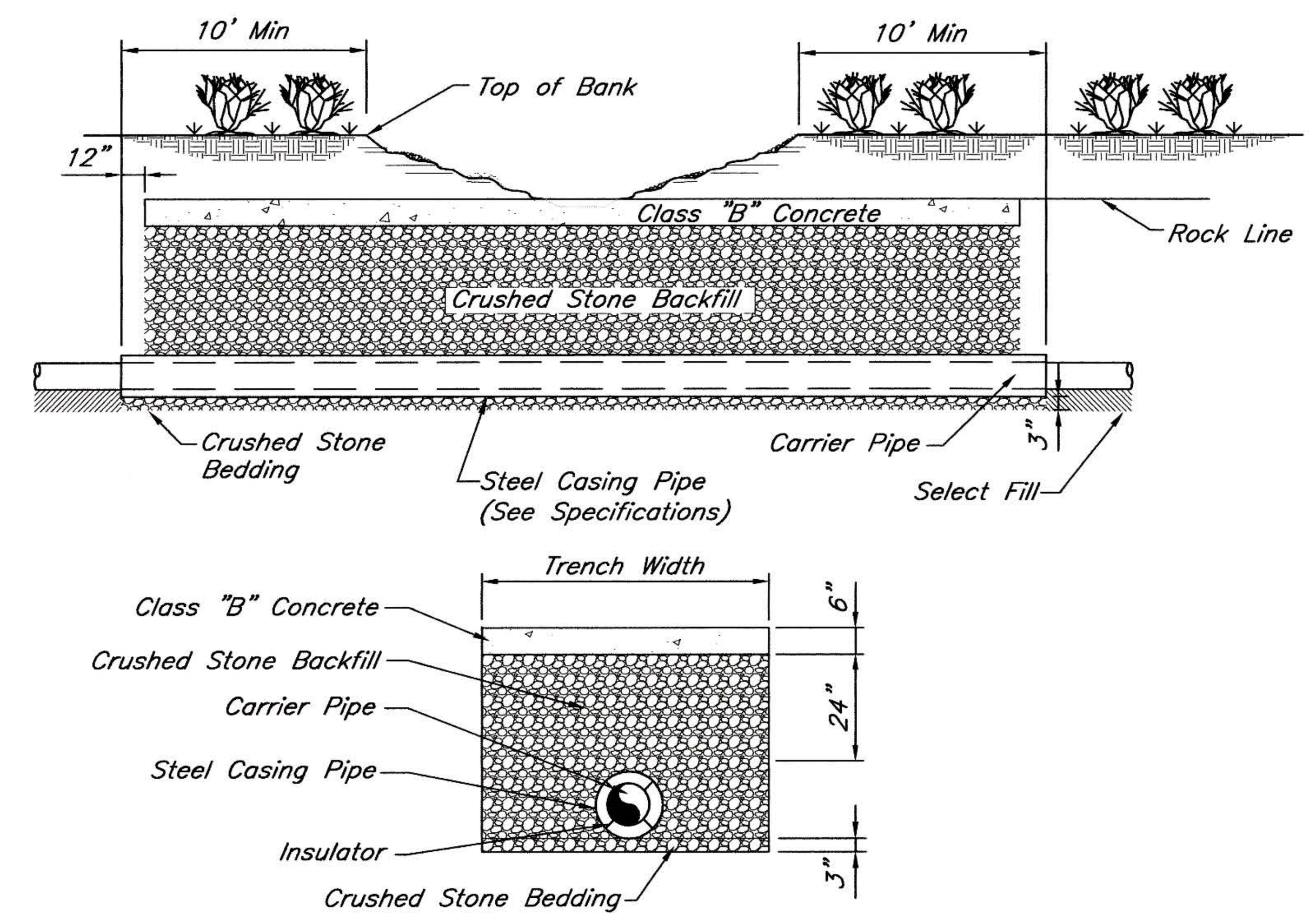


PLAN

Scale: 1/2"=1'-0"

–GENERAL NOTES–

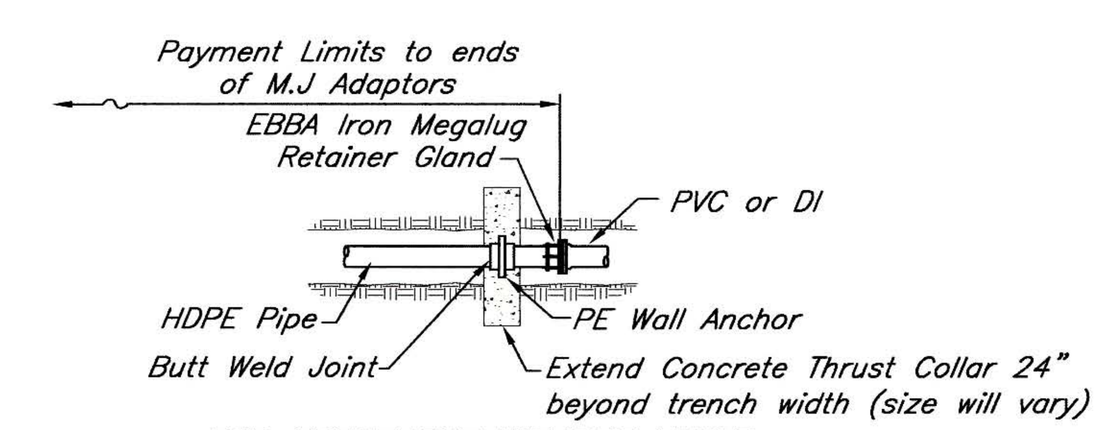
1. All Interior Piping, Valves and Metal Surfaces shall Receive Coatings as Follows:
   Prime Coat: Two (2) Coats of Tnemec Series 66 or Equal to a D.F.T. of 3.0 to 5.0 Mils
   Finish Coat: One (1) Coat of Tnemec Series 74 (Gloss) Polyurethane to a D.F.T. of 3.0 to 5.0 Mils.
   Finish Coat is to be Gray in Color, Surface Preparation shall be in Accordance with Paint Mfg. Recommendation.
2. All Metal Surfaces in Contact with Concrete shall be Primed with Koppers 40 Passivevator (Non–Ferrous) or Koppers 30 Metal Conditioners (Ferrous) and Treated with Two Coats of Koppers 82 Asphaltic Paint or Approved Equal.
3. Install D.I. Piping thru Pipe Sleeve in Concrete Structure where Lines Enter and Exit Structure. Grout Sleeve in Place with Non–Shrink Grout such as Embeco Sonogrout or Approved Equal. Pack Around Waterline in Sleeve with Dry Braided Hemp Caulked in Place.
4. All Exposed Concrete Corners shall have 3/4" Chamfer.
5. All piping and fittings outside of vault shall be restrained joint with Locking Gaskets or EBBA Iron Series 1100 MEGA LUG or equal.
6. Gaskets for flanged pipe shall be full face gaskets equal to TORUSEAL by American Cast Iron Pipe Co.
7. Provide stainless bolts/nuts assembled with anti–seize.



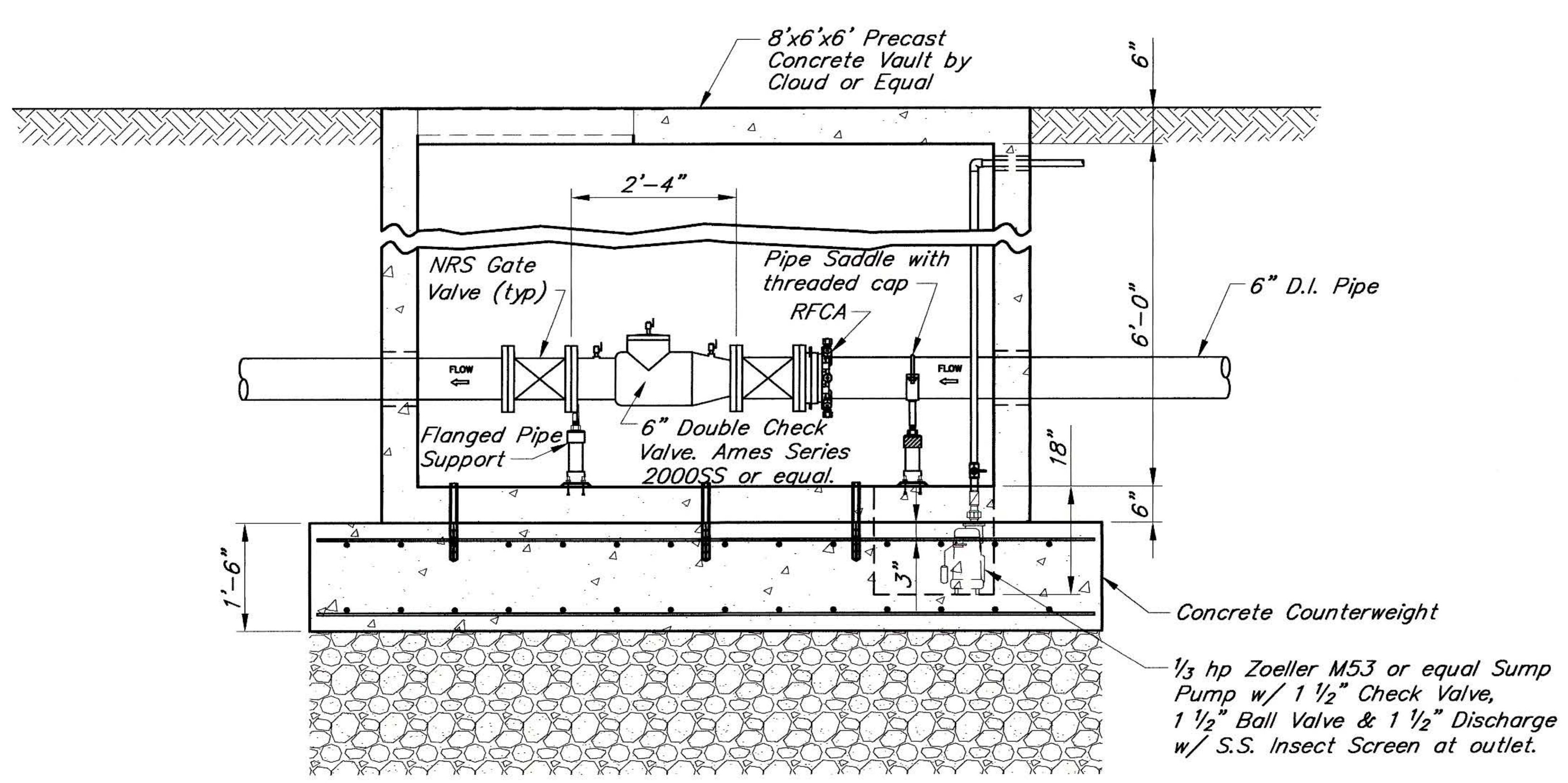
NOTE: This Crossing shall be made with Appropriate Fittings to prevent Excess Joint Deflection. Normally Four (4) Fittings will be Required. The Contractor, at his option, may provide extra Approach Trench Depth to avoid use of Bends. Allowable Deflection of Pipe may not be exceeded under any situation. See Typ. Roadway Crossing Installation Detail for Insulator Placement

STREAM CROSSING IN SOLID ROCK (TYPE B)

Dec., 2010 N.T.S.



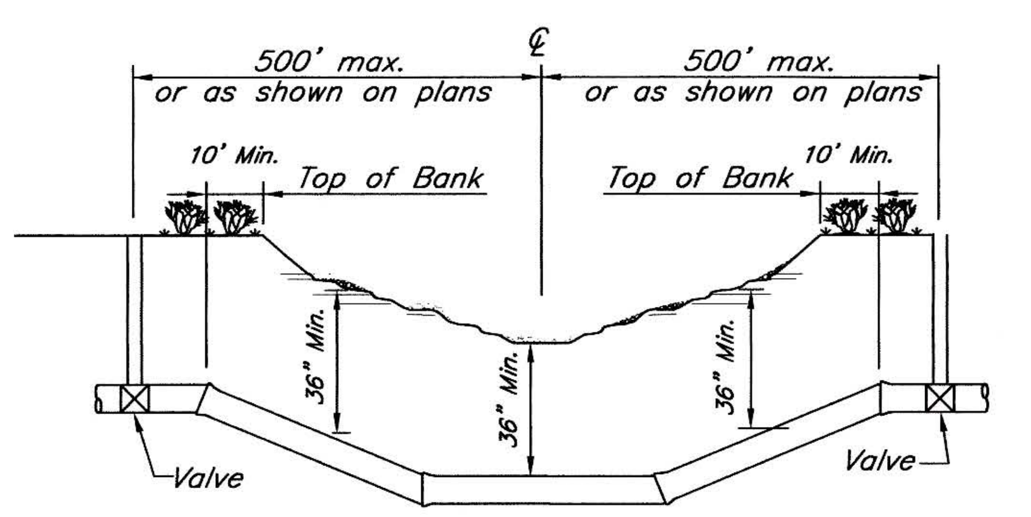
END TREATMENT WITHOUT VALVE



SECTION (A/1)

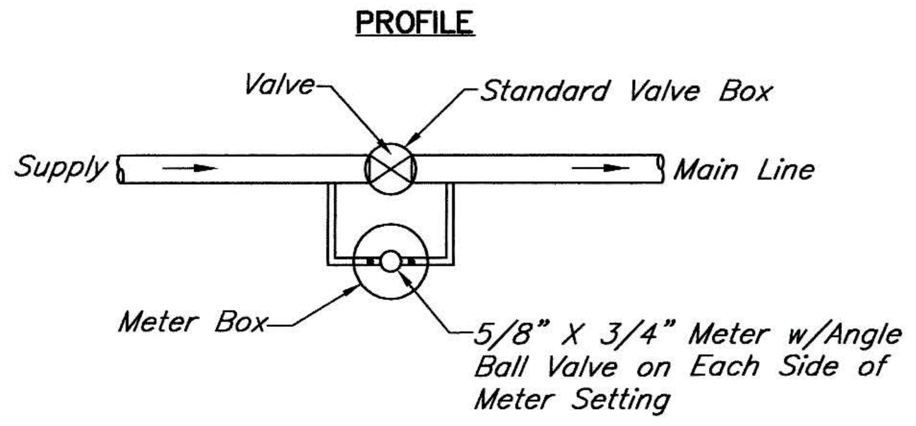
Scale: 1/2"=1'-0"

BACKFLOW PREVENTER



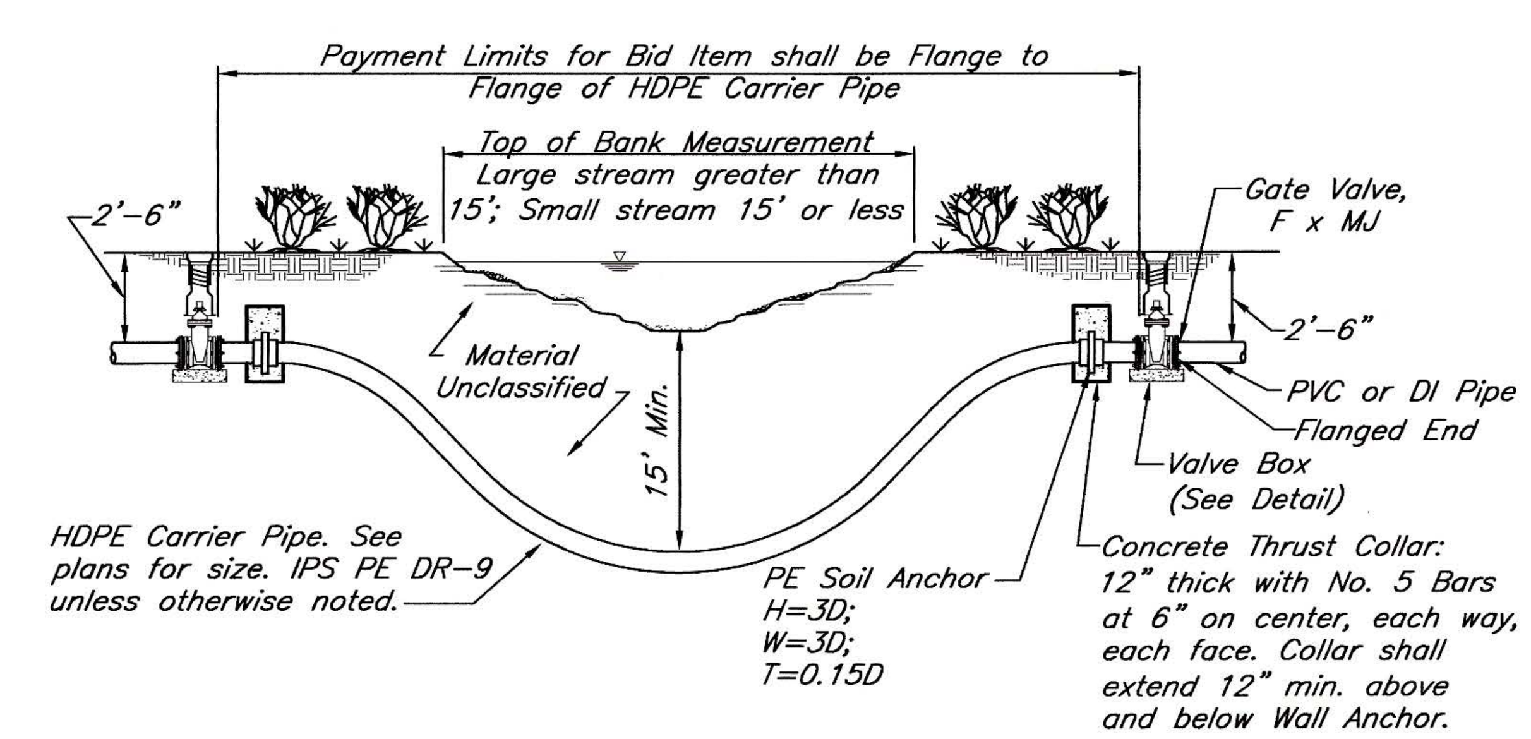
NOTES: Leak detection Meters shall be installed at Stream Crossings where indicated on the Plans. Gate Valves are a Separate Pay Item. Bid Item for Leak Detection Meters shall include the Main Line Taps, Piping, Meter Box, Setter, Ball Valves, And Meter in accordance with the Detail Shown on this drawing.

PROFILE



LEAK DETECTION METER

Dec., 2010 N.T.S.



NOTE: Payment shall be "Lump Sum" for specific individual Bid Items for Directional Bores of large stream crossings and/or some classified small streams where the physical crossing characteristics differ significantly from the other small streams in the project. Determination of required length is responsibility of Contractor. When a creek crossing test meter is shown on the drawings and it is necessary to tap the HDPE pipe for the meter connection, the tapping saddle specifically manufactured for HDPE pipe shall be used.

Payment shall be "each" for directional bores of small stream crossings unless contained in an individual specific bid item. All small stream crossings in the project shall be considered the same regardless of width (up to 15 L.F.) or depth. It is the responsibility of the Contractor to determine an average unit price that will be used for payment for each instance a blue line stream is crossed. Stream crossings may be added, for extended lines beyond those shown on the plans, at the same unit price providing the crossings are reasonably similar to those in the initial project. Stream crossings may be deleted, without affecting the unit price, if a line is deleted or shortened.

DIRECTIONAL BORE FOR STREAM CROSSINGS

Feb., 2013 Scale: 3/16"=1'-0"

MISCELLANEOUS DETAILS

CUMBERLAND FALLS HIGHWAY WATER DISTRICT
US 25W TRANSMISSION MAIN
WHITLEY COUNTY, KENTUCKY

DRAWN BY: JKP/PTH
CHECKED BY: CFM
CHECKED BY:
DATE: April 2014
SCALE: As Noted
REVISIONS

KENVIRONS, INC.
FRANKFORT, KENTUCKY

PROJECT NO.
2012059

SHEET NO.
D–3

SPECIFICATIONS AND CONTRACT DOCUMENTS

FOR

CUMBERLAND FALLS HIGHWAY WATER DISTRICT

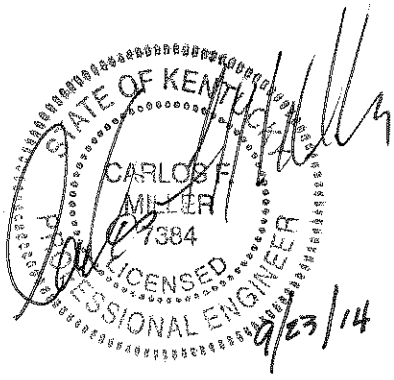
HIGHWAY 25 TRANSMISSION PIPELINE AND PUMP STATION

Prepared By:

KENVIRONS, INC.
452 VERSAILLES ROAD
FRANKFORT, KENTUCKY 40601

PROJECT NO. 2012059

SEPTEMBER 2014



TECHNICAL SPECIFICATIONS

DIVISION 1

GENERAL REQUIREMENTS

SECTION 0101

SPECIAL CONDITIONS

1.0 DESCRIPTION OF THE WORK AND DESIGNATION OF OWNER

These Specifications and accompanying Drawings describe the work to be done and the materials to be furnished for the construction of the project entitled "Colesburg Pump Station"

All references to the Owner in these Specifications, Contract Documents and plans shall mean the Cumberland Falls Highway Water District.

2.0 AVAILABLE FUNDS

This project is funded by USDA Rural Development and Cumberland Falls Highway Water District.

3.0 TIME OF COMPLETION

The time allowed for completion of this contract is 180 calendar days.

The time allowed for completion shall begin at midnight, Eastern Standard Time, on the date which the Owner, or his authorized representative, the Engineer, shall instruct the Contractor in writing to start work, but no later than 10 days after Notice to Proceed.

Additional time will be allowed the Contractor to cover approved over-runs or additions to the contract in the same proportion that the said over-run or addition in net monetary value bears to the original amount; the total of said additional time to be computed to the nearest whole calendar day.

4.0 LIQUIDATED DAMAGES

It is understood that time is the essence of this contract and that the Owner will sustain damages, monetary and otherwise, in the event of delay in completion of the work hereby contracted.

Therefore, if the said Contractor shall neglect, fail or refuse to complete the work within the time herein specified, or any proper extension thereof granted by the Owner, then the Contractor does hereby agree, as a part of the consideration for the awarding of these contracts, to pay to the Owner the amount specified in the contract, not as a penalty but as liquidated damages for such breach of contract

as hereinafter set forth, for each and every calendar day that the Contractor shall be in default after the time stipulated in the Contract for completing the work.

The said amount is fixed and agreed upon by and between the Contractor and the Owner because of the impracticability and extreme difficulty of fixing and ascertaining the actual damages the Owner would in such event sustain, and said amount is agreed to be the amount of damages which the Owner would sustain and said amount shall be retained from time to time by the Owner from current periodical estimates.

Liquidated damages are fixed at $800 per calendar day of over-run beyond the date set for completion or authorized extension thereof.

5.0 INSURANCE

Insurance is to be furnished by the Contractor for the benefit of the Owner, Contractor, and Subcontractors as their interests may appear. The minimum amounts of insurance coverage to be furnished under these contracts, in accordance with the applicable provisions of the General Conditions.

All policies written for and applicable to the contract of which this Specification is a part shall provide for a minimum of fifteen (15) days written cancellation notice with notice to be given both to the Owner and the Engineer. The Owner and Engineer shall be included as additional insured parties.

6.0 BONDING

6.1 PERFORMANCE AND PAYMENT BOND

The Contractor shall furnish separate performance and payment bonds issued by an approved bonding company in an amount at least equal to one hundred (100%) per cent of the contract price, as security for the faithful performance of this contract and for the payment of persons performing labor and furnishing materials in connection with this contract. These bonds shall be executed by a company authorized to do business in the State of Kentucky and shall be signed or countersigned by a Kentucky resident agent. Bonds shall remain in effect for one year after date of final acceptance of the work.

6.2 DEPARTMENT OF TRANSPORTATION BONDING

See Section 15100 – WATER LINES, Subsection 1.1.

7.0 SITE DIMENSIONS

All Contractors furnishing materials and equipment for this contract shall obtain exact dimensions at the site. Scale or figure dimensions on the drawings and

details show the correct size under ideal conditions and shall not, under any circumstances, be so construed as to relieve the Contractor from responsibility for taking measurements at the site and furnishing materials or equipment of the correct size.

8.0 DAMAGE TO EQUIPMENT STORED AND/OR IN PLACE PRIOR TO INITIAL OPERATION

Any equipment damaged or which has been subjected to possible damage by reason of inundation, improper storage and/or protection during the construction period of project, shall be handled only as follows:

a) Be replaced with new equipment.

b) With approval of the Engineer, be returned to the manufacturer of the equipment, or his authorized repair agency, for inspection and repair provided, however, that such repair after inspection will place the equipment in new condition, and restore the manufacturer's guarantee the same as for new equipment.

9.0 SALVAGED MATERIALS AND EQUIPMENT

All materials and/or equipment to be removed from existing structures and not specifically specified to be re-used shall remain the property of the Owner. Such materials and/or equipment shall be stored on sites by the Contractor as directed by the Owner.

The use of second hand and/or salvaged materials will not be permitted, unless specifically provided for in the detailed specifications. Materials and equipment shall be new when turned over to the Owner.

10.0 TEMPORARY FACILITIES

a) Build and maintain temporary offices and storage sheds as necessary for the work. Location of temporary buildings shall be subject to the approval of the Engineer.

b) Provide temporary heat, light and power required by the work. Temporary telephone service shall be provided in the job office paid for by the General Contractor, except that the party placing a long distance call shall pay the toll charge.

c) Each Contractor shall construct and maintain, in a sanitary condition, sanitary facilities for his employees and also employees of his subcontractors. At completion of the contract work these sanitary facilities shall be properly disposed of as directed by the Engineer.

d) Temporary construction for safety measures, hoists and scaffolds shall be erected in accordance with the General Conditions.

e) Construction yard shall be located on job site. Provide security and safety protection.

f) The obtaining of all utilities for construction, including power and water, shall be the responsibility of the Contractor, and he shall bear the cost of all utilities used for construction. Cost of all connections and facilities for use of utilities shall be borne by the Contractor.

11.0 PROPERTY PROTECTION

Care is to be exercised by the Contractor in all phases of construction to prevent damage and injury to the Owner's or other property.

In connection with work performed on "private property" (property other than that belonging to the Owner), the Contractor shall confine his equipment, the storage of materials, and the operation of his workmen to the limits indicated on the plans, or to lands and right-of-way provided for the project by the Owner, and shall take every precaution to avoid damage to the private property Owner's buildings, grounds and facilities.

Fences, hedges, shrubs, etc. within the construction limits shall be carefully removed, preserved, and replaced when the construction is completed. Where ditches or excavations cross lawns, the sod shall be removed carefully and replaced when the backfilling has been completed. If sod is damaged or not handled properly, it shall be replaced with new sod equal to existing sod at the Contractor's expense. Grassed areas, other than lawns, shall be graded, fertilized and seeded when construction is completed. When construction is completed the private property Owner's facilities and grounds shall be restored to as good or better condition than found as quickly as possible at the Contractor's expense.

12.0 CONFLICT WITH OR DAMAGE TO EXISTING UTILITIES AND FACILITIES

Insofar as location data is available to the Engineers, existing underground utilities (such as waterlines, sewer lines, gas lines, telephone conduits, etc.) are accurately located on the drawings. Due, however, to the approximate nature of much of this data, the location of any particular facility cannot be certified to be correct. In general, locations and elevations shown are approximate only.

Before proceeding with the work, the Contractor shall confer with all public or private companies, agencies, or departments that own and operate utilities in the vicinity of the construction work. The purpose of the conference is to verify the location of, and possible interference with, the existing utilities that are shown on

the Plans, arrange for necessary suspension of service, and make arrangements to locate and avoid interference with all utilities that are not shown on the Plans.

13.0 CONTROL OF EROSION

The Contractor shall be responsible for control of siltation and erosion from the project work. Control shall include all necessary ditching, check dams, mulching, etc. to prevent deposition of materials in roadside ditches. The Owner shall incur no extra costs from such work.

14.0 MEASUREMENT AND PAYMENT

14.1. Measurement of Quantities. All Work completed under the Agreement will be measured by the ENGINEER according to United States standard measure.

14.1.1. Unless otherwise specified, measurement of concrete quantities will include only that volume within the neat lines as shown on the Plans or as altered by the ENGINEER to fit field conditions. The prismoidal formula will be used in computing the volumes of structures, or portions of structures, having end sections of unequal areas.

14.1.2. All items which are measured by the linear foot, such as pipe, will be measured along the centerline distance of the installed item with no allowance for connections, fittings or laps at connections.

14.1.3. In computing volumes of excavation, borrow and embankments, the average end-area method will be used. For the purpose of ascertaining quantities, it is agreed that the planimeter shall be considered an instrument of precision adapted to the measurement of areas.

14.2 Lump Sum. When a complete structure or structural unit (in effect, "lump sum" work) is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories.

14.3 Plan Quantities. When the plan quantities for a specific portion of the Work are designated as the pay quantities in the Contract Documents, they shall be the final quantities for which payment for such specific portion of the Work will be made, unless the dimensions of said portions of the Work shown on the plans are revised by the ENGINEER. When revised dimensions result in an increase or decrease in the quantities of such Work, the final quantities for payment will be revised in the amount represented by the authorized changes in dimensions.

14.4 Actual Quantities. When actual quantities for a specific portion of the Work are designated as the pay quantities in the Contract Documents, they shall be the final quantities for which payment for such specific portion of the Work will

be made. The actual quantities will be determined by the difference in field measurements and cross sections before and after construction.

14.5 Scope of Payment. The contract unit prices whether based on lump sum, plan quantities or actual quantities for the various bid items of the Contract Documents shall be considered full compensation for all labor, materials, supplies, equipment, tools, and all things of whatever nature required for the complete incorporation of the item into the Work the same as though the items were to read "in Plan" unless the Contract Documents provide otherwise.

14.6 Payments. Estimates for payment, partial payments and final payments shall be in accordance with and follow procedures set forth in the General Conditions and Supplementary Conditions.

15.0 ACCESS ROADS

15.1 The CONTRACTOR, CONTRACTOR'S employees and all trucks delivering equipment, supplies or materials to the project shall use the access roads shown in the Plans for entering and leaving the project sites.

16.0 TESTING LABORATORY SERVICES

16.1 GENERAL

16.1.1 Work Included. From time to time during progress of the Work, the OWNER may require that testing be performed to determine that materials provided for the Work meet the specified requirements; such testing includes, but is not necessarily limited to:

1) Material Compaction
2) Cast-In-Place Concrete

16.1.2 Related Work Described Elsewhere. Requirements for testing may be described in various Sections of these Specifications; where no testing requirements are described, but the OWNER decides that testing is required, the OWNER may require testing to be performed under current pertinent standards for testing.

16.1.3 Selection of Testing Laboratory. The OWNER will select a testing laboratory.

16.1.4 Codes and Standards. Testing, when required, will be in accordance with all pertinent codes and regulations and with selected standards of the American Society for Testing and Materials.

16.1.5 Product Handling. The CONTRACTOR shall promptly process and distribute all required copies of test reports for which he is responsible and related instructions to ensure all necessary retesting and/or replacement of materials with the least possible delay in progress of the Work.

16.2 Payment for Testing Services.

16.2.1 Initial Services. The OWNER will pay for all initial testing services required by the OWNER.

16.2.2 Retesting. When initial tests indicate non- compliance with the Contract Documents, all subsequent retesting made necessary by the non-compliance shall be performed by a testing laboratory selected by the CONTRACTOR and approved by the ENGINEER and the costs thereof will be paid directly by the CONTRACTOR.

16.2.3 CONTRACTOR'S Convenience Testing. Inspection or testing performed exclusively for the CONTRACTOR'S convenience shall be the sole responsibility of the CONTRACTOR.

16.3 EXECUTION.

16.3.1 Cooperation with Testing Laboratory. Representatives of the testing laboratory shall have access to the Work at all times. The CONTRACTOR shall provide facilities for such access in order that the laboratory may properly perform its functions.

16.3.2 Schedules for Testing.

16.3.2.1 Establishing Schedule. By advance discussion with the testing laboratory selected by the OWNER, the CONTRACTOR shall allow for the time required for the laboratory to perform its tests and to issue each of its findings. The CONTRACTOR shall allow for this time within the construction schedule.

16.3.2.2 Revising Schedule. When changes of construction schedule are necessary during construction, the CONTRACTOR shall coordinate all such changes of schedule with the testing laboratory as required.

16.3.2.3 Adherence to Schedule. When the testing laboratory is ready to test according to the determined schedule but is prevented from testing or taking specimens due to incompleteness of the Work, all extra costs for testing attributed to the delay may be back-charged to the CONTRACTOR and shall not be borne by the OWNER.

16.3.3 Taking Specimens. All specimens and samples for testing, unless otherwise provided in these Contract Documents, will be taken by the testing

laboratory; all sampling equipment and personnel will be provided by the testing laboratory; and all deliveries of specimens and samples to the testing laboratory will be performed by the testing laboratory.

17.0 SUBMITTALS AND SUBSTITUTIONS

17.1 GENERAL.

17.1.1 Work Included. Wherever possible throughout the Contract Documents, the minimum acceptable quality of workmanship and materials has been defined either by manufacturer's name and catalog number or by reference to recognized industry standards. To insure that the specified products are furnished and installed in accordance with design intent, procedures have been established for advance submittal of design data and for its review and approval or rejection by the ENGINEER.

17.1.2 Related Work Described Elsewhere.

17.1.2.1 Contractual requirements for submittals are described in the General Conditions and Supplementary Conditions.

17.1.2.2 Individual submittals required are described in the pertinent sections of these Specifications.

17.2 SUBSTITUTIONS.

17.2.1 ENGINEER'S Approval Required. The Agreement is based on the materials, equipment, and methods described in the Contract Documents. The ENGINEER will consider proposals for substitution of materials, equipment, and methods only when such proposals are accompanied by full and complete technical data and all other information required by the ENGINEER to evaluate the proposed substitution. Do not substitute materials, equipment, or methods unless such substitution has been specifically approved for this Work by the ENGINEER.

17.2.2 "Or Equal". Where the phrase "or equal" occurs in the Contract Documents, do not assume that material, equipment, or methods will be approved as equal by the ENGINEER unless the item has been specifically approved for this Work. The decision of the ENGINEER shall be final.

17.2.3 Availability of Specified Items. The CONTRACTOR shall verify prior to bidding that all specified items will be available in time for installation during orderly and timely progress of the Work. In the event the specified item or items will not be so available, the CONTRACTOR shall notify the ENGINEER prior to receipt of Bids.

17.3 Identification of Submittals. The CONTRACTOR shall completely identify each submittal and resubmittal by showing at least the following information:

1) Name and address of submitter, plus name and telephone number of the individual who may be contacted for further information.

2) Name of project as it appears in these Specifications.

3) Drawing number and Specifications Section number to which the submittal applies.

4) Whether this is an original submittal or re-submittal.

17.4 COORDINATION OF SUBMITTALS.

17.4.1 General. Prior to submittal for ENGINEER'S review, the CONTRACTOR shall use all means necessary to fully coordinate all material, including the following procedures:

1) Determine and verify all field dimensions and conditions, materials, catalog numbers, and similar data.

2) Coordinate as required with all trades and with all public agencies involved.

3) Secure all necessary approvals from public agencies and others and signify by stamp, or other means, that they have been secured.

4) Clearly indicate all deviations from the Contract Documents.

17.4.2 Grouping of Submittals. Unless otherwise specifically permitted by the ENGINEER, the CONTRACTOR shall make all submittals in groups containing all associated items; the ENGINEER may reject partial submittals as not complying with the provisions of the Contract Documents.

17.5 Timing of Submittals. The CONTRACTOR shall make all submittals far enough in advance of schedule dates of installation to provide all required time for reviews, for securing necessary approvals, for possible revision and resubmittal, and for placing orders and securing delivery. In scheduling, allow at least five full working days for the ENGINEER'S review following his receipt of the submittal.

18.0 INSTALLATION REQUIREMENTS

Manufactured articles, materials, and equipment shall be applied, installed, connected, erected, used, cleaned, and conditioned as directed by the respective manufacturers, unless otherwise specified.

19.0 PROOF OF COMPLIANCE

Whenever the Contract Documents require that a product be in accordance with Federal specification, ASTM designation, ANSI specification, or other association standard, the CONTRACTOR shall present an affidavit from the manufacturer certifying that the product complies therewith. Where requested or specified, the CONTRACTOR shall submit supporting test data to substantiate compliance.

20.0 PROJECT RECORD DOCUMENTS

20.1 As the Work progress, the CONTRACTOR shall keep a complete and accurate record of changes or deviations from the Contract Documents and the Shop Drawings, indicating the Work as actually installed. Changes shall be neatly and correctly shown on the respective portion of the affected document, using blackline prints of the Drawings affected, or the Specifications, with appropriate supplementary notes. This record set of Drawings, Shop Drawings, and Specifications shall be kept at the job site for inspection by the ENGINEER.

20.2 The records above shall be arranged in order, in accordance with the various sections of the Specifications, and properly indexed. Prior to application for final payment, and as a condition to its approval by the ENGINEER, deliver the record Drawings and Specifications, arranged in proper order, indexed, and endorsed as hereinbefore specified.

20.3 No review or receipt of such records by the ENGINEER or OWNER shall be a waiver of any deviation from the Contract Documents or the Shop Drawings or in any way relieve the CONTRACTOR from his responsibility to perform the Work in accordance with the Contract Documents and the Shop Drawings to the extent they are in accordance with the Contract Documents.

21.0 PROJECT MEETINGS

The CONTRACTOR'S Superintendent for the Work shall attend project meetings as required by either the OWNER or ENGINEER.

22.0 VIDEO TAPE

The line CONTRACTOR, before proceeding with any work, shall make or have made a video of all areas where work is to be performed and a copy of this video

cassette shall be furnished to the ENGINEER to review for completeness. This video shall be utilized as backup and reference for claims and cleanup.

SECTION 01002

SPECIAL CONSTRUCTION CONSIDERATIONS

1.0 CONSTRUCTION SEQUENCE

1.1 It shall be the sole responsibility of the CONTRACTOR to plan and implement construction sequences, to follow the Plans and Specifications and to protect any portions of the Work already completed.

2.0 CLEAN-UP

The work will not be considered as complete, and final payment will not be made, until all areas in connection with the Work have been cleared of all rubbish, equipment, excess materials and temporary structures.

3.0 SECURITY BY CONTRACTOR

In addition to the other provisions of the Contract Documents, the CONTRACTOR shall be responsible for providing security as he deems necessary for his work areas, storage areas, office areas, equipment, and any other item or area that he is using. The OWNER will not be responsible for any damages due to insufficient site security.

4.0 BID SCHEDULE QUANTITIES

The material quantities shown in the bid schedule are not guaranteed and should not be used indiscriminately when ordering materials. The Contractor shall be responsible for ordering material quantities necessary for installation to the limits as shown on the drawings unless otherwise instructed. Any leftover quantities shall be the property of the Contractor unless other arrangements are made. The Owner shall not be responsible for re-stocking or other charges associated with left-over materials or increased costs associated with increases in price for materials needed to complete the project as shown on the drawings.

DIVISION 3

CONCRETE

SECTION 03001

CONCRETE

1.0 CAST IN PLACE CONCRETE

1.1 SCOPE

This specification covers the furnishing of all materials, except as may be otherwise provided in the contract, equipment, labor and plant, and performing all operations specified herein, including the manufacturing, transporting, placing, finishing and curing of the concrete. The furnishing and placing of reinforcing steel when specified is covered in a separate technical specification.

1.2 COMPOSITION

Concrete shall be composed of Portland cement, water, fine aggregate, coarse aggregate, and when specified or approved in writing by the Engineer, admixtures for entraining air or retarding agents. The design of the concrete mixture will be based on the water-cement ratio necessary to secure (a) a plastic workable mixture suitable for the specific conditions of placement, and (b) when properly cured, a product having durability, impermeability and strength, in accordance with all the requirements of the structures covered by these specifications. The concrete mixture shall be designed so that the concrete placed according to plans shall produce a minimum laboratory cylinder compressive strength equal to the strength designated in paragraph 3 for the class of concrete specified.

1.3 CLASSIFICATION

Concrete shall be classified as Class A. The basis of classification of concrete shall be the minimum compressive strength at twenty-eight (28) days as listed below. Other minimum design requirements are also shown.

Minimum Strength			Cement Factor	
Class	**(7-day)**	**(28-day)**	**(Bags/C.Y.)**	**Air Entrainment**
A	2850	4000 psi	6.0	4-½ ± 1-½ %

1.4 CEMENT

1.4.1 Portland Cement. Portland cement shall meet the requirements of ASTM Designation: C-150 for the type of cement specified.

1.4.2 Air-Entraining Portland Cement. Air entraining Portland cement shall meet the requirements of ASTM Designation: C-175 for the type of cement specified.

1.4.3 Storage of Cement on the Site. Cement shall be properly stored and protected from weather, dampness or other destructive agents and any cement which is damaged will be rejected and not permitted to be used in the work.

1.4.4 Sampling and Testing. Portland cement shall be subject to sampling and testing in accordance with ASTM Designation: C-150.

Air-entraining Portland cement shall be subject to sampling and testing in accordance with ASTM Designation: C-175.

1.5 AGGREGATES

1.5.1 Fine and Coarse Aggregates. Shall conform to the provisions of ASTM Designation: C-136 and ASTM Designation: C-33. Sand shall consist of clean, well graded particles of hard, durable stone and shall contain limited amount of deleterious substances. It shall be equivalent to washed Ohio, Scioto, or Cumberland River sand.

Coarse aggregate shall be washed river gravel or crushed limestone of hard durable particles and shall contain limited amounts of deleterious substances. The maximum size of coarse aggregate will be limited to one and one-half (1 1/2) inches.

1.5.2 Handling and Measurement of Materials. Aggregates shall be stored or stockpiled in such a manner that separation of coarse and fine particles of each size will be avoided and that various sizes will not become intermixed before proportioning. Methods of handling and transporting aggregates shall be such as to avoid contamination, excessive breakage, segregation or degradation, or intermingling or various sizes.

Scales for weighing aggregates and cement shall be beam type or springless dial type. They shall be accurate within 1 percent under operating conditions. All exposed fulcrums, clevises and similar working parts of scales shall be kept clean.

The quantities of cement and aggregates in each batch of concrete as indicated by the scales, shall be within the following percentages of the required batch weights:

Cement - plus or minus 1.0 percent
Aggregates - plus or minus 2.0 percent

Measuring tanks for mixing water shall be of adequate capacity to furnish the maximum amount of mixing water required per batch and shall be equipped with outside taps and valves to provide for checking their calibration unless other means are provided for readily and accurately determining the amount of water in the tank.

Cement shall be measured by weight or in bags of 94 lbs. each. When cement is measured by weight, it shall be weighted on scale separate from that used for other materials, and in a hopper entirely free and independent of the hopper used for weighing the aggregates. When cement is measured in bags, no fraction of a bag shall be used unless weighed.

Aggregates shall be measured by weight. Mix proportions shall be based on saturated, surface-dry weights. The batch weight of each aggregate shall be the required saturated, surface-dry weight plus the weight of surface moisture it contains.

Mixing water shall consist of water added to the batch, ice added to the batch, water occurring as surface moisture on the aggregates and water introduced in the form of admixtures. The added water shall be measured by weight or volume to an accuracy of 1 percent of the required total mixing water. Added ice shall be measured by weight. Wash water shall not be used as a portion of the mixing water for succeeding batches.

Dry admixtures shall be measured by weight, and paste or liquid admixtures by weight or volume, within a limit of accuracy of 3 percent.

1.5.3 Sampling and Testing. When testing is required, the sampling shall be done in accordance with, and the testing results shall conform to, the ASTM Standards referenced herein. The source from which the aggregates are to be obtained shall be selected well in advance of the time when the material will be required in the work. Samples of the aggregates, when requested, shall be furnished at least fifteen (15) days in advance of the time when the placing of concrete is expected to begin.

Usually 150 pounds of sand for initial tests and 150 pounds for periodic tests will be sufficient. Usually 200 pounds of coarse aggregate for initial tests and 200 pounds for periodic tests will be sufficient.

Unless otherwise specified, all test samples shall be taken under the supervision of the Engineer and delivered to the designated point by the Contractor at his expense. Tests will be made by and under the supervision of the Engineer. Routine control tests and analysis of the aggregates at various stages in the processing operations will be made by the Engineer. The Contractor shall provide such facilities as the Engineer may consider necessary for the ready procurement of representative test samples.

It shall be the responsibility of the Owner to pay for the necessary tests. Once a material has been tested and approved for use, it shall be the Contractor's responsibility to use material throughout the job which is equal in all respects and from the same source as that approved material he delivered to the testing laboratory.

The Engineer shall order additional material tests, if in his opinion the material stored or being used is not equal to the approved tested material. The Contractor shall pay for additional tests if the material is not suitable in accordance with these specifications or if the characteristics of the material are such that a redesign of concrete mix is necessary.

If the Contractor desires to change supplier and/or source of materials after materials have been tested and approved, the Engineer may order additional material tests, the cost of which shall be charged to the Contractor.

In rare instances, a material may meet the requirements of these specifications, but have unusual characteristics which render it unsuitable for the use intended. Therefore, the Owner reserves the right to reject materials if adequate reason is furnished. The Owner also reserves the right to reject material suppliers and sources if quality, uniformity, and other important considerations are not and/or cannot be acceptably maintained. If suppliers or sources of material are rejected after work begins, it may be necessary to test materials from different suppliers and/or sources. If the Engineer deems that tests are necessary, the Contractor shall pay the cost of the necessary tests and all concreting shall be stopped until material is approved for use by the Engineer.

Each material must come from a single source, unless otherwise approved in writing by the Engineer.

All materials must be tested in accordance with these specifications and approved by the Engineer in writing before used in the work, unless the Engineer establishes that some or all of the tests will not be required because of the size of the project or for other reasons. Reports of test results shall be submitted to the Engineer in four (4) copies. It is the intent that the Owner shall pay for material tests necessary to insure suitability for the work, but the Owner shall not pay for material tests caused by negligence, indecision, or carelessness on the part of the Contractor, his subcontractors, or his suppliers.

In the case of ready-mixed concrete the requirements for design mix and testing shall be the same unless waived by the Engineer.

After award of the contract, the Contractor shall submit in writing to the Engineer the name, address and qualifications of the ready mix supplier who will furnish concrete for the project. The Contractor shall also submit the supplier and source of the sand, coarse aggregate, cement and admixture. The Engineer shall then select a testing laboratory and request proposed mixes from the Contractor or ready-mix plant. The Engineer will then indicate tests and design mixes required, to the testing laboratory. The testing laboratory shall also receive a copy of the materials specifications. After receiving the requisition for tests, the Contractor shall send materials per these specifications to the testing laboratory.

1.6 WATER

Water used in mixing concrete shall be fresh, clean and free from injurious amounts of sewage, oil, acid, alkali, salts, or organic matter, and its source shall be subject to the approval of the Engineer. The water used in mixing must be a minimum required for a plastic mix. No water will be permitted for purposes of hastening mixing and reducing tamping or vibration.

1.7 ADMIXTURES

1.7.1 Air-Entrainment. The air-entraining admixtures shall fully meet the requirements of ASTM Designation: C-260 and shall be subject to tests in accordance with ASTM Designation: C-233.

1.7.2 Retarding Agents. Approved types of retarding agents shall be included in the concrete mix when specified on drawings or authorized in writing by the Engineer.

1.7.3 Other Compounds. The use of calcium chloride or other accelerators or anti-freeze compounds will not be allowed.

1.8. CONSISTENCY

The consistency of any concrete shall be such that it can be worked readily into the corners and angles of the forms and around reinforcement with the method of placing employed on the work, but without permitting the materials to segregate or excess free water to collect on the surface. The following ranges represent the extreme limits of allowable slump when tested, in accordance with ASTM Designation: C-143. Where vibrators are used, the Engineer may allow a slightly less slump than the specified minimum.

Class of Concrete	Slump Range (Inches)
Class A	1½ to 3

The quantity of mixing water shall not be changed without the consent of the Engineer.

1.9 AIR-ENTRAINED CONCRETE

1.9.1 General. When air-entrained concrete is specified, air-entrainment shall be accomplished by using an air- entrained Portland cement or by using an air-entraining admixture with normal Portland cement. If the entrained air content falls below the specified limit when using air- entrained cement, an air-entraining admixture shall be added in sufficient quantity to bring the entrained air content within the specified limits. If the entrained air content is found to be greater than the maximum specified, when using an air-entrained cement, the use of an air-entraining cement shall be prohibited and air-entrainment shall be accomplished by using an air-entraining admixture with normal Portland cement. Air-entraining admixtures shall be added in solutions to a portion of the mixing water by means of a mechanical batcher in a manner that will insure uniform distribution of the agent throughout the batch. The air content of freshly mixed air-entrained concrete shall be determined as a percentage of the volume of the concrete by following the methods specified in ASTM Designation: C-138, C-173, or C-23l. Air content determination shall be made on samples of concrete during placement of the concrete in the forms.

Unless otherwise specified the air content (by volume) of the concrete at the time of placement shall be:

Maximum Size Aggregate	Air Content (%)
3/8 inch to 1/2 inch	6 to 9
over 1/2 inch to 1 inch	5 to 8
over 1 inch to 2 1/2 inches	3 to 6

1.9.2 Adjustment of Mix Proportions. When air-entrained concrete is specified, the amount of water and fine aggregate prescribed for normal concrete shall be reduced to compensate for the increased volume of air contained in the air-entrained concrete. This is to maintain the concrete's strength.

1.10 QUALITY OF CONCRETE

1.10.1 Control. The Contractor shall be responsible for the design of the concrete mixtures and the quality of the concrete including ready-mix. Prior to any concrete construction or any change in the mix during construction, the Contractor shall furnish a statement to the Engineer giving the proportions by dry weight of cement and of fine and coarse aggregate that will be used in the manufacture of each class of concrete contained in the contract. The Contractor will also furnish material samples to the laboratory for testing a design mix. Based on laboratory evidence, the Engineer will either approve the proposed mix or indicate the necessary proportions to meet the specified requirements.

1.10.2 Measurements. All materials entering into the concrete shall be mechanically measured by weight except the air-entraining admixture and water which may be measured by volume.

1.10.3 Delivery Ticket. Where truck mixers or ready-mix are used, the Contractor shall submit, for each load, a certified delivery ticket given the quantities of cement, fine and coarse aggregate, water, admixture, and the time that water was added to the batch.

1.11 DESIGN MIX AND CYLINDER TESTS

Standard tests of the strength of the concrete may be made by the Engineer at any time he elects to do so. The following tests will be performed by the methods indicated:

Test	Method (ASTM Designation)
Sampling	C-172
Slump Test	C-143
Air Content	C-231 or C-173
Compression Test Specimens	C-31 or C-42
Compressive Strength	C-39 or C-42
Unit Weight	C-138

Test of a portion of a batch may be made on samples representative of that portion for any of the following purposes:

(1) Determining uniformity of the batch.

(2) Checking compliance with requirements for slump and air content when the batch is discharged over an extended period of time.

(3) Checking compliance of the concrete with the specifications when the whole amount being placed in a small structure, or a distinct portion of a larger structure, is less than a full batch.

1.11.1 Slump Test. At least one slump test shall be made before first concrete pour, at the start of pouring any concrete and at each seven cubic yards deposited during one operation. These shall be made from same samples as those taken for cylinder tests, and records of same kept therewith. Tests shall be made according to ASTM Designation C-143 and as required under ASTM Designation C-94 for ready-mixed concrete. The Contractor shall furnish the necessary equipment and labor for making slump tests. Water in excess of the maximum required for a practical concrete mix will have adverse effects on shrinkage, durability, and strength of concrete. Concrete which has a greater slump than specified or directed by the Engineer can be rejected by the Engineer without cost to the Owner.

1.11.2 Entrained Air Tests. The Contractor shall furnish and have on the job at all times, one (2) LA-345 Chase Air Indicator Kit, one (1) LA-340 Spare Chase Air Indicator, and two (2) quarts of isoproyl alcohol (rubbing alcohol) for the Engineer's use in making entrained air measurements. The alcohol can be obtained locally at any drug store and the one (1) LA-345 and one (1) LA-340 can be procured from Forney's Inc., Route 18, R.D. No. 2, Wampum, Pennsylvania 16157, for approximately $40.00.

The amount of measured entrained air shall be recorded by the Engineer. Mortar shall be sampled only from concrete taken directly from the mixer. At least one (1) air measurement shall be made for each test cylinder taken. Concrete which has more or less entrained air than specified or directed by the Engineer can be rejected by the Engineer without cost to the Owner.

1.11.3 Initial Design Mix Cylinder Tests. Where more than 50 cubic yards of concrete are placed: The testing laboratory selected by the Owner shall make a set of six (6) test cylinders from the design mix. Three (3) shall be tested at 7 days and three (3) shall be tested at 28 days per ASTM Designation C-39. Test cylinders shall have a compressive strength per Article 3 of this section. The CONTRACTOR shall pay the cost of the design mix and design mix cylinder tests, and the Owner shall not pay for additional design mixes and design cylinder tests, caused by negligence, indecision, or carelessness on the part of the Contractor or his suppliers.

It is important for the Contractor to pursue all concrete testing requirements with dispatch so that approval of concrete can be granted by the Engineer in writing after all tests are completed.

1.11.4 Periodic Cylinder Tests. All cylinders shall be made per ASTM C-31 and tested per ASTM C-39. The Contractor shall furnish all labor and equipment for sampling and curing cylinders on the job site and transportation to the laboratory

for testing. The Owner shall select the laboratory and the Contractor shall bear the cost for testing the concrete cylinders.

At the start of concreting, three cylinders shall be made. One shall be tested at 7 days and two shall be tested at 28 days.

Throughout the remainder of the job, the Engineer shall direct when cylinders shall be taken and in what number they shall be taken. At each time when twenty (20) or more cubic yards of concrete are placed during one operation, and when the sum of smaller deposits of concrete equal thirty (30) cubic yards since previous test, and at any change in mix, three (3) cylinders shall be made. One (1) shall be tested at 7 days and two (2) shall be tested at 28 days.

For a strength test, three (3) test specimens will be made from a composite sample. The test result will be the average of the strength of the three specimens, except that, if one specimen in a test shows manifest evidence of improper sampling, molding, or testing, it shall be discarded and the remaining two strengths averaged. Should more than one specimen, representing a given test, show definite defects due to improper sampling, molding or testing, the entire test shall be discarded.

The Engineer will ascertain and record the batch number for the concrete and the exact location in the work at which each batch represented by a strength test is deposited.

The Engineer shall have free entry to the plant and equipment furnishing concrete under the contract. Proper facilities shall be provided for the Engineer to inspect materials, equipment and process and to obtain samples of the concrete. All tests and inspections will be conducted so as not to interfere unnecessarily with the manufacture and delivery of the concrete.

1.12 FAILURE TO MEET STRENGTH REQUIREMENTS

If cylinders do not meet strength requirements, the Engineer can order shutdown on all concreting and redesign of concrete mix by the laboratory selected by the Owner. The cost of mix redesign shall be paid for by the Contractor. The Engineer can also order additional tests, such as load tests, Swiss Hammer tests, and/or core tests in the areas of the work represented by unacceptable cylinders. If areas of work are found to be under strength requirements, the Engineer can order the Contractor to strengthen or replace those areas as the expense of the Contractor.

When it is determined that such concrete shall be removed and replaced the Contractor shall be notified in writing, stating the extent of the replacement to be made.

1.13 BATCHING AND MIXING

1.13.1 Equipment. The Contractor shall provide at the site of the work a modern and dependable batch-type mixing plant with a capacity consistent with the size of the job. The equipment shall be capable of combining the aggregate, cement and water into a uniform mixture and of discharging this mixture without segregation. Adequate facilities shall be provided for the accurate measurement and control of each of the materials entering the concrete. The complete plant assembly shall include provisions to facilitate the inspection of all operations at all times. Ready-mix concrete may be used, if approved by the Engineer, in which case the mixing plant at the site will not be required. All mixing requirements specified herein for concrete mixed at the site shall be applicable to ready-mixed concrete. Measurements of materials for ready-mixed concrete shall conform to ASTM Designation: C-94. The Engineer shall have free access to the mixing plant at all times. Truck mixers will be allowed, provided the use of this method will cause no violation of any applicable provisions of specifications for concrete contained herein. Truck mixers, unless otherwise authorized by the Engineer, shall be of the revolving drum-type, watertight, and so constructed that the concrete can be mixed to insure the uniform distribution of materials throughout the mass. Each truck mixer shall be equipped with a tank of known capacity which shall be equipped with an accurate device for measuring the amount of water added. Truck mixers and agitator shall be operated within the limits of capacity and speed of rotation designated by the manufacturer of the equipment.

1.13.2 Mixing Time. Neither the speed nor the volume capacity of the mixer shall exceed those recommended by the manufacturer. Excessive overmixing, requiring additions of water to preserve the required consistency, will not be permitted. The mixing time for each batch after all solid materials are in the mixer drum, provided that all the mixing water shall be introduced before one-fourth (1/4) of the mixing time has elapsed, shall be not less than two (2) minutes for mixers having capacities up to two (2) cubic yards. For mixers of larger capacities, this minimum shall be increased fifteen (15) seconds for each cubic yard or fraction thereof of additional capacity.

When a truck mixer is used, each batch of concrete shall be mixed not less than fifty (50) nor more than three hundred (300) revolutions, at a mixing speed of not less than four (4) r.p.m. after all materials are in the mixer drum. In all such cases, however, the concrete shall be delivered to the job site and discharged within 1 1/4 hours or before the drum has revolved 300 times, whichever comes first, after the mixing water has been added.

1.14 CONVEYING

Concrete shall be conveyed from mixer to forms as rapidly as practicable, by methods which will prevent segregation or loss of ingredients. There shall be no vertical drop greater than five (5) feet, except where suitable equipment is

provided, to prevent segregation and where specifically authorized by the Engineer. Chuting from towers or elevated positions of the mixer will be permitted, but the water content will be subject to the Engineer's control and excess water will not be allowed, in order to force the concrete to flow clean from the chutes, unless all flushing of chutes is discharged outside the forms.

Belt conveyors, chutes or other similar equipment in which the concrete is delivered to the structure in a thin, continuously exposed flow, will not be permitted, except for very limited or isolated sections of the work and only then if approved in writing by the Engineer. Such equipment shall be arranged to prevent objectionable segregation.

Where wall forms exceed five (5) feet in height, suitable measures, such as the use of tremie tubes, where practicable, or portholes, shall be provided in the forms to limit the vertical drop of the concrete to a maximum of five (5) feet. Openings shall be spaced around the perimeter of the formed area so that laterial flow of fresh concrete will be limited to three (3) feet. Drop chutes which may be provided to convey the concrete through wall ports shall have an outside pocket under each form opening to stop the concrete and allow it to flow easily over into the form without separation.

No concrete shall be placed until the Engineer has given his approval of the subgrade, forms and reinforcing steel in place. If the reinforcing steel is not placed in accord with the drawings, the Engineer shall stop the Contractor from placing any concrete until the error is corrected. Under no circumstances will an attempt be made to correct errors by inserting additional unscheduled bars. No concrete shall be placed except in the presence of the Engineer or his representative, and the Contractor shall give reasonable notice of his intention to pour.

Before any concrete is placed, the forms and subgrade shall be free of chips, dirt, sawdust, or other extraneous materials.

1.15 PLACING

1.15.1 General. Concrete shall be placed within one and one-quarter (1-1/4) hours after the introduction of the water to the cement and aggregates. In hot weather or under conditions contributing to quick stiffening of the concrete, or where the temperature of the concrete is 85^{O}F or above, the time shall be reduced to 45 minutes. The Engineer may allow a longer time, providing the setting time of the concrete is increased a corresponding amount by the addition of an approved set-retarding mixture. Concrete shall be deposited as closely as possible to its final position in the forms so that flow within the mass and consequent segregation are reduced to a minimum.

Vibrators may be used to aid in the placement of the concrete provided they are used under experienced supervision, and the forms designed to withstand their

action. The duration of vibration shall be limited to that necessary to produce satisfactory consolidation without causing objectionable segregation. Vibration shall not be applied directly to the reinforcement steel or the forms nor to concrete which has hardened to the degree that it does not become plastic when vibrated.

The Contractor shall keep at least one spare vibrator on the job during all concrete placing operations.

When a vibrator is used the Contractor shall also spade the concrete along form surfaces a sufficient amount to prevent excessive size or numbers of air-void pockets in the concrete surface, except where an approved absorptive form lining is used; in which case the spading specified above will not be permitted.

1.15.2 Lifts in Concrete. The permissible depth of concrete placed in each lift shall be as shown on the drawings or specified herein. All concrete shall be deposited in horizontal layers not exceeding twenty (20) inches in thickness, unless otherwise authorized or directed. The placement shall be carried on at such a rate that the formation of cold joints will be prevented. If a delay occurs in excess of a thirty (30) minute interval between any two (2) consecutive batches or loads, or in case of any delay between placing batches that allows previously placed concrete to take initial set, the Contractor shall discontinue the placing of concrete and make, at his own expense, a construction joint satisfactory to the Engineer before proceeding with the placing operations. He shall remove any portion of the previously placed concrete that is deemed necessary for the proper formation of the construction joint and no payment shall be made to the Contractor for the concrete removed. The thirty (30) minute limitation, cited immediately above, may be extended in those cases where an approved type retarder is added to the concrete mixture to delay the set of the concrete. Use of a retarder in the mix shall be subject to approval of the Engineer.

Hoppers, chutes, and pipes shall be used as necessary to prevent splashing of mortar on forms and reinforcing above the layer being placed.

1.15.3 Placing Temperature. Concrete shall be mixed and placed only when the temperature is at least forty (40) degrees F. and rising, unless permission to pour is obtained from the Engineer, in which event all material shall be heated and otherwise properly prepared so that batching and mixing can proceed in full accord with the provisions of this specification. The methods proposed for heating the materials and protecting the concrete shall be approved by the Engineer. Salt, chemicals, or other materials shall not be mixed with the concrete for the purpose of preventing freezing. Accelerating agents shall not be used.

Concrete placement will not be permitted when, in the opinion of the Engineer, the sun, heat, wind, or humidity prevents proper placement and consolidation.

When the atmospheric temperature may be expected to drop below 40°F at the time concrete is delivered to the work site, during placement or any time during the curing period, the following provisions also shall apply:

(1) The temperature of the concrete at the time of placing shall not be less than 50°F nor more than 90°F. The temperature of neither aggregates nor mixing water shall be more than 100°F just prior to mixing with the cement.

(2) When the daily minimum temperature is less than 40°F, concrete structures shall be insulated or housed and heated after placement. The temperature of the concrete and air adjacent to the concrete shall be maintained at not less than 50°F nor more than 90°F for the duration of the curing period.

(3) Methods of insulating, housing and heating the structure shall conform, to "Recommended Practice for Cold Weather Concreting," ACI Standard 306.

(4) When dry heat is used to protect concrete, means of maintaining an ambient humidity of at least 40 percent shall be provided unless the concrete has been coated with curing compound or is covered tightly with an approved impervious material.

For obtaining the proper curing conditions for the concrete poured, steam heating equipment, oil-fired blowers (airplane heaters) located outside the enclosure and blowing hot air into the enclosure, or other similar equipment of a capacity sufficient to maintain the required minimum temperature all over, will be required. In conjunction with forced air heaters, means of supplying moisture to the area being cured will also be required. Oil or coke buring salamanders and other fuel-burning heaters produce carbon dioxide which combines with calcium hydroxide in fresh concrete to form a weak layer of calcium carbonate. When this occurs, the surface of the concrete floor will dust under traffic. For this reason, carbon dioxide producing heaters shall not be used while placing concrete and for the first 24 to 36 hours of the curing period unless they are properly vented.

The Contractor must have a sufficient steam retaining canvas or other protective covering at the site to cover all sides and tops of forms to be poured and concrete to be cured, before pouring of concrete will be allowed. This covering must be placed over and around forms and concrete being cured in such a manner that circulation of curing air will prove effective to the tops of floors and to the outside, top and corners of concrete structures, as well as to their interiors. Concrete shall be moist cured in accordance with paragraph 18 of this section. The Contractor may strip forms during curing period with covering removed, provided atmospheric temperatures are above specified curing temperatures, concrete surfaces are kept moist, and time and labor is available for recovering for lower night temperatures.

When climatic or other conditions are such that the temperature of the concrete may reasonably be expected to exceed 85°F at the time of delivery at the work site, during placement, or during the first 24 hours after placement, the following provisions also shall apply:

(1) The Contractor shall maintain the temperature of the concrete below 85°F during mixing, conveying, and placing. Methods used shall conform to "Recommended Practice for Hot Weather Concreting," ACI Standard 605.

(2) The concrete shall be placed in the work immediately after mixing. Truck mixing shall be delayed until only time enough remains to accomplish it before the concrete is placed.

(3) Exposed concrete surfaces which tend to dry or set too rapidly shall be continuously moistened by means of fog sprays or otherwise protected from drying during the time between placement and finishing, and after finishing.

(4) Finishing of slabs and other exposed surfaces shall be started as soon as the condition of the concrete allows and shall be completed without delay.

(5) Concrete surfaces exposed to the air shall be covered as soon as the concrete has hardened sufficiently and shall be kept continuously wet for at least the first 24 hours of the curing period, and for the entire curing period unless curing compound is applied as specified in subsection 7, below.

(6) Formed surfaces shall be kept completely and continuously wet for the duration of curing period (prior to, during and after form removal) or until curing compound is applied as specified in subsection 7, below.

(7) If moist curing is discontinued before the end of the curing period, white pigmented curing compound shall be applied immediately.

1.15.4 Concrete on Rock Foundations. Rock surfaces upon which concrete is to be placed shall be clean, free from oil, standing or running water, mud, objectionable coatings, debris, loose semidetached, or unsound fragments. Faults or seams shall be cleaned to a depth satisfactory to the Engineer, and to firm rock on the sides. Immediately before concrete is placed, all such rock surfaces shall be cleaned thoroughly by use of high velocity air-water jets, wet sandblasting, or other means satisfactory to the Engineer. All rock surfaces shall be kept continuously wet for forty- eight (48) hours and all approximately horizontal surfaces shall be covered, immediately before the concrete is placed, with a layer of mortar of the same sand-cement ratio as used in the concrete.

1.15.5 Concrete on Earth Foundations. Unless otherwise authorized all concrete shall be placed upon clean, damp surfaces free from frost, ice, or deleterious materials, and standing or running water. Concrete shall not be placed in mud, dried porous earth or upon fill that has not been subject to approved rolling or

tamping until optimum compaction has been obtained. The Contractor shall take all measures to accomplish the results specified in this paragraph.

1.15.6 Vertical Point Spacing. The layout of all monoliths shall be as shown on the drawings or as directed and approved by the Engineer before construction is started.

1.15.7 Placing Concrete Through Reinforcement. In dropping concrete through reinforcement, care shall be taken that no segregation of the coarse aggregate occurs.

1.16 CONSTRUCTION JOINTS

Contractor shall furnish and install vinyl or plastic waterstops as manufactured by W.R. Meadows, Inc., Waterstops Inc., or B.F. Goodrich Inc., or approved equal quality. Waterstops shall be center bulb type 6 inches wide unless shown otherwise in the plans. Care and diligence shall be exercised in securing proper embedment in the concrete mix.

The waterstop shall be extruded from elastomeric polyviny- chloride material and joints shall be cemented as recommended by the manufacturer. The Contractor may use other waterstop materials subject to the Engineer's approval.

Construction joints shall be located as indicated on the contract drawings, or as approved by the Engineer. The surfaces of construction joints shall be clean when covered with fresh concrete. Cleaning shall consist of the removal of all laitance, loose or defective concrete and foreign material. Cleaning of the surface of construction joints shall be accomplished by the use of high velocity air-water jets, wet sandblasting, or other effective means satisfactory to the Engineer. Surfaces of construction joints that have been permitted to dry by reason of the succeeding lift or adjoining concrete not being placed within the specified post-curing period shall be moistened and kept continuously moist for at least forty-eight (48) hours immediately prior to the placing of the succeeding lift or adjoining concrete. All pools of water shall be removed from the surfaces of construction joints before the new concrete is placed.

1.17 FINISHING

1.17.1 Defective concrete, honeycombed areas, voids left by the removal of tie rods, ridges on all concrete surfaces permanently exposed to view or exposed to water on the finished structure, shall be repaired immediately after the removal of forms unless otherwise authorized or directed. Voids left by removal of tie rods shall be reamed and completely filled with dry-patching mortar.

Defective concrete shall be repaired by cutting out the unsatisfactory material and placing new concrete which shall be secured with keys, dovetails, or anchors. Defective areas shall be chipped away to a depth of not less than 1

inch with the edges perpendicular to the surface. The area to be patched and a space at least 6 inches wide entirely surrounding it shall be wetted to prevent absorption of water from the patching mortar. A grout of equal parts Portland Cement and sand, with sufficient water to produce a brushing consistency, shall then be well brushed into the surface, followed immediately by the patching mortar. The patch shall be made of the same material and of approximately the same proportions as used for the concrete except that the coarse aggregate shall be omitted. The mortar shall not be richer than 1 part cement to 3 parts sand. On exposed surfaces, white Portland Cement shall be substituted for a part of the grey Portland Cement to match the color of the surrounding concrete. The proportion of white and grey cements shall be determined by making a trial patch. The amount of mixing water shall be as little as consistent with the requirements of handling and placing. The mortar shall be retempered without the addition of water by allowing it to stand for a period of 1 hour during which time it shall be mixed occasionally with a trowel to prevent setting.

The mortar shall be thoroughly compacted into place and screeded off so as to leave the patch slightly higher than the surrounding surface. It shall then be left undisturbed for a period of 1 to 2 hours to permit initial shrinkage before being finally finished. The patch shall be finished in such a manner as to match the adjoining surface.

Excessive rubbing of formed surfaces will not be permitted. All unformed surfaces of concrete, exposed in the completed work, shall have a wood float finish without additional mortar.

1.17.2 When concrete is honeycombed, damaged or otherwise defective, the Contractor shall remove and replace the structure or structural member containing the defective concrete, or correct or repair the defective parts. The Engineer will determine the required extent of removal, replacement or repair.

Prior to starting repair work the Contractor shall obtain the Engineer's approval of his plan for making the repair. Such approval shall not be considered a waiver of the Contracting Officer's right to require complete removal of defective work if the completed repair does not produce concrete of the required quality and appearance. Repair work shall be performed only when the Engineer is present. Repair of formed surfaces shall be started within 24 hours after removal of the forms.

Joints and edges of unformed surfaces that will be exposed to view shall be chamfered or finished with molding tools.

1.17.3 In order that the rubbing required by these specifications shall be effective, non-supporting forms may be stripped with 24 hours after concrete pouring is completed, and initial rubbing required completed with 48 hours. If possible, patching and rubbing shall be done at the same time. This requirement regarding form removal is secondary to heating requirements, and the

specifications heretofore included regarding heating of concrete shall take precedence.

After the required curing time has elapsed, support forms may be removed to allow finishing. Finish shall be Type I, II, or III as required by the "Concrete Finishes" section. In general, surfaces that will show in the finished work will be rubbed down with a coarse carborundum stone. Floors and slabs shall be float finished as soon as possible after pouring unless otherwise specified. Cement or mortar coating will not be permitted. The Contractor should refer to the section on "Concrete Finishes" for complete finish requirements for all concrete units.

Rubbing is not required lower than 6 inches below water levels in basins, but all fins must be removed and holes patched. Exposed inside surfaces to be painted must be rubbed smooth.

The surfaces of exposed concrete roofs, walks, and copings shall be finished with a wooden float and left with a gritty surface similar to that in general use for sidewalks. This finish and floating must be done at the proper period in the setting of the concrete. These outside exposed surfaces of floors and roofs must be finished as one piece of work without a separate top coat.

Basin and channel floors shall be struck off smooth and finished with a steel float to produce a surface easily cleaned. The inside exposed floors must be finished with a steel float to even surfaces and present a neat, smooth, and satisfactory appearance. Finish with bevel around all curbings, and other openings. Floors must be finished to drain to floor traps and sump with slopes as shown on the plans. Floors at the walls must be level except where shown otherwise on the plans.

Surfaces of precast concrete members that are to be painted shall have all air holes and other imperfections filled and dressed to present surfaces comparable in smoothness and appearance to rubbed concrete as set forth above.

1.17.4 Watertightness. All concrete when finished must be watertight. Exposed concrete surfaces shall show no dampness when the interior of basins or exterior of pits have been filled with water for seven days. To obtain this result, the foregoing specifications must be rigidly followed. In case any leakage or dampness shows on the surface of any such walls after testing the time stated, then such defects must be remedied by the Contractor and work will not be accepted until this is done.

1.17.5 Openings for Pipes and Joints to Pipes. Where pipes pass through concrete walls or floor pours they shall do so by the use of a mechanical joint wall sleeve. The sleeve shall be cast into the pour and it shall be of sufficient length to allow easy installation or removal of the main line pipe.

Where malleable pipe (steel, wrought iron, or copper), brittle pipe (hard rubber), rubber hose, or any pipe cut to fit on the job, passes through any concrete slab, floor or wall, a wrought or cast iron pipe nipple with about 1/2 inch greater diameter than the outside of the pipe shall be used as a sleeve and cast into the slab. In case of floors above ceilings, these sleeves shall extend 1/2 inch to 1 inch above floor surface, to prevent scouring water from running into them. If joint about pipe is required for watertightness or pipe support, the annular ring shall be caulked with dry, unbraided oakum to within 2 inches of surface. The ring at surface shall be filled with nonshrink grout, raked back 1/2 inch, and filled with 1/2 inch cap of Portland Cement grout as previously mentioned.

Where holes greater than 10 inch diameter have to be cut for pipe in existing concrete slabs or walls, the space about the pipe shall be formed to original surfaces and the pipe wrapped with 1/2 inch braided hemp. In grouting this space, use a nonshrink grout, such as Sonneborn "Ferrolith G" or Masters Builders "Embeco". Where walls and spaces give sufficient room for safely using large aggregate, this may be added in a quantity equal to the sand specified. After removal of forms, the yarn shall be removed for a depth of 2 inches from water side and/or exposed surfaces, and the space refilled to surface with a nonshrink grout. Then the joint shall be raked back 1/2 inch from the surface and filled with a one to two mix grout of Portland Cement and sand.

1.18 CURING AND PROTECTION

1.18.1 General. All concrete shall be cured for a period of not less than seven (7) consecutive days by an approved method, or combination of methods. The curing process shall be done so as to prevent loss of moisture from the concrete for the duration of the entire curing period. Unhardened concrete shall be protected from heavy rains and flowing water. All concrete shall be adequately protected from damage.

1.18.2 Moist Curing. Concrete shall be moist cured by maintaining all surfaces continuously (not periodically) wet for the duration of the entire curing period. Water for curing shall be clean and free from any elements which will cause staining or discoloration of the concrete. Where forms of wood are used and left in place during curing, the wood shall be kept wet at all times.

1.18.3 Membrane Curing. At the option of the Contractor and when approved by the Engineer, the concrete may be cured with an approved curing compound of the surface membrane type in lieu of moist curing with water provided a permanent stain is not produced and provided the concrete surface is not to receive rubbed finish, terrazzo, tile, paint, chemical hardening, grout, cement patch, or concrete topping. The curing compound shall be applied to formed surfaces immediately after the forms have been removed and the surfaces cleaned of any loose sand, mortar and debris. The surface to receive the compound shall be moistened thoroughly with water and the compound applied as soon as the moisture film has disappeared but when the surface is still damp.

On unformed surfaces the compound shall be applied immediately after the surface loses its free water and has a dull appearance.

The curing compound shall be applied in a twocoat continuous operation by approved spraying equipment and at a coverage of not more than two hundred (200) square feet per gallon for both coats. The second coat shall be applied to overlap the first coat in a direction at approximately right angles to the direction of the first application. Concrete surfaces which are subjected to heavy rainfall within three (3) hours after the curing compound has been applied shall be resprayed by the method and at the coverage herein specified. All concrete surfaces on which curing compound has been applied shall be adequately protected for the duration of the entire curing period from any damage that would disrupt the continuity of the curing membrane.

The curing compound shall conform to Type 2 or Type 3 of ASTM Designation: C-309.

All curing compound shall be delivered to the site of the work in the original sealed container bearing the name of the manufacturer, the brand name and the manufacturer's batch number. The compound shall be approved prior to use. The compound shall be stored so as to prevent damage to the containers, and water-emulsion types shall be protected from freezing.

1.18.4 Cold Weather. The air and forms in contact with the concrete shall be maintained at temperatures above forty (40) degrees for at least seven (7) days and at a temperature above freezing for at least 21 days. Concrete, permitted to be cured with curing compounds, shall be provided the same protection against freezing and low temperatures as provided herein. No fire or excessive heat shall be permitted near or in direct contact with concrete at any time.

1.19 FORMS

1.19.1 Material. Forms shall be wood, steel, or other approved material. Wood forms shall be tongue-and-groove lumber of uniform width and thickness, or plywood having a minimum of five (5) plies, a minimum thickness of 9/16 inch, and a type made especially for concrete forms. Steel forms shall be of a type acceptable to, and commonly used in the construction field. The type, shape, size, quality and strength of all material of which the forms are made shall be subject to the approval of the Engineer.

1.19.2 Construction. Forms shall be true to line and grade, mortartight, and sufficiently rigid to prevent objectionable deformation under load. Where forms for continuous surfaces are placed in successive units, care shall be taken to fit the forms over the complete surface so as to obtain accurate alignment of the surface and to prevent leakage of mortar. Forms shall be constructed such that keyways, waterstops, and dowels can be placed as shown in the plans.

Responsibility for their adequacy shall rest with the Contractor. The form surfaces shall be smooth, free from irregularities, depressions, sags, or holes when used for permanently exposed faces. Bolts and rods used for internal ties shall be so arranged that, when all forms are removed, all metal will not be less than one (1) inch from any concrete surface. Wire ties will not be permitted. All forms shall be so constructed so that they can be removed without hammering or prying against the concrete. All exposed joints shall be chamfered and suitable molding shall be placed to bevel or round exposed edges or corners, unless otherwise directed by the Engineer.

Temporary openings shall be provided in the inside form of all wall forms and column forms to facilitate cleaning and inspection immediately before depositing concrete. When wood sheathing is used for the inside form, the bottom board shall be fitted and removed to provide a continuous cleanout space and if plywood is used, the forms shall be started with a 6- inch wide piece for the same purpose. Washing out of all forms and other concrete before pouring new materials must be done with water or air from a hose under pressure. The hose must be provided with a suitable nozzle for this work. The intent of these specifications is to produce a perfectly watertight structure in all cases, without any subsequent repair work. Forms shall be so assembled that their removal will not damage the concrete.

Contact surfaces of forms shall be divided into two categories; forms for exposed concrete, and forms for unexposed concrete. Exposed concrete shall mean concrete normally exposed to view and shall be considered extending 6 inches below planned regrade or water level. Exposed concrete shall exclude interior surfaces of covered water holding basins and unpainted, unfinished, interior surfaces of manholes and vaults. Unexposed concrete shall be concrete not normally exposed to view and shall include all concrete not included by exposed concrete, unless otherwise noted on the plans or in the specifications. Either unlined forms or lined forms (as hereinafter specified) shall be used for exposed concrete. A combination of lined forms for exposed concrete and unlined forms for unexposed concrete may be used in a structure where only a part of the structure is exposed. When this combination occurs, the Engineer will determine, upon request of the Contractor, if that portion of the structure which requires lined forms can be reduced in section to accommodate the liner without offsetting the liner backing from the sheathing used for the unexposed portion of the structure.

(1) Forms for Exposed Concrete

(a) Unlined. The contact surface of forms shall be constructed from 5/8 inch or 3/4 inch 5 ply structural plywood of concrete form grade. All concrete form plywood shall be designated by grade marking each panel. Full sized sheets of plywood must be used except where smaller pieces will cover an entire area. The edges of all plywood sheets shall be straightened on the bench to insure close fitting, tight joints. All vertical

joints shall be backed solidly and the edge of abutting sheet shall be nailed to the same stud.

When the one form is erected and reinforcement is in place, and before the other form is erected, the Engineer shall be notified and the other form shall not be placed until work already done is approved. Open joints which would permit leakage of grout shall be sufficient cause for rejection of forms. If, in the opinion of the Engineer, pointing of slightly open joints will prevent leakage, then such pointing shall be done with an approved mixture. Pointing shall be carefully done and there shall be no trace of the pointing mixture on the surface of the sheathing.

Contact surfaces of forms shall be in good condition. The Engineer has the right to reject forms which will not produce a smooth, uniform, concrete surface.

(b) Lined. The backing for form lining shall be constructed of a good grade of form lumber that is solid, straight, and free from defects that might impair its strength but need not be of the quality used for contact forms. Square-edged, sized lumber may be used for form boarding in place of shiplap or tongue-and-groove.

The boarding for lined forms may be horizontal or vertical, depending upon convenience. Form sheathing shall be securely nailed to the studs and the edges of the boards shall be in contact to prevent any bulging of the lining.

Plywood faced panel or patented forms in good condition, with tight fitting joints, such as steel-ply forms, can be substituted for lined forms if a smooth wall surface, as required by these specifications, can be obtained. Minor variations in concrete texture at form joints will be permitted.

Lining material shall be 1/4 inch structural plywood securely nailed to the form sheathing. All lining material shall be used in as wide pieces as possible. Areas less than 4 feet in width shall be lined with a single width of plywood.

Joints in lining and backing shall not occur at the same place and butting edges of adjacent sheets shall be nailed to the same board. The lining material shall be nailed to the backing beginning at the center of the board and working toward the edges to prevent buckling. Lining material may be re-used, if it is in satisfactory condition and is approved by the Engineer. Open joints which would permit leakage of grout shall be sufficient cause for rejection of forms. If, in the opinion of the Engineer, pointing of slightly open joints will prevent leakage, then such pointing shall be allowed.

In the case of lined circular forms where the backing for form lining is constructed in chords of a circle, the form lining shall be adequately supported by variable thickness shim strips on at least 6 inch centers so that the liner forms a circular surface within tolerances specified herein.

(2) Forms for Unexposed Concrete

Forms shall be constructed of a good grade of form lumber that is solid, straight and free from defects which might impair its strength, but need not be of the quality required for contact surfaces of forms for exposed concrete. Forms shall be of shiplap of T & G No. 2 wood sheathing, 3/4 inch plywood, 5/8 inch plywood or approved equal. Panel or patented forms may be used upon approval of the Engineer.

(3) Form Ties

Forms ties shall be as follows:

(a) "Water-Seal" type of ties shall be used for water holding structures or structures subject to flooding.

(b) Nonwater holding structures, which are not subject to flooding, shall have ties approved by the Engineer.

Form ties shall have a minimum working strength when fully assembled of at least 3,000 pounds. Ties shall be so adjustable in length as to permit tightening of forms and of such type as to leave no metal closer than 1 inch from the surface and they shall not be fitted with any lugs, cones, washers or other device to act as a spreader within the form or for any other purpose which will leave a hole larger than 7/8 inch in diameter or a depression back of the exposed surface of the concrete. Wire ties shall not be permitted.

1.19.3 Construction Tolerance. The forms shall be constructed and rigidly braced in place within the following tolerances:

(1) Variation from true alignment as shown on the drawings in the lines and surfaces of walls:

In 10 feet	1/4 inch
In 20 feet maximum	3/8 inch
In 40 feet or more	3/4 inch

(2) Variation from the level or from the grades indicated on the drawings in floors or slabs:

In 10 feet	1/4 inch
In 20 feet maximum	3/8 inch
In 40 feet or more	3/4 inch

(3) Variation in sizes and/or locations of floor and/or wall openings:

1/4 inch

(4) Variation in thickness of slabs and walls and in cross-sectional dimensions of columns and beams:

Minus	1/4 inch
Plus	1/2 inch

(5) Variation in plan dimension of footings:

Minus	1/2 inch
Plus	2 inches

1.19.4 Wetting and Oiling Forms. The inside surface of wood board forms shall be soaked with clean water and kept continuously wet for 12 hours before any concrete is placed. In case forms have been erected for some time and have become dry so that joints have opened, then the forms shall be thoroughly soaked at least twice each day for at least 3 days prior to placing concrete. If the forms cannot be tightened to the satisfaction of the Engineer, they shall be torn down and rebuilt. Plywood forms may be treated with a nonstaining form oil, mineral oil or lacquer. If oil is used, all excess oil shall be wiped off with rags to leave the surface of the forms just oily to the touch. In freezing weather oil shall be used.

Coatings of dust shall be removed from contact surfaces of forms before placing concrete. Concrete shall not be placed in any form until inspected by the Engineer and permission is given to start placing.

1.19.5 Removal. Forms shall not be removed without approval of the Engineer. All form removal shall be accomplished in such a manner as to prevent injury to the concrete.

Forms shall not be removed sooner than the following minimum times after the concrete is placed. These periods represent cumulative number of days and fractions of days, not necessarily consecutive, during which the temperature of the air adjacent to the concrete is above 50°F.:

Element	Time
Beams, arches - supporting forms and shoring	14 days
Conduits, deck slabs - supporting (inside) forms and shoring	7 days
Conduits (outside forms), sides of beams, small structures	24 hours
Columns, walls, spillway risers - with side or vertical load	7 days
Columns, walls, spillway risers - with no side or vertical load	4 days
Concrete supporting more than 30 feet of wall in place above it.	7 days
Concrete supporting 20 to 30 feet of wall in place above it.*	4 days
Concrete supporting not more than 20 feet in place above it.*	24 hours

* Age of stripped concrete shall be at least 7 days before any load other than the weight of the column or wall itself is applied.

When conditions on the job are such as to justify the requirements, forms will be required to remain in place for longer periods. Forms for beams, girders, and flood slabs shall remain in place for at least seven (7) days and shall only be removed when test cylinders used under the same conditions as the members break with a compressive strength as required in these specifications.

1.19.6 Design, Inspection and Approval of Form Work. The design and engineering of the form work, as well as the construction, shall be the responsibility of the Contractor. The Engineer's approval of form work design and/or drawings, as submitted or as corrected in no way shall relieve the Contractor of his responsibility for adequately constructing and maintaining the forms so that they will function properly.

Forms, form joints, and reinforcing steel placement shall be checked by the Resident Engineer before closing up the forms. Concrete shall not be placed in any form until the placing of steel and erection of form work have been completed and approved in the completed state by the Resident Engineer. Immediately after completion of pouring, tops of all forms shall be adjusted to line and approved by the Resident Engineer as to conformity with the tolerances specified herein.

1.20 EXPANSION OR CONTRACTION JOINTS

1.20.1 General. Where required, joints shall be provided at the location indicated on the drawings and according to the details shown, or as otherwise approved. The methods and materials used shall be subject to approval and the materials shall conform to the specification applicable. In no case shall any fixed metal,

embedded in concrete be continuous through an expansion or contraction joint, except as specifically detailed in the drawings.

1.20.2 Expansion Joint Filler. At all expansion joints shown on the drawings, a premolded joint filler of the thickness specified, shall be provided to prevent bond between and allow for the expansion and contraction of adjacent parts. The filler material shall be of sufficient length and width, and shall be accurately cut, matched and placed to prevent contact of the concrete in the parts of the structure to be separated.

Preformed expansion joint filler shall conform to the requirements of ASTM Specification D 1752, Type I, Type II or Type III, unless bituminous type is specified.

Bituminous type preformed expansion joint filler shall conform to the requirements of ASTM Specification D 994.

1.20.3 Asphalt-Treated Roofing Felt. Two layers of heavy, smooth surface asphalt-treated roofing felt, approximate weight 55 pounds per 100 square feet, shall be placed at expansion joints, as shown on the drawings.

1.20.4 Waterstops. Where required, waterstops shall be installed in joints as shown on the drawings or as otherwise directed to provide a continuous water-tight diaphragm in the joint. All joints in metal waterstops shall be brazed or welded. Joints in rubber and plastic waterstops shall be cemented, fused, or vulcanized as recommended by the manufacturer. Adequate provisions shall be made to support and completely protect the waterstops during progress of the work. The Contractor shall replace or repair, at his own expense, any waterstops punctured, ruptured, or otherwise damaged before final acceptance of the work.

Copper used for waterstops shall conform to ASTM Designation: B-248.

Steel used for waterstops shall conform to ASTM Designation: A-366 or ASTM Designation: A-93.

Wrought iron used for waterstops shall conform to ASTM Designation: A-162 or ASTM Designation: A-163.

Plastic material used for waterstops shall conform to ASTM Designation: D-742.

The rubber waterstop material shall meet the following physical requirements when and if tested, in accordance with the appropriate sections of Federal Test Method Standard No. 601, ASTM Designation: D-395, and ASTM Designation: D-1432.

Hardness. The Shore A durometer hardness shall be 60 to 70.

Elongation. The elongation shall be a minimum of 400 percent.

Tensile Strength. The tensile strength shall be a minimum of 2,500 pounds per square inch.

Water Absorption. The water absorption shall be a maximum of 5 percent by weight after immersion in water for two (2) days at 158°F.

Tensile Strength After Aging. The tensile strength after accelerated aging for five (5) days at 158°F., shall not be less than 80 percent of the original tensile strength.

Compression Set. The compression set after 22 hours at 158°F., shall not be more than 30 percent.

Specific Gravity. The specific gravity shall be 1.20 plus or minus .05.

1.20.5 Dowel Bar Assembly. Where required, dowel bar assembly shall be installed at the expansion joints as shown on the drawings. The dowel bars shall be plain, smooth steel bars of the size specified on the drawings and shall conform to ASTM Designation: A-15. An expansion sleeve shall be provided on one end of each dowel bar. The sleeve shall be metal of an approved type, crimped or capped on one end, and provided a minimum of three (3) inch length of covering of the dowel bar with a minimum of three-quarters (3/4) of an inch expansion chamber beyond the end of the dowel bar. The portion of the dowel bar on the expansion sleeve side of the joint shall be coated with a heavy grease to prevent bond between the bar and the concrete. The dowel bar assembly shall be securely held in place by use of metal dowel chairs at each intersection of a dowel bar and spacer bar. The dowel bars shall be installed on proper horizontal and longitudinal alignment to assure a workable expansion device. The premolded joint filler at these expansion joints shall be held in a true vertical plane by means of a header board. The header board shall remain in place for a minimum of thirty (30) minutes after the concrete has been placed on one side or until the concrete has set sufficiently to prevent sloughing, before the header is removed and the work of placing concrete continued.

1.21 FURNISHING AND PLACING STEEL REINFORCEMENT

The furnishing and placing of reinforcing steel, when specified, is covered in a separate technical specifications.

1.22 EMBEDDED ITEMS

1.22.1 General. Before placing concrete, care shall be taken to determine that all embedded items are firmly and securely fastened in place as indicated on the drawings or required by the Engineer. All embedded items shall be thoroughly clean and free of oil and other foreign matter such as loose coatings, of rust,

paint, and scale. The embedding of wood or other perishable materials in concrete shall be prohibited unless specifically directed or authorized by the Engineer. Any air lines, water lines, wall sleeves, or other materials embedded in structures, as construction expedients authorized by the Engineer, shall conform to the above requirements and, upon completion of their use, shall be backfilled with concrete or grout as directed by the Engineer.

1.22.2 Pipe Embedded in Concrete. Where pipe is partially or wholly encased in concrete, care shall be taken that the pipe is firmly and securely held in place so that the alignment and grade of the pipe is not disturbed while the concrete is placed around the pipe.

1.23 CONSTRUCTION

Concrete work shall be performed in accordance with these specifications on concrete. The vertical surfaces of the cradle, expansion and contraction joints shall be formed. The cradle shall be poured with the pipe in place and to line and grade. Construction joints that are used shall conform with the requirements of paragraph 16. Expansion and contraction joints shall conform with requirements of paragraph 20.

1.24 SEALING JOINTS IN CONCRETE AND CONCRETE PIPE

1.24.1 General. This specification covers the requirements for sealing or filling joints in concrete pipe and concrete structures where expansion joint material is not used.

1.24.2 Type. The sealing compound shall be a cold- application mastic, single component or multiple component type.

The single component type shall be a ready-mixed nondrying compound furnished in troweling consistency or in preformed rope or strip form.

The multiple component type shall be composed of two or more substances that are to be mixed prior to application.

1.24.3 Quality. Sealing compound shall conform to the requirements of one of the following specifications:

ASTM Specification D 1850; Concrete Joint Sealer, Cold- Application Type. Penetration, determined as specified in ASTM D 1850, shall be not greater than 120.

Federal Specification SS-S-00210; Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints.

Federal Specification TT-S-227; Sealing Compound; Rubber base, Two Component (For Caulking, Sealing and Glazing in Building Construction), Type II.

1.24.4 Application. The compound will be applied using manufacturer's instructions to joints identified in the plans or as otherwise required in accordance with good construction practices.

1.25 MEASUREMENT AND PAYMENT

Payment will be based on one of the following criteria as specified and described in the Contract Bid Item Descriptions and on the Drawings:

A. Cost shall be included in the work to which it is subsidiary and no separate measurement and payment will be made.

B. Payment will be based on Plan Quantities or a percentage of concrete installed to complete the structure as computed by the Engineer or as shown on the Drawings.

Payment as specified above shall be considered as full compensation for all labor, materials, equipment and incidentals necessary to perform the work as required.

Payment for concrete placed outside the lines shown on the drawings due to overexcavation or Contractor error will not be made. Where extra concrete is authorized by the Engineer in writing, payment will be made at a price agreed upon by the Contractor and the Engineer.

SECTION 03002

CONCRETE REINFORCEMENT

1. GENERAL

1.1. Description of Work. This specification covers furnishing, cutting, bending, handling, and placing of steel reinforcement for all reinforced cast-in-place concrete included in this Contract.

1.2. Codes and Standards. The provisions of the following codes, specifications, and standards latest editions shall apply:

(1) American Concrete Institute, ACI-315, "Manual of Standard Practice for Detailing Reinforced Concrete Structures."

(2) American Concrete Institute, ACI-318, "Building Code Requirements for Reinforced Concrete."

(3) Concrete Reinforcing Steel Institute, "Placing Reinforcing Bars."

1.3. Submittals.

1.3.1. Shop Drawings. Within 15 days after award of the Contract, the CONTRACTOR shall prepare and submit to the ENGINEER for review complete shop drawings in accordance with Section 1A of these Specifications. The CONTRACTOR shall not allow delivery of the reinforcing steel to the job site until a review of the shop drawings has been completed by the ENGINEER. Shop drawings shall include the following:

(1) Reinforcement bar schedules complete with the quantity, shape and size, dimensions, weight per foot and total weights, and bending details.

(2) Details of bar supports including types, sizes, and support spacing and sequence.

(3) Plan and elevation views detailing reinforcing placement.

(4) Location and arrangement of accessories.

(5) All details and notes appearing on the Drawings.

1.3.2. Mill Tests. Mill tests of reinforcement shall be submitted prior to use for each 15 tons or less shipped to the job site. Tests shall be conducted in

conformance with ASTM A-615, and the methods described therein. Cost of the test shall be borne by the CONTRACTOR. Three (3) copies of each test report shall be submitted to the ENGINEER. The bars shall be properly tagged so as to permit identification of the heat number shown on the mill test report for any and all steel delivered to the Work.

2. MATERIALS

2.1. Reinforcing Steel Bars. All bar reinforcement shall be new billet steel deformed bars of American manufacture conforming to ASTM Designation: A-615, Grade 60. Bars shall be plainly marked showing size, type and grade in accordance with these Specifications.

2.2. Bar Supports. Bar supports shall conform to ACI-3125.

2.3. Wire Ties. Ties shall be 16-gage or heavier black annealed wire.

2.4. Other Materials. All other materials, not specifically described but required for proper completion of concrete reinforcement, shall be as selected by the CONTRACTOR subject to the approval of the ENGINEER.

2.5. Rejection of Materials. Reinforcement with any of the following defects will not be permitted in the Work:

(1) Bar lengths, depth and bends exceeding the specified fabrication tolerances.

(2) Bends or kinks not indicated on the Drawings or Shop Drawings.

(3) Bars with reduced cross-section due to excessive rusting or other cause.

3. EXECUTION

3.1. Bending. Reinforcing bars may be mill or field bent. No bars partially embedded in the concrete shall be field bent. All bends shall be made in compliance with requirements of the American Concrete Institute Standard 315 and by approved machine methods except as noted otherwise on the drawings. All bends shall be made without heating.

3.2. Handling and Protection.

3.2.1. Protection. The CONTRACTOR shall use all means necessary to protect concrete reinforcement before, during, and after installation and to protect the installed work.

3.2.2. Storage. Steel reinforcement shall be stored above the surface of the ground upon platforms, skids, or other supports and shall be protected, as far as

practicable, from mechanical injury, surface deterioration caused by conditions producing rust, and fouling with dirt, grease and other bond breaking coatings.

3.2.3. Identification. All necessary precautions to maintain identification of bars after bundles are broken shall be exercised.

3.3. Placing.

3.3.1. Surface Coatings. All reinforcement shall be free from dirt, oil, grease, paint, mill scale, loose or thick rust, or other coating which might destroy or reduce its bond with the concrete when the surrounding concrete is placed.

3.3.2. Bracing Reinforcement. All reinforcement shall be placed in accordance with the Drawings and shall be held so securely in position by wiring and blocking from the forms and by wiring together at intersections that it will not be displaced during the depositing and compacting of the concrete. Tack welding of bars will not be permitted.

3.4. Splices.

3.4.1. General. All splices in reinforcement shall be as shown on the Drawings or as directed by the ENGINEER. Unless otherwise specified on the Drawings, by statement or scaled distance, splices shall overlap at least 40 times the diamter of the smaller bar but not less than 12 inches.

3.4.2. Method of Splicing. Splice by lapping ends, placing bars in contact, and tightly wire tieing.

3.4.3. Splices in Adjacent Bars. Alternate sides for splices of horizontal reinforcing bars in the riser.

3.5. Openings.

3.5.1. Amount of Reinforcement Removed. Where reinforcing bars must be field cut to allow for thimbles, manholes and other required openings, the amount of steel removed shall be the absolute minimum necessary to provide the opening and maintain the minimum concrete cover as required.

3.5.2. Additional Reinforcement for Cracking. All openings shall be reinforced against potential cracking by placing No. 5 bars or other size bars designated in the Drawings in both faces normal to the plane of cracking. The bars shall not be less than 3'-0" in length, except where otherwise shown on the Drawings, and shall be placed inside the main reinforcement and tied to the main reinforcement.

3.5.3. Supplemental Reinforcement. Where reinforcing bars are removed to provide an opening, supplemental reinforcement shall be provided in the

direction of the bars removed. This reinforcement shall have a minimum area of the total bars removed, and shall extend at least 18 inches past the edges of the opening, unless shown otherwise in the Drawings.

3.6. Tolerances.

3.6.1. Minimum Cover. The minimum cover for all main reinforcement shall conform to the dimensions shown on the Drawings which will indicate the clear distance from the edge of the reinforcement to the concrete surface.

3.6.2. Allowable Tolerances. The following tolerances will be allowed in the placement of reinforcing bars as shown on the Drawings:

(1) Variation in protective cover

1/4 inch for 2.5-inch cover
1/2 inch for 4-inch cover

(2) Variation of spacing

1/12 of indicated spacing

3.7. Inspections.

3.7.1. Notice. The ENGINEER or his representative shall have 24 hours notice and the opportunity to inspect and approve the placement of reinforcing steel before concrete is placed.

3.7.2. Purpose. Such inspections are in the nature of assisting the CONTRACTOR to minimize errors, and in no case will they relieve the CONTRACTOR of his responsibility to provide the materials and workmanship required by the Contract Documents.

4. MEASUREMENT AND PAYMENT

No direct measurement or payment will be made for any concrete reinforcing. Payment shall be included in the payment for the work to which it is subsidiary in the Bid Schedule.

SECTION 03003

CONCRETE FINISHES

1. GENERAL

These specifications are supplemental to the "Concrete" section and provide additional instructions to the requirements therein.

2. CONCRETE FINISHES (except floors)

Hardened concrete surfaces shall be finished in accordance with this section of the specifications and the instructions in the "Concrete" section. The various types of finishes described shall be applied as per the schedule shown in the "Special Provisions" section of the specifications.

2.1 TYPES

Type I - All holes left by removal of ends of ties, and all other holes, depressions or voids shall be filled solid with mortar after first being thoroughly wetted. Holes shall be filled with a small tool that will permit packing the hole solidly with mortar. Mortar shall consist of one part cement to three parts sand, and the amount of mixing water shall be as little as consistent with the requirements of handling and placing. Color of mortar shall match the adjacent wall surface.

Type II - After completing the Type I finish specified above, the Contractor shall also remove all fins, burrs and other projections left by the removed forms.

Type III - This finish shall be applied after the completion of the Type II finish. A smooth, uniform surface shall be obtained using the "carborundum-rub" finish which shall consist of the following procedure: Surfaces shall be rubbed with a carborundum stone to eliminate irregularities. Unless the nature of the irregularities require it, the general surface of the concrete shall not be cut into. Bulging or protruding areas, which result from slipping or deflecting forms shall be ground flush or chipped out and re-dressed as directed by the Engineer. Brush finishing or painting with grout or neat cement will not be permitted. Corners and edges shall be slightly rounded by the use of the carborundum stone. No rubbing shall be done before the concrete is seven (7) days old or until the concrete is thoroughly hardened and the mortar used for patching is firmly set.

3. CONCRETE FLOOR FINISHES

The finish of all floors and slabs shall be as described below, by types, and further outlined on the final pages in this section of the Specifications. Listed below are descriptions of the various type finishes.

3.1 TYPE "A" SCREEDED - This finish shall be obtained by placing screeds at frequent intervals and striking off to the surface elevation required. Unless otherwise stipulated, this type of finish shall be used on slabs over which quarry tile, ceramic tile, terrazzo, bituminous mixtures, grout swept in by mechanism, or similar type wearing surface is subsequently to be applied.

TYPE "B" WOOD FLOATED - This type of integral finish shall be obtained by working a previously screeded surface with a wood float until the desired texture is reached. Unless otherwise stipulated, this type finish shall be used for exterior paved areas, sidewalks, ramps and steps. Care shall be taken to prevent the formation of laitance and excess water on the finished surface.

TYPE "C" STEEL TROWELED - This type of integral floor finish shall be obtained by first screeding and then giving a preliminary wood float finish which shall be true, even and free from depressions.

After this operation, and when the concrete has hardened sufficiently to prevent excess fine material from working to the surface, the surface shall be compacted and smoothed with not less than two thorough and complete steel troweling operations. The finish shall be brought to a smooth, dense surface, free from defects and blemishes. In areas that are to be covered with resilient flooring, one complete steel trowling operation will be sufficient.

TYPE "D" SWEPT-IN GROUT TOPPING - This finish shall be applied to certain tank floors as specified. Grout topping shall be placed and spread on a previously screeded and hardened concrete slab. Before placing the grout, the surface shall be properly cleaned, washed, and coated with a mixture of water and Portland Cement. The grout shall then be plowed and swept into neat conformance with the blades or arms of the apparatus by turning or rotating the previously positioned mechanical equipment. Special attention is to be paid to true grades, shapes and tolerances as specified by the manufacturer of the equipment. Before beginning this finish, the Contractor shall notify the Engineer and the equipment manufacturer of the details of the operation, and obtain approval and recommendations, respectively, before commencing work.

TYPE "E" HARDENED FINISH - Floor surfaces requiring a hardened finish shall receive a concrete hardener of a type scheduled on the final pages of this section. Concrete hardeners shall be either a liquid applied to the floor surface or a metallic compound which is troweled into the floor surface and made integral

with the floor. All concrete hardeners shall be applied in strict conformance with the manufacturer's directions and instructions.

TYPE "F" COLOR FINISH - Coloring agents shall be a product of an experienced manufacturer and shall be applied in complete accordance with the manufacturer's instructions. Colors and make will be specified on the final pages of this section, if their use is required.

4. PAYMENT

No separate payment will be made for this item. Cost for this work shall be included in the bid for work to which it is subsidiary.

DIVISION 5

METALS

SECTION 05002

ANCHOR BOLTS AND EXPANSION ANCHORS

1. SCOPE. This section covers cast-in-place anchor bolts and expansion anchors to be installed in hardened concrete.

The General Equipment Stipulations set forth additional requirements for anchor bolts for equipment.

2. GENERAL. Unless otherwise specified or indicated on the drawings, all anchor bolts shall be cast-in-place bolts and shall have a minimum 3/4 inch diameter. Anchor bolts and expansion anchors for buried and immersion service and in splash zones shall be galvanized or zinc plated. All other anchor bolts and expansion anchors shall be carbon steel unless otherwise specified or indicated on the drawings.

3. MATERIALS.

Bolts and Nuts

Carbon Steel	ASTM A307.
Stainless Steel	IFI-104, Grade 303 or 305.
Galvanized Steel	Carbon steel bolts and nuts; hot-dip galvanized ASTM A153 and A385, or zinc plated ASTM A164 Type GS.
Flat Washers	ANSI B18.22.1; of the same material as bolts and nuts.

Expansion Anchors

For Concrete Fed Spec FF-S-325; wedge type, Group II, Type 4, Class 1 or 2; self-drilling type, Group III, Type 1; or nondrilling type, Group VIII, Type 1 or 2; Phillips, Hilti, Rawlplug, USM< or Wej-It.

4. ANCHOR BOLTS. Anchor bolts shall be delivered in time to permit setting when structural concrete is placed. Anchor bolts which are cast-in-place in concrete shall be provided with sufficient threads to permit a nut to be installed on the concrete side of the concrete form or supporting template.

Two nuts, a jam nut, and washer shall be furnished for anchor bolts indicated on the drawings to have lock nuts; two nuts and a washer shall be furnished for all other anchor bolts.

5. EXPANSION ANCHORS. Expansion anchors shall be installed in conformity with the manufacturer's recommendations for maximum holding power, but in no case shall the depth of hole be less than four bolt hole diameters. Minimum distance between the center of any expansion anchor and an edge or exterior corner of concrete shall be at least 4-1/2 times the diameter of the hole in which the anchor is installed. Unless otherwise indicated on the drawings, the minimum distance between the centers of expansion anchors shall be at least 8 times the diameter of the hole in which the anchors are installed.

Nuts and washers for expansion anchors shall be as specified for anchor bolts.

6. PAYMENT

No separate payment will be made for any anchors. Cost for these items shall be included in the items to which they are subsidiary in the Bid Schedule and no measurement of the quantities will be made.

SECTION 05003

MISCELLANEOUS METALS

1. GENERAL. The Contractor shall furnish all labor, materials, equipment and services necessary for fabrication and erection of all miscellaneous steel angles, beams, plates and channels as shown on the Drawings and specified herein and not specifically included under other sections of these Sepcifications.

2. APPLICABLE STANDARDS. In the absence of other instructions, all work under this section shall be governed by the latest edition of:

SPECIFICATIONS FOR THE DESIGN, FABRICATION AND ERECTION OF STRUCTURAL STEEL FOR BUILDINGS - American Institute of Steel Construction.

All welding shall conform to the latest code of the American Welding Society.

3. SUBMITTALS. Shop drawings, giving complete information necessary for fabrication, layout and installation of all metal work, shall be submitted to the Engineer for approval prior to fabrication.

The preparation of shop drawings for fabricated metal items shall be coordinated by the Contractor with the manufacturers of various equipment in order to comply with details, locations, openings, etc. required by the manufacturers.

Field measurements shall be made to verify all dimensions in the field which may affect installation of work before shop drawings are made and/or fabrication is performed.

4. STRUCTURAL STEEL. Steel shall conform to the requirements of ASTM A 36.

5. ANCHORAGE ITEMS. The Contractor shall furnish all bolts, nuts, shims, pins, screws, straps, nails and other anchors, which may be required by the Drawings or job conditions, to secure all items permanently in place, whether or not specifically called for or shown on the Drawings.

6. FABRICATION AND INSTALLATION OF METAL WORK. All metal items shall be accurately fabricated and erected with exposed joints close fitting. All joints shall be of such character and so assembled that they will be as strong and rigid as adjoining sections. Joints shall be located where least conspicuous. Items shall have smooth finished surfaces except where otherwise shown or specified.

Where welding is required or permitted, it shall conform to the requirements for shielding metal arc welding of the Standard Code for Arc and Gas Welding in Building Construction of the American Welding Society. Shop drawings shall show welding and shall indicate the size, length, spacing and type of welds. Joints required to be welded shall be continuously welded or spot welded as specified and face of welds dressed flush and smooth where exposed to view.

Members or parts to be built in with masonry or concrete shall be in a form affording a suitable anchorage or shall be provided with approved anchors, expansion shields or other approved means of securing members.

Ferrous and non-ferrous metals shall be insulated at all contacts with felt washers, strips or sheets, bitumastic paints, or other approved means.

6.1 All required anchors, couplings, bolts, and nuts required to support miscellaneous metal work shall be furnished and installed as required.

6.2 Weights of connections and accessories shall be adequate to safely sustain and withstand stresses and strains to which they will be normally subjected.

6.3 Connections shall be bolted except where welding is called for in the Drawings. Bolts shall be 3/4 inch diameter unless noted or required otherwise.

6.4 Accurately place all miscellaneous metal items in the locations and to the required elevations.

6.5 Adequately brace any items which are cast in concrete masonry work.

6.6 Use concealed anchors wherever possible.

7. CLEANING. Remove and properly dispose of all debris and litter; leave the work area in a clean condition.

8. PAYMENT. No separate payment will be made for any of the miscellaneous metal items covered by this specification. Cost for these items shall be included in the items to which they are subsidiary in the Bid Schedule and no measurement of the quantities will be made.

DIVISION 11

EQUIPMENT

SECTION 11004

PUMPING EQUIPMENT

1.0 GENERAL

Furnish all labor, materials, equipment and services for manufacturing, assembling, delivering, installing, testing and placing in service all pumping equipment including pumps, motors, bases and appurtenances.

The CONTRACTOR shall also provide the services of a qualified start-up engineer (factory representative) who has had prior on-site experience to assist in performing start-up, check-out and initial operation services as well as aid in installation of the pumping equipment. The lump sum price for this item shall also include the services of a factory representative of the pump manufacturer during start-up. These services shall be provided as long as so deemed by the Engineer.

Unless otherwise specified, the pump manufacturer shall furnish each pumping unit complete with drive motor and all other components, and shall be held entirely responsible for the compatibility in all respects of all components furnished.

Pumping units shall be as specified herein and shown on the Drawings.

Design conditions and characteristics of all pumps to be furnished under this contract are included in the specific pump section of this specification.

2.0 DEFINITIONS

When the term "pumping unit" is used it shall be deemed to mean a pump or pumps, complete with, but not limited to, drive motor, accessories, appurtenances and all associated equipment.

3.0 CONTRACT DRAWINGS

The contract drawings are intended to show a general arrangement of pump equipment, drives, structural supports, foundations, connected piping and valves.

The pump suction and discharge nozzles shown shall be considered minimum sizes unless otherwise specified.

4.0 MANUFACTURER

4.1 QUALITY ASSURANCE

All pumping units shall be of approved design and make and products of manufacturers who have built equipment of similar type, size and capacity.

4.2 ADDITIONAL SUBMITTALS

The Contractor shall submit, upon request, any additional information that the Engineer may deem necessary to determine the ability of the proposed manufacturer to produce the specified equipment.

4.3 REPLACEMENT PARTS CAPABILITY AND SERVICE

Pumping units shall be the products of manufacturers who can produce evidence of their ability to promptly furnish any and all interchangeable replacement parts as may be needed at any time within the expected life of the pumps. Upon request, the Contractor certify and shall submit full details of the proposed manufacturer's ability to promptly fill replacement orders. The manufacturer shall have a fully staffed factory trained service center within three (3) hours of the installation.

4.4 MANUFACTURE INFORMATION

All manufacturer information required by the specifications shall be submitted by the Contractor within thirty (30) calendar days of the date of receipt of the Notice to Proceed.

Any additional information or data, specifically requested by the Engineer, concerning manufacturer's capabilities (especially relating to requirements described hereinbefore), shall be submitted by the Contractor within fourteen (14) calendar days of the receipt of the written request therefore, unless otherwise specified.

Approval of the manufacturers or suppliers will not be given until all information required by the specifications or requested by the Engineer has been submitted and found acceptable.

4.5 DISQUALIFICATION OF MANUFACTURER

A. Failure to successfully comply with the provisions of sub-paragraphs 4.1 through 4.4, inclusive, will constitute grounds for disqualification of pump manufacturer.

B. Poor performance of similar pumping equipment now in operation under the specified conditions of service and pump rating constitute grounds for disqualification of the pump manufacturer, supplier, or both, unless such poor performance has been corrected.

5.0 SUBMITTALS (SHOP DRAWINGS)

5.1 GENERAL

The Contractor shall comply with the provisions in the specifications regarding submittals, unless otherwise specified herein.

5.2 CONTENT OF SUBMITTALS

The following shall be included in submittals as a minimum. However, any additional information or data shall be added if and whenever requested by the Owner or Engineer. Where applicable, submit separate data for each pump.

5.3 DESCRIPTIVE LITERATURE

A. Dimensions

B. Materials of construction (including required coatings)

C. Performance data
   1. Size of pump
   2. GPM
   3. TDH
   4. BHP
   5. Overall pump efficiency (inlet through discharge head)
   6. RPM
   7. Performance curves showing overall pump efficiencies
   8. NPSH curve (if applicable)
   9. Shutoff head
   10. Weight of pump
   11. Head
   12. Rated HP of motor
   13. Weight of motor
   14. Certified test for each pump with the test curves approved by the Engineer before pumps are shipped.

5.4 INSTALLATION INFORMATION

Submit drawings and information necessary for final design of foundations, connecting piping and valves, pump drip and drainage piping, electrical

connections, starting, speed regulating and protective equipment, and auxiliary equipment.

Submit drawings showing location, size and full details of foundation bolts for all components for all pumping units.

For all pumping units, a dimensioned and scaled assembly outline drawing or drawings of the complete pump, drive, and all associated equipment furnished shall be submitted for approval. Such drawing or drawings shall show plan, elevation, and any other views or sections requested.

For all pumping units, a scaled cross-sectional drawing of the assembled pump showing full details and materials of construction shall be submitted for approval.

The Contractor shall submit all other drawings, material lists and other information specified, requested and/or necessary to show complete compliance with all details of the contract documents.

5.5 MAINTENANCE AND OPERATIONS MANUAL

Manual shall contain all information necessary for proper operation and maintenance of pumping units, as well as the location of the nearest permanent service headquarters. Three (3) bound copies of the pump station operation and maintenance manual shall be provided.

6.0 TIME OF DELIVERY

Since time is of the essence on all work under this contract, manufacturers or suppliers are hereby notified that they will be required through the Contractor to state and guarantee a firm delivery date for all equipment specified under this section which they offer to furnish.

7.0 MANUFACTURER'S REPRESENTATIVE

For all pumping units the Contractor shall furnish the services of accredited representatives of the pump manufacturer who shall supervise the installation, adjustment, and testing of each pumping unit and give instructions to operating personnel. Pumping equipment shall be tested for performance according to curves and other approved data as soon as practical after installation. Failure of the equipment to perform as curves indicate and with other approved data shall be sufficient cause for rejection. As one condition necessary to acceptance of any pumping unit, the Contractor shall submit a certificate from the manufacturer, stating that the installation of the pumping unit is satisfactory, that the unit is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication, and care of the unit.

8.0 IDENTIFICATION - NAMEPLATE

Each piece of equipment shall be provided with a substantial nameplate, securely fastened in place and clearly inscribed with the manufacturer's name, year of manufacture, serial number, and principal rating data.

9.0 TOOLS AND ACCESSORIES

The Contractor shall provide one spare mechanical seal/gasket/sleeve kit for each pump. The Contractor shall furnish with each type, kind, or size of pumping unit, two sets of any special suitable marked high grade tools, gauges and fixtures which may be needed to adjust, operate, maintain, or repair the equipment. Such tools and appliances shall be furnished in neat special steel cases fitted with locks and keys, and delivered to the Engineer prior to the initial operation of the equipment.

10.0 GUARANTEE PERIOD

After successful completion of tests and trials under operating conditions on all equipment, the Contractor shall guarantee all equipment and materials from undue wear and tear, from mechanical and electrical defects, and from any failure whatever except those resulting from proven carelessness or deliberate actions of the Owner, for a minimum of one year from the date of acceptance by the Owner. This one-year minimum shall not replace a standard manufacturer's guarantee if it exceeds one year.

11.0 PUMP WARRANTY

The Contractor guarantees and warrants that during the warranty period, the pumps will operate satisfactorily and continuously according to the pump schedule specified herein, and that after due notice has been given by the Owner, he or the pump manufacturer will proceed, within a reasonable time, to adjust, regulate, repair and renew at his own expense such part or parts, equipment, auxiliaries, appurtenances or perform such work as is necessary to maintain the guaranteed capacities, efficiencies and performances.

12.0 EQUIPMENT

12.1 OPERATING CONDITIONS.

Oak Grove Booster Pump Station. The pump station shall be capable of delivering the fluid medium at the following capacities and heads:

PUMPS #1 and #2

Minimum GPM 0	@ 130 feet TDH
Design GPM 800	@ 110 feet TDH
Maximum GPM 1200	@ 50 feet TDH
Efficiency at design GPM	83%

NPSH requirements shall not exceed 20 feet at design GPM.

The pump driver shall be a standard A.C. induction motor, open drip proof construction of the horizontal extended shaft, normal thrust type and shall be 30 h.p., 1800 rpm and suitable for 3 phase, 480 volt electrical service.

The pumps shall be equal to Patterson End Suction Curve E4J11A-CC, Size 5x4x11.

12.2 BOOSTER PUMPS.

12.2.1 General. The booster pumps shall meet the hydraulic and driver data as set forth in the specification section titled, "OPERATING CONDITIONS".

1. A data sheet covering each pump completely filled in.

2. Performance Curve showing expected performance at points other than the design conditions. Curve shall show head, capacity, efficiency and horsepower based on performance and shall cover the complete operating range of the pump from zero capacity to the maximum capacity. The curve is to also include a net positive suction head required curve.

3. Drawings of the proposed equipment giving general dimensions sufficient to determine how the equipment is to be supported and if it will fit within the space available.

12.2.2 Booster Pumps – Horizontal End Suction, Close Coupled Centrifugal Type. The booster pumps shall be of the horizontal end suction, centrifugal type. The pumps shall be of closed grain cast iron construction complete with bronze trim. The pumps shall conform to the detailed specifications as set forth below:

A. Casing. Volute type, bolted to adapter, with recessed lock fit to insure alignment. Discharge nozzle can be swiveled to any one of three positions. Separate suction cover bolted to casing through machined lock joint. No stud or bolt holes are tapped through casing to liquid ways. Tapping openings provided for priming, venting, draining and suction and discharge gauge connections. Piping connection to be as shown on plans and as per pump data sheets,

NPT threaded nozzles integral with casing or 125 lbs. ANSI flat face standard drilled flanges.

B. Impeller. Enclosed, single suction type, cast in one piece. Impeller shall be constructed of ASTM B148-954 Aluminized Bronze material. All impellers are to be statically balanced to insure smooth operation, also hydraulically balanced except in some small sizes where end thrust is but a minor factor. Impeller is mounted directly on the extended motor shaft, is keyed to shaft and held in lateral position between shaft sleeve and impeller washer. A self locking cap nut will hold a compression seal washer securely against hub and prevent leakage of liquid between shaft sleeve and shaft.

C. Wearing Rings. Renewable type; maintain proper running clearance with impeller hubs to minimize leakage between suction and discharge.

D. Shaft Sleeves. To be shouldered on shaft near impeller and covers full length of shaft from impeller hub to motor end bracket. Seals by compression between shaft sleeve and impeller hub, also between sleeve and shoulder on shaft, protecting shaft from contact with liquid. Shaft sleeve is free to expand or contract with temperature changes.

E. Stuffing Box. The stuffing box shall be cast integral with the pump casing and will be complete with tapped openings for sealed liquid or a flushing connection. The stuffing box shall be suitable for conversion to use standard packing. The stuffing box hardware shall be non-corrosive.

The stuffing box shall contain a face type mechanical seal. The seal shall have a carbon rotating head against a Ni-Resist stationary face and be complete with a Buna-N boot with stainless spring and spring retainer.

F. Adapter. Maintains rigid assembly between motor and casing. Machined locked between adapter and motor end bracket keeps adapter and casing in permanent alignment with motor and extended motor shaft. Sides of adapter are fully open for ready access to stuffing box and gland.

G. Motor. Motors shall be Premium Efficiency/Inverter Duty with Aegis type grounding device, insulated bearings and capable of operating on Variable Frequency Drives (VFD). The motors shall have normally closed heat sensors. Assembled as integral part of the complete units. End brackets is machined to match recessed lock fit on adapter to insure permanent alignment. Shaft carries impeller and sleeve. Motor

bearings are ball bearing type, designed to carry all radical and thrust loads, and are installed in sealed housings which retain lubricant and exclude dirt and moisture. Motors are drip protected type, having splash proof bracket on pump end and drip proof bracket on outboard end.

12.3 PUMP PRESSURE GAUGES

Provisions shall be made for a tap on the inlet/outlet side of each pump so test gauges can be installed. Gauges shall not, under any circumstances, be mounted directly on the pump.

12.4 COMPRESSION COUPLINGS

Each pump discharge run shall include a compression type, flexible coupling to prevent binding of the pump or control valve. Each coupling shall consist of two (2) follower rings, a flared middle ring with end flares generous enough to provide adequate gasket seat areas, two (2) resilient rubber gaskets and steel bolts. The coupling when installed shall provide a permanent, leak-proof, flexible installation. The discharge piping shall be rodded together with all-thread rods to prevent expansion of the coupled pipes.

In lieu of a compression coupling, a restrained, removable flange such as Uni-Flange or a flanged coupling adapter (FCA) may be used to relieve strain on a pump or control valve. The flanged coupling adapter will be of the same manufacturer as the compression couplings used elsewhere in the equipment capsule and shall be a regular product of that manufacturer. Flanged coupling adapters shall be complete on the flanged end with an integral rubber flange gasket and on the open end with a triangular section rubber follower gasket and follower ring. Bolts for the flanged coupling adapter will be individual to the FCA and be supplied with the FCA.

13.0 MISCELLANEOUS

Nameplates and other dataplates shall be stainless steel, suitably secured to the pump.

Parts shall be completely identified with a numerical system (no alphabetical letters) to facilitate parts inventory control. Each part shall be properly identified by a separate number, and those parts which are identical shall have the same number to effect minimum spare parts inventory.

14.0 ACCEPTANCE

Any defects in the equipment or failure to meet the guaranteed requirements of these specifications shall be promptly corrected by the Contractor by

replacement or otherwise. The decision of the Engineer as to whether or not the Contractor has fulfilled his obligation shall be final and binding on all parties.

15.0 MEASUREMENT AND PAYMENT

Payment will be based on one of the following criteria as specified in the Contract Bid Item Descriptions and/or on the Drawings:

A. Cost shall be included in the work to which it is subsidiary and no separate measurement and payment will be made.

Payment as specified above shall be considered as full compensation for all labor, materials, equipment and incidentals necessary to perform the work as required.

SECTION 11006

DOUBLE CHECK VALVE ASSEMBLY

1.0 GENERAL

A Double Check Valve Assembly shall be installed at each noted location to prevent the unwanted reversal of polluted water into the potable water supply.

2.0 PRODUCT

The main valve body shall be manufactured from 300 series stainless steel to provide corrosion resistance, 100% lead free through the waterway. The double check shall consist of two independently operated spring loaded cam check valves, required test cocks, and inlet and outlet resilient seated shutoff valves. Each cam check shall be internally loaded and provide a positive drip tight closure against the reverse flow of liquid caused by back siphonage or back pressure. The modular cam-check includes a stainless steel spring and cam arm, rubber faced disc and a replaceable seat. There shall be no brass or bronze parts used within the cam check valve assembly. The valve cover shall be held in place through the use of a single grooved style two bolt coupling. The main assembly shall consist of two independently operating torsion spring check assemblies, two resilient seated isolation valves and four ball valve type test cocks. The assembly shall be an Ames Company Series 2000SS or approved equal.

3.0 PAYMENT

Payment for this item shall be included in the item to which it is subsidiary in the Bid Schedule and as shown in the Drawings.

END OF SECTION

SECTION 11007

ELECTROMAGNETIC FLOW METER

1.0 GENERAL

1.1 SCOPE

This section describes the requirements for a flow sensor.

Under this item, the contractor shall furnish and install the flow measurement equipment and accessories as indicated on the plans and as herein specified.

1.2 QUALITY ASSURANCE

Referenced Standards and Guidelines - Complies with applicable portions of ANSI/AWWA Standards and NSF/ANSI Standard 61, Annex G. There are currently no AWWA standards that specifically address electromagnetic metering.

Flow measurement function complies with Industry Standards

a. ANSI B16.5 Class 150 RF
b. AWWA Class B
c. NEMA 4X/6P (IP66/IP67)
d. CSA

1.3 SUBMITTALS

The following information shall be included in the submittal for this section:

1. Outline dimensions, conduit entry locations and weight
2. Customer connection and power wiring diagrams
3. Data sheets and catalog literature for microprocessor-based transmitter and transducer
4. Interconnection drawings
5. Installation and operations manual
6. List of spare parts
7. Complete technical product description including a complete list of options provided

8. Any portions of this specification not met must be clearly indicated or the supplier and contractor shall be liable to provide all additional components required to meet this specification

1.4 SYSTEM DESCRIPTION

Electromagnetic flow meter is intended for fluid metering in industries including water, wastewater, food and beverage, pharmaceutical and chemical. Measures fluid flow of water or fluids which are highly corrosive, very viscous, contain a moderate amount of solids, or require special handling. No moving parts are in the flow stream. Amplifier can be integrally mounted to the detector or can be remote-mounted. Unit is ideally suited for measuring dynamic, non-continuous flow. In applications where a minimum and/or maximum flow rate must be tracked and monitored, the unit provides pulse signals that can be fed to dedicated batch controllers, PLCs and other more specialized instrumentation.

1.5 DEFINITIONS

Amplifier – Device used for increasing the power of a signal. It does this by taking energy from a power supply and controlling the output to match the input signal shape but with larger amplitude.

ANSI – (American National Standards Institute) A private non-profit organization that oversees the development of voluntary consensus standards for products, services, processes, systems, and personnel in the United States. The organization also coordinates U.S. standards with international standards so that American products can be used worldwide.

AWWA – (American Water Works Association) An international non-profit professional organization founded to improve water quality and supply.

Detector Coils – Also called an "induction loop", an electromagnetic communication or detection system which uses a moving magnet to induce an electrical current in a nearby wire.

Electrode – An electrical conductor used to make contact with a nonmetallic part of a circuit (e.g. a semiconductor, an electrolyte or a vacuum).

Modbus RTU – a serial communications protocol published by Modicon (now Schneider Electric) in 1979 for use with its programmable logic controllers (PLCs). This is used in serial communication & makes use of a compact, binary representation of the data for protocol communication.

NEMA – (National Electrical Manufacturers Association) Is the 'Association of Electrical Equipment and Medical Imaging Manufacturers' in the United States. Its approximately 450

member companies manufacture products used in the generation, transmission, distribution, control, and end use of electricity. These products are used in utility, industrial, commercial, institutional, and residential applications.

NSF – (National Science Foundation) A United States government agency that supports fundamental research and education in all the non-medical fields of science and engineering.

PLCs – (Programmable Logic Controller) A digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures. PLCs are used in many industries and machines.

PTFE – (Polytetrafluoroethylene) A synthetic flouropolymer of tetrafluoroethylene that finds numerous applications. The best known brand name of PTFE is Teflon by DuPont Co.

Serial Communications – In telecommunication and computer science, serial communication is the process of sending data one bit at a time, sequentially, over a communication channel or computer bus. This is in contrast to parallel communication, where several bits are sent as a whole, on a link with several parallel channels.

2.0 PRODUCTS

1.1 APPROVED MANUFACTURERS

Basis-of-Design Product: Subject to compliance with specifications, provide flow measurement equipment by one of the following:

1. Krohne, Waterflux 3000
2. Toshiba, Series LF654
3. Badger Meter, M-2000
4. MJK MagFlux

1.2 OPERATING CONDITIONS

A. System Components

1. Metering Tube (Detector)

   Consists of stainless steel tube lined with a non-conductive material. Energized detector coils around tube create a magnetic field across the diameter of the pipe. As a conductive fluid flows through the magnetic field, a voltage is induced across two electrodes; this voltage is proportional to the average flow velocity of the fluid.

2. Signal Amplifier

Consists of unit which receives, amplifies, and processes the detector's analog signal. Signal is converted to both analog and digital signals that are used to display rate of flow and totalization. Processor controls zero-flow stability, analog and frequency outputs, serial communications and a variety of other parameters. Integrated LCD display indicates rate of flow, forward and reverse totalizers and diagnostic messages. Display guides user through programmable routines.

B. Operational Requirements

1. Electromagnetic Flow Meter

a. The flow meter system shall operate with a pulsed DC excitation frequency, and shall produce a signal output that is directly proportional and linear with the volumetric flow rate of the liquid flowing through the metering tube. The metering system shall include a metering sensor tube (detector), a signal amplifier, and the necessary connecting wiring. The metering system shall have the ability to incorporate a meter mounted or remote mounted amplifier.

b. Engineering Units:

The signal amplifier shall be program selectable to display the following units of measure: U.S. gallons, imperial gallons, million gallons (U.S.), cubic feet, cubic meters, liters, hector-liters, oil barrels, pounds, ounces or acre feet.

c. Operating Principle: Electromagnetic Induction

d. Metering Tube (Detector)

1. The metering tube (detector) shall be constructed of 316 stainless steel, and rated for a maximum allowable non-shock pressure and temperature for steel pipe flanges, according to ANSI B16.5.

2. The metering tube (detector) shall be available in line size from ¼" [6 mm] to 54" [1400 mm].

3. The metering tube (detector) end connections shall be carbon steel or 316 stainless steel flanged, according to ANSI B16, Class 150 and AWWA Class B standards.

4. The insulating liner material of the metering tube (detector) shall be made of a hard rubber elastomer and NSF-listed for meter sizes 4" and above, in conformance with manufacturer's recommendation for the intended service or an NSF-listed meter option with PTFE liner.

5. The metering tube (detector) shall include two self-cleaning measuring electrodes. The electrode material shall be corrosion resistant and available in Alloy C or 316 stainless steel.

6. The metering tube (detector) shall include a third "empty pipe detection" electrode located in the upper portion of the inside diameter of the flow tube in order to detect an empty pipe condition when the flow tube is running partially empty. Empty pipe detection that is not activated until the pipe is 50% empty is not acceptable.

7. The metering tube (detector) housing shall be constructed of carbon steel, welded at all joints, and rated to meet NEMA 4X/6P (IP66/IP67) ratings.

8. For remote amplifier applications, the metering tube (detector) junction box enclosure shall be constructed of cast aluminum (powder-coated paint) and shall meet NEMA 4X/6P (IP66/IP67) ratings.

9. When installed in non-metallic or internally lined piping, the metering tube (detector) shall be provided with a pair of corrosion resistant grounding rings. The grounding ring material shall be 316 stainless steel.

10. Fluid Temperature Range

    i. For remote amplifier applications, the fluid temperature range shall be 32°F to 178°F [0°C to 80°C] at a maximum ambient temperature of 122°F [50°C] for the hard rubber liner material.

e. Signal Amplifier

1. The signal amplifier shall be microprocessor based, and shall energize the detector coils with a digitally controlled pulsed DC. The excitation frequency shall be program selectable for the following: 1Hz, 3.75Hz, 7.5Hz, or 15Hz. (factory optimized to pipe size and application)

2. The signal amplifier electrical power requirement shall be 85-265VAC, 45-65Hz. The power consumption shall not exceed 15W.

3. The signal amplifier shall have an ambient temperature rating of -4°F to 140°F [-20°C to 60°C].

4. The signal amplifier shall include non-volatile memory capable of storing all programmable data and accumulated totalizer values in the event of a power interruption.

5. Automatic zero stability, low flow cut-off, empty pipe detection and bi-directional flow measurement shall be inherent capabilities of the signal amplifier.

6. All signal amplifier outputs shall be galvanically isolated to 250 volts.

7. The signal amplifier and remote junction enclosures shall be constructed of cast aluminum (powder-coated paint) and shall meet NEMA 4X/6P (IP66/IP67) ratings.

8. Outputs:

   The signal amplifier shall provide a total of four digital outputs, one analog output and one digital input.

   i. Up to four open collector digital outputs, program selectable from the following: Forward pulse, reverse pulse, AMR pulse, flow set point, empty pipe alarm, flow direction, reset output, error alarm and 24V supply.

   ii. Up to two active digital (24 Volt) outputs, program selectable from the following: Forward pulse, reverse pulse, AMR pulse, flow set point, empty pipe alarm, flow direction, preset output, error alarm and 24V supply.

   iii. Up to two AC solid-state relay outputs, program selectable from the following: Frequency output, flow set point, empty pipe alarm, flow direction, preset amount and error alarm.

   iv. One digital input, program selectable from the following: Remote reset, batch reset and positive return to zero.

   v. Advanced protocol support using Modbus/RTU.

   vi. One analog output programmable and scalable from the following: 0-10mA, 0-20mA, 2-10mA or 4-20mA. Voltage sourced and isolated. Max. loop resistance = 800 ohms.

f. Control and Programming

1. The signal amplifier shall be programmed via three function buttons. The programming functions shall be available in a user-friendly, menu driven software through the four-line LCD interface. The signal amplifier shall accommodate the following languages: English, German, Czech, French or Spanish.

2. Programmable parameters of the amplifier include, but are not limited to: calibration factors, totalizer resets, unit of measure, analog and pulse output scaling, flow-alarm functions, language selection, low-flow cutoff, noise dampening factor and excitation frequency selection.

3. The signal amplifier shall have a programming option allowing entry of a selected numeric password value for tamper protection.

g. System Performance

1. The metering system shall operate over a flow range of 0.10 to 39.4 ft/s [0.03 to 12.0 m/s].

2. The metering system shall perform to an accuracy ± 0.50 percent of rate for velocities greater than 1.64 ft/s [0.50 m/s], ± 0.004 ft/s [± 1 mm/s] for velocities less than 1.64 ft/s [0.50 m/s].

3. The metering system shall be capable of measuring the volumetric flow rate of liquids having an electrical conductivity as low as 5.0 micromhos per centimeter.

4. The system measuring repeatability shall be <0.10% of full scale.

h. Indication

The signal amplifier shall include a four-line, 20-character, backlit LCD interface to display the following values:

Flow rate in selectable rate units
Forward totalizer in selectable volume units
Reverse totalizer in selectable volume units
Net totalizer in selectable volume units
Error or alarm messages
Software revision level

3.0 EXECUTION

1.1 INSTALLATION

Follow manufacturer's recommendation for installation. Installation will conform to the guidelines provided by the Installation & Operation Manual.

The supplier of the electromagnetic flow meter shall be specifically aware of the installation of the flow meter position relative to the configuration of the piping, fittings, valves, etc. as shown in the pump station Drawings. The supplier shall certify the performance of the

metering systems accuracy, as herein specified, relative to the installation of the flow meter within the piping configuration shown on the Drawings.

1.2 CALIBRATION

Each meter shall be hydraulically calibrated in an ISO 9000-certified testing facility, which utilizes a computerized gravimetric testing method with a measuring uncertainty of 0.1%.

Each meter shall be provided with a calibration certificate indicating the measured error (percent deviation) at three different flows, respectively equivalent to 25%, 50% and 75% of the nominal flow rate for each size.

1.3 MANUFACTURER'S WARRANTY

Terms

The manufacturer of the above specified equipment warrants the Product to be free from defects in materials and workmanship appearing within the earlier of either: One (1) year after installation; or one (1) year and six (6) months after shipment from manufacturer.

END OF SECTION

SECTION 11210

BOOSTER PUMP STATION

1.0 SCOPE

The Contractor shall furnish and install one factory built automatic pumping station. The station shall be complete with all equipment factory installed in a welded steel chamber with a prefabricated roof scuttle and steps for access. The station shall be manufactured by Dakota Pump Incorporated, Mitchell, South Dakota, Engineered Fluid, Inc. or Engineer approved equal. The internal equipment shall include two pumps and motors, piping and valves, sump pump, ventilation system, dehumidifier, heater, automatic central control panel with starters and breakers, and all internal wiring. Reference Specification Division 16 – Electrical and Electrical Drawings.

The manufacturer of the specified equipment shall be regularly engaged in the manufacturing of packaged water boosters, packaged water control vaults, packaged water meter vaults and packaged sewage lift stations. The manufacturer shall have at least ten years of successful experience in manufacturing the above type of equipment. The entire equipment package specified shall be UL approved under the package pumping systems (QCZJ). The specified equipment shall have a UL label certifying the package system is in compliance with the (QCZJ) UL listing. Equipment manufactured without the QCZJ UL listing will not be accepted.

In these specifications and on the accompanying drawings, there is specified and shown material and equipment deemed most suitable for the equipment and service anticipated. This is not done, however, to eliminate manufacturers equally as admirable and efficient. Contractors shall prepare their bid on basis of particular equipment and materials that is specified. Award of contract shall constitute contractual obligation to furnish specified equipment and materials.

In the event the contractor obtains engineer's approval on equipment other than that which was specified, contractor shall, at his own expense, make any changes in structures, buildings or piping necessary to accommodate equipment.

It will be assumed that cost to contractor of equipment proposed to be substituted is less than that of the equipment in the contract, and if a substitution is approved, the contract price shall be reduced by an amount equal to savings.

1.1 OPERATING CONDITIONS

Each pump shall be capable of delivering 800 gallons per minute of water against a total dynamic head of 100 feet. The pumps shall have a maximum allowable speed of 1800 RPM. The minimum rated horsepower of each motor shall be 30. The minimum pump efficiency shall be 83%, and the maximum net positive suction head required shall be 20 feet. See Specification Section 11004 – Pumping Equipment.

2.0 MATERIALS

2.1 EQUIPMENT CHAMBER

The station shall be built in two major sections, consisting of the main pump chamber and the prefabricated roof scuttle. Both sections shall be joined at the factory before shipment, to minimize field erection.

The pump chamber shall be an round / round shape, fabricated from 3/8-inch minimum thickness ASTM A36 steel plate. The nominal size as listed on the drawings. This interior height shall be adequate to permit use of a chain or cable hoist for pump disassembly. A lifting hook shall be welded to the ceiling over each pump to facilitate service work. The chamber top and bottom shall join the side shell to form a T-Joint. Chambers manufactured with lap joints will not be accepted.

The equipment chamber top shall be fabricated from 3/8-inch minimum thickness ASTM A36 steel plate. It shall be welded to the side shell on both the inside and the outside with fillet welds of adequate section to insure the structural integrity of the completed unit. The pump station manufacturer shall determine the chamber top reinforcement. The size and location of these beams shall be determined to adequately resist the loads imposed by the depth of bury of the chamber. Reinforced lifting holes, in four locations near the beam-ends, shall be provided to support the entire weight of the finished chamber with all appurtenances.

The equipment chamber floor shall be 3/8-inch minimum thickness ASTM A36 steel plate. It shall be welded to the side shell on both the inside and the outside with fillet welds of adequate section to insure the structural integrity of the completed unit. The pump station manufacturer shall determine the chamber bottom reinforcement. The size and location of these beams shall be determined to adequately resist the loads imposed by the depth of bury of the chamber.

Side reinforcement shall be welded to the exterior (flat side wall) of the chamber as required. The pump station manufacturer shall determine the chamber side reinforcement. The size and location of these structural members shall be determined to adequately resist the loads imposed by the depth of bury of the chamber.

An 18" diameter sump shall be provided in the chamber floor. This sump shall be fabricated from 1/4 inch steel plate. Where steel pipes pass through the chamber walls, a continuous watertight weld shall be made on both sides of the wall.
Fresh air shall enter the chamber from above the ground through a "Green Vent" with a screened opening, mounted on a 4" steel vent tube. Air shall be discharged above grade with the same arrangement. The intake shall extend down to 18" from the floor. Air shall be exhausted above grade, via a blower system. Intake and exhaust piping must be ridged and permanently fixed. The screen vents shall be rust proof vinyl coated with bronze screen and heave 14 gauge top hats.

The equipment hatch shall be a prefabricated metal roof scuttle with a minimum clear opening of 30 inches by 36 inches. The cover shall be 11-gauge aluminum with a 3" beaded flange.

Insulation shall be glass fiber 1" thick, fully covered and protected by a metal liner of 18-gauge aluminum. The scuttle shall be provided with a 3 1/2" flange with holes for bolting to the framing on the equipment chamber top. The scuttle shall be completely assembled with heavy pintle hinges, compression spring operators enclosed in telescopic tubes, positive snap latch with turn handles and padlock hasps, weatherproof padlock with two keys, and an automatic hold open arm with red vinyl grip release.

2.2 STAIR ENTRANCE

The chamber entrance manway shall be a prefabricated metal roof scuttle with a minimum clear opening of 30" by 96". The cover shall be 11-gauge aluminum with a 3" beaded flange. Insulation shall be glass fiber 1" thick, fully covered and protected by a metal liner of 18-gauge aluminum. The scuttle shall be provided with a 3 1/2" flange with holes for bolting to the framing on the equipment chamber top. The scuttle shall be completely assembled with heavy pintle hinges, compression spring operators enclosed in telescopic tubes, positive snap latch with turn handles and padlock hasps, weatherproof padlock with two keys, and an automatic hold open arm with red vinyl grip release.

The vault entrance system shall be manufactured and provided to conform to OSHA guidelines for fixed industrial stairs. The maximum angle of the staircase to the floor shall be 48 degrees. The tread run and tread rise shall fall within the OSHA guidelines. The widths of the stair treads shall be a minimum of 28". The minimum headroom above each step shall be 84". The staircase system shall have a minimum of 36" of free space in front of the bottom step and shall not interfere with access to the equipment inside the station. The stair assembly shall include 9 ¼" for rise and 8 ¼" for tread run. The rise height and tread width shall be uniform throughout any flight of stairs including the foundation structure used as one or more treads of the stairs. The top stairway platform shall be no less than the width of the stairway and a minimum of 30" in length measured in the direction of travel.

The chamber stairwell assembly shall be manufactured of 3/8" minimum thickness, ASTM A36 steel plate. The exterior of the stairwell shall be reinforced with a 3" channel minimum and shall include additional reinforcement as required for depth of bury. After final manufacturing, the staircase shall be blasted and coated per the paint specification listed in these specifications.

The removable stair support reinforcement shall be manufactured with 8" channel minimum with welded 2" angle for the tread support. The stair treads shall be Grip Strut Safety Grating pre-galvanized, 12 gauge serrated steel. The minimum length of each stair thread shall be 28" minimum and the minimum width shall be 9 ½" and the minimum height shall be 2". The stair treads shall be bolted to the angle support.

A hand rail shall be provided on each side of the staircase inside the station staircase system as shown on the drawings. The minimum diameter of the hand rail shall be 1 ½" and be manufactured of 14 gauge minimum stainless steel piping. Spacing brackets shall not exceed 8'. The hand rail height shall be between 30" and 34" from upper surface of top rail to surface of tread in line with face riser at forward edge of tread. The hand rail shall be mounted to the stair support and shall be removable.

2.3 PUMPS

Two 5x4x11 horizontal end-suction centrifugal water pumps equal to Aurora, Patterson, Paco shall be installed in the booster station. Each pump shall meet all the requirements set forth in this specification and Specification Section 11004 – Pumping Equipment under Operating Conditions, as follows:

	Maxiumum Conditions
Flow -	800 gpm
TDH -	100 feet
Frequency -	60 Hz
Speed -	1,800 rpm
Efficiency -	83%
Power -	30 hp

Each pump shall be bronze fitted, single stage with close grain cast iron construction. The pump casing shall have a bronze replaceable wear ring. The impeller shall be bronze, of the enclosed type, and statically and dynamically balanced. The one-piece pump/motor shaft shall be stainless steel or steel with a bronze sleeve. The pump shall have a single mechanical shaft seal of the Ni-Resist type, and properly vented to the suction connection. Suction and discharge connections shall be either threaded connections or 125 lb. ANSI flanges, depending upon pump size.

Each pump shall be close-coupled to a 30 HP, 1800 RPM, 3 phase, 60 hertz, 230/460 volt ball-bearing, open drip proof, standard horizontal electric motor, with a service factor of 1.15. Motor shall be of such size that it will operate continuously without exceeding its horsepower rating, exclusive of its service factor, at the design conditions. The motors shall be premium efficient for use with variable speed drives.

2.3.1 CERTIFIED PUMP TESTS. The pumps shall be tested at the manufacturer's plant before shipment. The tests shall consist of checking the unit at the specified rated speed, capacity, efficiency, brake horsepower and at such other conditions of head and capacity to properly establish and provide a certified performance curve. The standards of the Hydraulic Institute shall govern the procedures and calculations for these tests.

2.4 POWER DISTRIBUTION PANEL

The power distribution center and electrical controls shall be mounted in a common NEMA Type 1 gasketed fabricated steel enclosure. The enclosure shall have a full opening door, mounted on heavy piano hinges. Suitable type latching devices shall be provided on the door. Starters, breakers, relays, timers and wiring raceway shall be neatly arranged on a removable steel back plate. All circuit breaker operators, selector switches, indicating lights, and single phase items shall be mounted on or through die cut openings in the enclosure door. A duplex grounding type convenience outlet shall be mounted in die cut openings on the side of the enclosure, for operation of 115-volt devices. It shall not be necessary to open this enclosure,

except for adjustment of controls. Additional enclosures may be used as necessary to meet power and control requirements.

The following will also be required for the pump station:

1. 20A/1P circuit breaker for power to telemetry panel (approx. 500watts)
2. 20A/1P circuit breaker for power to pole light OLF-1 (200watts)
3. 30A/1P circuit breaker for power to battery charger, block heater etc. for generator (approx. 2500watts)

2.5 VFD PANEL

The control panel shall conform to the National Electrical Code specifications and shall be UL listed and labeled in accordance with UL standards No. 508 for Industrial Control Panels. In accordance with U.L. procedures, a U.L. label shall be affixed to the control panel.

Properly sized, heavy duty, molded case thermal-magnetic air circuit breakers shall be provided for branch circuit disconnect service and for over-current protection of all control, motor and auxiliary circuits. Properly sized open frame, across the line, NEMA rated magnetic motor starters shall be provided for the pump motors.

The pump starting equipment shall be a three phase, solid state Allen Bradley PowerFlex 400 variable frequency drives, or approved equal, with an integral keypad and display on which all the programmable features may be adjusted and on which the parameters can be viewed. A. The manufacturer shall have minimum 5 years experience in the design and manufacture of Variable Frequency Drives (VFDs). The VFD and all associated bypass equipment shall be UL Listed according to UL 508C – Power Conversion Equipment. As verification, a UL label shall be attached on the enclosure. The VFD shall be designed, constructed and tested in accordance with UL, CSA, NEMA, and NEC standards. Every power converter shall be tested with an AC induction motor while loaded and temperature cycled within an environment chamber. The VFD shall convert the input AC main power to an adjustable frequency and voltage as defined in the following sections. The VFD shall be listed and labeled as a complete unit and shall include all accessories and requirements as described below.

A. Storage ambient temperature range: -40 to 85□C (-40 to 185□F).
B. Ambient temperature operating range: -10 to 45□C (14 to 113□F).
C. Relative humidity range: 5% to 95%, non-condensing.
D. Operating elevation: 1000 Meters (3,300ft).
E. Shock: 15G peak for 11ms duration.
F. Vibration: 0.152 mm (0.006 inches) displacement, 1G peak.
G. Seismic: The AC drive shall meet the seismic requirements of the 2003 International Building Code as specified by AC156.

The AC drive shall be sized to operate a variable torque load. The speed range shall be from a minimum speed of 1.0 Hz to a maximum speed of 60 Hz. The VFD shall be rated IP30/NEMA 1/UL Type 1. Conduit knockouts shall be provided for bottom cable entry. All VFDs shall be wall mountable. The VFD shall be designed to operate from an input voltage as

listed elsewhere in the specifications. Current overload rating: 110% of rated current for 60 seconds. Starting torque: 150% at 1 Hz. Speed regulation: 2%. The VFD shall be protected against short circuits, between output phases and to ground. The VFD shall have under-voltage and over-voltage protection. The VFD shall provide class 10 motor overload protection investigated by UL, to comply with N.E.C. Article 430. The VFD shall be able to sense a loss of load and signal a fault. If the input analog reference is lost, this shall cause a warning to be issued and the user shall have the option of pre-selecting either (1) stopping and displaying the fault, (2) running at programmable preset speed, or (3) running at min or max frequency. Upon VFD fault, drive shall store the DC bus voltage, out current and output frequency in readable parameters. PID regulator shall be standard in the VFD. This allows a pressure or flow signal to be connected to the VFD for closed loop control. The PID setpoint shall be adjustable from the Programming Terminal, Analog Inputs or Communication Networks. The VFD shall have at minimum (3) programmable set points that lock out continuous operation at frequencies, which may produce mechanical resonance. The setpoints shall have an adjustable bandwidth. The VFD shall be capable of determining the speed and direction of a spinning motor and adjust its output to "pick-up" the motor at the rotating speed. The VFD shall have a programmable restart function to automatically restart the equipment after restoration of power after an outage. A maintained 2-wire start input shall be necessary for this function. The VFD shall have the capability to use an analog input or PID output as a start – stop command. This input can be a separate input or also used as the speed reference. Signal level below the "sleep" level acts as a Stop Command and a signal level above the "Wake" level acts as a Start Command. Sleep / Wake time and level shall be programmable. The VFD shall have the capability to attempt (9) restarts following a fault condition before locking out and requiring manual intervention. The time between restarts shall be adjustable. Damper interlock can be wired directly into the drive to disable the drive output until desired damper position is obtained, even with a valid run command. The VFD shall include an integral programming terminal. The programming terminal shall have at minimum a 2 line by 16 character LCD display with LED backlight. Digital speed control buttons shall be provided. Potentiometers are not acceptable. Programmable Hand-Off-Auto buttons shall be provided to toggle both start and frequency control or only the frequency control to and from the programming terminal. Text support in multiple languages, including but not limited to English, German, French, Italian, Spanish, Portuguese and Dutch.

(1) Optically isolated analog input (-10 to 10V or 0 to 20mA), user selectable. (1) Non-isolated analog input (0 to 10V or 0 to 20mA), user selectable. Analog I/O must have 10 bit resolution or better. Both analog inputs and outputs should be able to be used simultaneously in either voltage or current modes or a combination of each. (2) Analog outputs (0 to 10V or 0 to 20mA), user selectable. Analog I/O must have 8 bit resolution or better. Both analog outputs should be able to be used simultaneously in either voltage or current modes or a combination of each. (7) Digital inputs (24V DC), user programmable. Inputs must be configurable as sink or source. The VFD shall have a dedicated digital input for a Purge function. The Purge input shall override all "Stop" commands over the network as well as (1) Customer Interlock. The VFD shall have (2) dedicated digital inputs for Customer Interlocks:

a. One interlock will not record a fault and permit running after external condition is met. Purge input will override this interlock.

b. One interlock will cause a drive fault and require control system to reset prior to returning to ready condition. This input will always be active even during Purge.

(2) Relay outputs, form C (1 N.O. and 1 N.C.), user programmable. Both relays must be programmable for a minimum of 16 different combinations including Drive Ready, At Frequency, Motor Running, Motor Overload, Above Frequency, Above Current and others. Digital Optocoupler Output shall be user programmable with normally open or normally closed configuration. Digital Optocoupler Output must be programmable for a minimum of 16 different combinations including Drive Ready, At Frequency, Motor Running, Motor Overload, Above Frequency, Above Current and others.

Acceleration time shall be adjustable from 0.1 to 600 seconds. Deceleration time shall be adjustable from 0.1 to 600 seconds. (4) preset speeds shall be provided. VFD shall have an adjustable PWM frequency to allow tuning the VFD to the motor. The VFD shall have an RS-485 port as standard. The following protocols should be integral to the drive and selectable via a parameter without any field programming to download software prior to operation:

1. Modbus RTU.
2. Metasys N2.
3. Siemens P1-FLN.

Optional protocols such as LonWorks®, BACnet®, ControlNet™, PROFIBUS™ DP, EtherNet/IP™ and DeviceNet™ shall be available. A. Warranty shall be 24 months from the date of certified start-up, not to exceed 30 months from the date of shipment.

To protect the motors from single phasing, low voltage, voltage unbalance and reverse phasing, a phase monitor shall be supplied with the pump station controls. The phase monitors voltage and phase sensing circuit shall constantly monitor the three phase line voltages and detect harmful power line conditions. When any of the conditions occur, and output relay shall be deactivated until power line conditions return to an acceptable level. Trip and reset delays shall be provided to prevent nuisance tripping due to rapid power fluxuations.

To protect the electrical system and equipment from damage due to excessive line surges caused by lightning or other circuit disturbances, a secondary surge arrester shall be supplied with the pump station controls. The arrester shall comply with ANSI standard C62.11-1987. The arrester shall be available in a one-pole, two-pole or three-pole version, and be suitable for both indoor and outdoor use. The arrester shall be permanently sealed in a LEXAN housing. The arrester shall have a maximum continous operating voltage rating of 650 volts rms. The permissible line-to-line voltage of the system to which the arrester is applied depends on the circuit configuration, grounding, and voltage regulation. The secondary surge arrester shall be a Tranquell as manufactured by General Electric.

Six digit, non-resettable elapsed time meters shall be provided to record the running time of each pump motor. These devices shall be mounted in die cut openings in the enclosure door.

Hand-Off-Automatic switches shall be oil tight, 2 or 3 position, and grouped conveniently with oil tight, full voltage indicating lights, on the panel door. Indicating lights shall identify the following functions:

1. Red - Low suction pressure.
2. Red - High discharge pressure.
3. Green - Pump #1 running.
4. Green - Pump #2 running.

The VFD panel shall have terminals for the following telemetry interface I/O:

Digital inputs
1. VFD1 call to run
2. VFD2 call to run

Relay Outputs
1. VFD1 run status
2. VFD2 run status
3. VFD 1 fault
4. VFD 2 fault

Analog Inputs
1. VFD1 speed control
2. VFD2 speed control

Analog Outputs
3. VFD1 speed feed back
4. VFD2 speed feed back

2.6 TELEMETRY INTERFACE PANEL

The pump station shall be supplied with a Nema 1 telemetry interface panel. A ¾" minimum telemetry entrance conduit complete to the telemetry panel shall be supplied. The telemetry interface panel shall be supplied with 1/60/120 volt power. The interface panel shall be supplied with telemetry control circuits from the main control panel to the telemetry interface panel terminal strip. The Contractor/Pump Station Manufacturer shall coordinate with EIC, the telemetry provider. Reference Specification Section 11900 – Integration of Telemetry Controls.

2.7 VENTILATION BLOWER

As specified in the Equipment Chamber section above, the ventilation system shall work to exhaust air from the chamber and draw air into the chamber. The ventilator shall be direct driven by a shaded pole, 1 phase, 60-hertz, 115-volt motor. The ventilator shall be a high efficiency type blower with a capacity of 458 cubic feet per minute at 0.2 inches static pressure.

2.8 LIGHTS

Five 40-watt fluorescent light fixtures shall be mounted on the ceiling to illuminate the station interior. Each fixture shall be enclosed with a gasketed protective wrap-around lens. A manual switch located in the entrance man way shall operate the lights.

2.9 DEHUMIDIFIER

A dehumidifier, incorporating a fan to circulate air over the evaporator coils, shall control humidity in the pump station. It shall be provided complete with a humidistat and a thermostat that will de-energize the chilling mechanism and allow the fan to operate, if the humidity and temperature conditions are such that the condenser coils freeze. The dehumidifier shall have a minimum rating of 50 pints per day at 80 degrees Fahrenheit and 60% relative humidity. Condensate shall be piped to the sump, using 1/2" polyethylene tubing.

2.10 HEATER

A 3000-watt electric space heater with a minimum capacity of 10,240 BtuH and controlled by an adjustable thermostat shall be provided to regulate the temperature in the pump station. The heater shall have a fan to provide even heat distribution throughout the chamber.

2.11 SUMP PUMP

A submersible sump pump shall be installed in the chamber sump pit. It shall have a heavy duty, oil filled, close-coupled motor, in a cast iron housing and shall operate on 1 phase, 60 hertz, 115 volt power. The minimum capacity of the sump pump shall be 1200 gallons per hour at 20' total dynamic head. A mercury float switch, capable of operation in the depth of the sump pit, shall control the sump pump. The sump pump shall have a minimum 1 1/4 inch discharge.

2.12 PIPING AND VALVES

The pipe used in the booster station shall be black seamless steel pipe, Schedule 40, manufactured in accordance with the dimensional tolerances and material specifications of current AWWA standards for steel pipe and butt weld fittings.

Certified welders employed by the pump station manufacturer shall perform all pipe welds. If requested, the pump station manufacture shall provide copies of the welding certificates of the employees who are to perform the pipe welds.

The steel piping in the station shall be supported by rectangular or round tubing that shall be fully welded at both end points to the steel pipe and to the steel floor. The size of the welded pipe supports shall be determined by the station manufacture.

The internal surface off the steel piping shall be coated with "Nap Gard" fusion bonded epoxy coating. The coating shall be certified to meet the requirements of NSF 61 for potable water services. The interior piping service shall cleaned and be free of mill scale, oil dust and rust.

A liquid cleaner/phosphate in a pressure applied system to remove all oil and contaminates. It shall then be oven dried. After the oven drying, it shall be blast cleaned to a minimum of SSPC-SP6 commercial blast cleaning. After finial cleaning, the pipe must be pre-heated to 450 degrees. The fusion bonded coating shall be electrostatically applied allowing for an even uniform coat. The coated pipeshall then be placed back in the cure oven for final bake. The recommended mill thickness for "Nap Gard" fusion bonded epoxy coating is 10 mils.

After the station piping and valves have been manufactured, the station piping system, including pumps, piping, fittings and all valves that make up the entire station piping shall be first tested with high-pressure air to test for leaks. High-pressure air shall be pumped into the piping system and a soap solution shall then be sprayed on any welded joints for leak indication. After final assembly of the pumps, piping and valves, the entire system shall be hydrostatically tested to test for leaks at all joints, connections and weld seams. Any deficiencies found during the air test or the hydrostatic test shall be repaired and the system shall be retested.

Suction and discharge header piping shall be fabricated utilizing weld tees and/or weld reducing tees to maintain smooth water flows and minimize hydraulic losses in the transition from the pump branch piping to the header piping.

Piping with fusion bonded internal pipe coatings shall include a chamber penetration sleeve. The sleeve shall be manufactured using the next size larger piping with fabricated weld cap ends. The sleeve shall be slipped of the pipes and be attached to the pipes by end seam welds prior to the epoxy coating. The sleeve shall prevent destruction of the pipe coating during the sleeve to chamber weld. The sleeve shall be shown in the submittal drawings.

Isolation valves used inside the station shall be lug style butterfly valves with cast iron ASTM A-126 Class B bodies and aluminum bronze discs. Valve stems shall be 416 stainless steel. Molded-in resilient seats shall provided bubble-tight shutoff to 250 psi. Round, polished disc and hub edges shall provide 360 degree concentric seating, minimum flow restriction, lower torques and longer seat life. The molded-in liner shall be EPDM. The upper bushings shall be polyester. The Upper and lower inboard bearings shall be bronze. Each valve shall be factory tested to 110 percent of specified pressure rating. Valves 6" and smaller shall be provided with 10 position lever lock handles with throttle plates incorporating an infinite position stop, a memory stop, and a padlocking device for either fully open or fully closed position. Valves 8" and larger shall be provided with gear operators, complete with crank handles and position indicators.

Wafer style silent check valves shall be center guided, spring loaded, non-slam type and suitable for installation in any position. The plug, with integral shaft, shall be fully guided in bronze bearings at both ends, and shall be retained at both its fully opened and closed positions by a minimum length of one shaft diameter. Silent check valves shall be used in each pump discharge line to help suppress surges by returning the spring-assisted plug to its closed position before any reverse flow can occur.

The pump station shall be supplied with a magnetic flow meter mounted in the common header pipe. The electromagnetic flow meter shall be an MJK MagFlux system with MJK Magflux

Flow Sensor, MJK MagFlux Flow Converter and MJK MagFlux Display Unit with manufacturer recommended accessories or approved equals as contained in Specification Section 11007 – Electromagnetic Flow Meters.. The electromagnetic flow measurement system shall consist of a Flow Sensor which uses Faradays law of electromagnetic induction along with a microprocessor based Flow Converter and Display. Utilizing Faraday's Law, the sensor converts the liquid flow through the sensor into electrical voltage proportional to the velocity of the flow.

The sensors shall be produced from 304 stainless steel pipe, coils, 316L stainless steel electrodes and a hard rubber liner, soft rubber liner, or PTFE liner as required for compatibility with the media. The sensor shall have a stainless steel outer jacket or carbon steel outer jacket with two part epoxy coating for corrosion resistance. A minimum of 3 pipe diameters up stream and 2 pipe diameters downstream of straight smooth pipe are recommended. (Consult Factory for any variations.) The flow sensor operating temperature shall be: Media Temperature -25°C to 110°C (-13°F to +230°F), Ambient Temperature -30°C to 80°C (-22°F to + 176°F). The flow sensor shall be capable of being installed for permanent burial or submergence up to 30 ft. (IP 67/NEMA 4X) using manufacturer's submergence and waterproofing kits and be capable of temporary (30 minutes) submergence up to 3 ft. (IP 67) without a submergence kit. The flow sensor shall be full bore internal diameter throughout to reduce liner erosion and reduce turbulence at high flow ranges.

The flow sensors shall be factory calibrated and wet tested to deliver ±0.25% reading accuracy for sizes from ¼ inch up to 12 inch diameters, and ±0.5% reading accuracy up from 14 inch to 20 inch diameters, ±1% reading accuracy from 24 inch to 40 inch diameters, and ±2% reading accuracy in sizes above 40inches diameter. Accuracies will be NIST Traceable. The flow sensor shall be delivered with a calibration certificate for verification of performance and shall have calibration and flow set up data marked on the sensor. No tools or instruments shall be required to enter or confirm calibration data during set-up. The flow sensor shall have no electronic components except the electrodes and coils and shall be capable of operating in 100% humidity on a permanent basis, be capable of being mounted in at angles up to 45° from vertical around the center axis of a horizontal pipe and be capable of being installed in any direction without regard to flow direction. The flow sensors 316L electrodes shall be lobed so as to create a scouring effect with flow through the tube. The flow sensor shall also include a grounding electrode to eliminate the need for grounding rings (except when using non-conducting pipe). The flow converter shall be have an enclosure rating of IP 67 (NEMA 6) and have a measurement accuracy of ±0.1%.

The Flow Converter shall energize and detect signals generated at the flow sensor electrodes and self adjust frequency and amplitude to maximize accuracy across a wide range of flow velocities, shall include program for periodic self-cleaning of flow sensor electrodes using cyclic reverse polarization systems to prevent material attachment and to detach plated materials, shall be capable of measuring fluid velocities in low ranges from 0 to 0.2m/S (0.6ft/sec.) and in a maximum velocity up to 10m/s (30ft/sec), and shall be a flow rate transmitter with a fully scalable 4-20mA output proportional to all or part of the full-scale flow rate and capable of transmitting with a maximum line load of 800 Ω. The flow converter shall be capable of transmitting a 4-20mA output proportional to the flow in either direction, or 4-20 mA proportional to flow in both directions, selectable after installation. The flow converter shall

have one voltage free electromechanical relay rated for a maximum of 50VDC at 1 Amp one voltage free relay rated for 50VAC/VDC 120mA max. Both relays are programmable for totalizer counter output, batch counters, high/low flow alarm, system error, empty pipe alarm, and flow direction indication. The flow converter shall accept one external digital input rated at a maximum of 30VDC with a signal less than 5VDC registered as = 0 and a signal greater than 10 VDC as registered as = 1. Minimum pulse length 100ms. The flow converter shall be capable of reading flow in both directions and have three re-settable tantalizers and three non-resettable totalizes capable of totalizing the total flow or net flow in both directions. The flow converter shall have two batch counters utilizing dynamic adaptive batch counting to minimize under shooting and over shooting of batch volume by self adjusting the batch cycle based on actual batch size measurement results. The flow converter shall have a MODBUS RTU-mode for control and communication using either the MJK MagFlux Display unit or for communication with a PLC.

The manufacturer shall supply a document with the list of program registers upon request. The flow converter shall use an RS 485 communication interface capable of transmitting up to 3000 ft. the controls and data in the MODBUS RTU mode to a PLC or MJK Display Unit. The flow converter shall be capable of operating without a display, with a remote display, with an integral display or as a member of a group of converters working from a single display. The flow converter shall be capable of being operated remote to the flow sensor. Converter shall have CE conformance. The flow converter dimensions with cover or display unit attached shall not exceed 6.4" W x 5.9"H x 3.5"D and must be capable of interchanging with any other flow sensor from the same manufacturer, without the use of electronic memory media exchange. The flow converter must be capable of being remote mounted up to 150 ft from the flow sensor and require only one set of communication cabling to the sensor for operation.

The display unit shall be a white dot matrix 64 x128 pixel graphic backlit display and shall allow up to four lines of customizable text with automatic font scaling allowing maximum size up to ½ an inch for the primary measurement parameter. The display unit shall indicate flow, flow direction, volume, totalizers, configuration, and set-up operations in plain English text, shall display a graphical trend line of the flow history which can be expanded to show greater detail down to 5 minutes increments of flow rates and shall collect 160,000 flow data points with date and time at user specified time intervals. The display unit shall communicate with the flow converter using a MODBUS RTU mode using RS485 communications on standard twisted wires for distances up to 3000 ft. The display unit shall be capable of controlling, configuring, and data logging for up to four flow converters and flow sensors at the same time with simultaneous displays of measurements. The display unit shall hold all settings in a flash memory in the event of a power outage. Battery back-up is not acceptable. The display unit shall have a USB port for connection to a personal computer for downloading data in CSV file types suitable for use with commonly available spreadsheet and data management software. The USB port shall also be capable of letting the operator store all flow meter settings as a file on a PC, configure the flowmeter converter from a PC, upload software updates, and upload standard configurations. The display unit shall be able to be remote mounted up to 3000 ft from flow converters. The display unit shall have four keypad buttons for configuration and operation by the user and for use as a digital input for control and shall be capable of showing 'pop-up' alarm messages which shall persist as long as the alarm condition exists and will disappear 5 minutes after.

The flow sensor shall be compatible with flow rate and media. The flow converter capable of converting conductive liquid velocity signal into flow rate and transmitting proportional signal, totalizing signal and relay signals. The display unit capable of displaying all measurements and set-up functions, and capable of providing data logging functions and program uploads. Calibration shall be by registering the flow sensor's serial number to the flow converter by keying it into the display unit. Use of memory chips or other electronic media for this purpose is not allowed. The system shall start-up and accurately measure immediately after flow sensor registration. The operator shall use the integral keypad on the display unit to program relays for error alarms, limit alarms, totalizer output, batch control output, digital inputs and all operating parameters and variables. The operator shall use an alarm re-set to manually cancel alarm messages. The flow converter shall have built in service functions so a full calibration can be carried out using only a hand held multimeter.

The suction side of each pump shall include a flexible pump connection/expansion joint to reduce control pulsation shocks and noise transmission. The elastomer connector shall be constructed of neoprene and nylon with bias-ply tire cord. Solid plate steel flanges grip the sealing area and provide a fluid tight connection without the use of gaskets. The flanges shall be drilled and tapped to mate with the companion flanges. The single sphere arch shall be self-cleaning.

Compression type couplings shall be used in each pump discharge pipe run, and as required, to enable easy dismantling of station pumps and piping for maintenance and service. Couplings shall consist of two steel follower rings, two resilient gaskets, one steel middle ring, and a set of steel follower trackhead bolts.

The sump pump discharge piping shall be 1 1/4" SCH 40 pipe and include one check valve, one union for disassembly, and 1/4" drain back tubing from just inside the chamber discharge coupling to the sump.

2.13 PRESSURE GAUGES

Two pressure gauges, one for influent pressure and one for discharge pressure shall be mounted adjacent to the control pressure switches. Gauges will be 4 ½" in diameter per ASME B40.100 and shall be graduated in psi. Rated accuracy will be ± .5% of full scale and the operating temperature shall be -40°F to +150°F. Additional error when temperature changes from referenced temperature of 60°F ±0.4% for every 18°F rising or falling (percentage of span). Standard features shall include a black fiberglass-reinforced thermoplastic case, black aluminum pointer, white aluminum with black lettering, dampened movement option, copper alloy C-type bourdon tube, copper alloy (0.6 mm) restrictor, copper alloy with ¼" NPT lower mount pressure connection with M4 internal tap and be weather resistant (NEMA 3 / IP54).

The ¼" high pressure ball isolation valve standard features shall include a one piece brass body (UNI 5705-65), PTFE self-lubricating seats with flexible-lip design, double seal system to all the valve to be operated in both directions, chrome plated brass ball, blowout-proof brass stem with Viton O-ring, nylon black wedge handle that clearly shows ball position, and NPT taper ANSI B.1.20.1 connections.

2.14 CONTROL PRESSURE SWITCHS

The pump station shall be supplied with two separately mounted pressure transmitters to monitor the suction pressure and discharge pressure. Each pressure transmitter shall sense gauge pressure of a predetermined span and transmit a 4-20 mA signal to the telemetry panel. The accuracy of the transmitters shall be ±0.13% (RSS method) full scale. The transmitter case shall be manufactured of 17-PH4 stainless steel and shall include a ¼" NPT external pressure fitting. The transmitter shall meet NEMA 4 and IP65 environmental protection ratings. The pressure transmitters shall be supplied with a 24 VDC power supply. The input and output wiring shall be accomplished with a intergral barrier strip terminal. Input voltage shall be 120 VAC, 60 Hz. Output voltage shall be 24 VDC unregulated filtered, <29 VDC with no load, and >21 VDC at 100 mA.

2.15 FLOOD DETECT LEVEL SWITCH

For water on the floor indication, a level switch shall be provided. The level switch stem, float, mounting and other wetted shall be all CPVC. The electrical termination shall be 18 gauge PVC jacketed lead wires. The sensor shall be supplied with a ¼" NPT connection, have an operating temperature of -40 degrees F to +180 degrees F and a PSI pressure maximum of 15. The switch shall be recognized under File #E45168.

3.0 EXECUTION

3.1 WIRING

Power service to the water booster station shall be 3 wire, 3 phase, 60 hertz, 230 volt. Wiring of the station shall be in accordance with the National Electrical Code. All internal wiring shall be installed in conduit. The station shall be completely wired at the factory, except for power feed lines.

A 10 KVA dry type single-phase power transformer shall be provided to supply power to the station single-phase loads. The transformer shall have a dust tight enclosure and shall be suitable for wall mounting. The transformer shall have Class H insulation and shall be UL approved for indoor applications.

The sump pump, dehumidifier, heater, exhaust blower, and all 115-volt accessory items shall be supplied with suitable lengths of 660 volt, 14-3 rubber covered power cord. These items shall plug directly into outlets, which are identified by engraved, laminated plastic nameplates.

All wiring in the control panel shall be color-coded. All wiring from the control panel to the junction boxes adjacent to equipment served shall be in conduit. Short leads of flexible, polyvinyl covered steel conduit, with compatible grounding fittings, shall be used at the pump motors to enable the motors to be removed and laid down on the station floor. All conduits shall be neatly arranged and securely clamped to slotted steel channel, welded to the structure. The pump station shall be supplied with heavy wall, rigid, schedule 40 PVC conduit with solvent weld connections. The conduit shall be sized to adequately handle the type,

number and size of the equipment conductors to be carried. A ground wire shall be run in all PVC conduits.

3.2 WELDING

All steel members shall be joined by electric arc welding, with welds of adequate section for the joint involved. Where possible, all joints shall be welded inside and outside the chamber. All welds shall be continuous and watertight.

3.3 CORROSION PROTECTION

After all welding has been completed, all inside and outside surfaces of the structure shall be factory blasted to remove all rust, mill scales and weld slag. All weld spatter and surface roughness shall be removed by grinding. Surface preparation will comply with SSPC-SP10 specifications. The blast profile on the steel should be 1.5 to 2.5 mils in depth and be of a sharp, jagged nature. Surfaces must be free of grit dust.

Following the cleaning, all weld areas shall coated by hand brushing using Devoe High Performance Coatings Bar-Rust 235 multi-purpose epoxy coating or approved equal. Following the hand coating, the balance of the structure shall be coated per the attached specification.

The structure and other exposed metal shall receive a 4-8 mils dry or 5.9 to 11.7 mils wet coating of Devoe High Performance Coatings Bar-Rust 235 multi-purpose epoxy coating or approved equal. The high solids coating shall be an advance technology epoxy and have exceptional corrosion protection. The coating shall be suitable for salt and fresh water immersion. Solids by volume shall be 68% +/- 2%.

Following the hand brush coating, the exterior portions of the chamber and access way which are buried, shall have a 12-mil coating of a one coat, high build polyamide cured Sher-Tar epoxy enamel containing 24% pigment by weight / 76% vehicle by weight or approved equal.

A touch-up kit containing epoxy coatings, as specified above, shall be provided for the coating of all field welds and for repair of any scratches or abrasions that have occurred during shipment or installation.

Six 17# packaged magnesium anode packs with heavy copper wire shall be provided for cathodic protection. They shall be placed at the extreme limits of the excavation, prior to backfilling. The #12 wire anode leads shall be run into a 3/4" conduit, provided through the chamber wall, then down into the anode test box located in the pump chamber. The anode test box shall have a 0-30 milliamp gauge and a selector switch to monitor the performance of each anode. The anode test box shall be housed in a NEMA 1 enclosure.

The vault walkway area shall be covered with industrial, rubber safety matting. The mat shall be a heavy duty, ½" minimum thickness compounded of open slot design with a safety patter to promote sure footing. The underside of the mat shall include a pattern to permit aeration and drainage. The floor mat shall not be glued to the floor.

3.4 PROVISIONS FOR TELEMETRY

The pumps shall be controlled by a telemetry system, specified elsewhere and provided by others. The pump station manufacturer shall provide a 15-amp circuit breaker, wire and conduit for power service to the telemetry panel location, inside the booster station. The pump manufacturer shall also provide wire and conduit to the telemetry system from each peripheral device inside the booster station. The telemetry panel shall be shipped to pump station manufacturer for installation.

3.5 FACTORY TESTS

Upon completion of manufacturing and prior to shipment, the package pump station equipment shall be tested within the manufacture's facility. Equipment shall be plumbed to a minimum 10,000 gallon reservoir and operated in a loop cycle.

The flow operation test shall be simulated to project specific pumping conditions, or as near as allowed by the test facility. Flow shall be recorded from a Magnetic Flow Meter at the entrance to the reservoir. Suction and discharge pressures shall be accurately recorded from the suction and discharge manifolds within the equipment. The test facility shall provide suction head pressure greater than zero feet.

The test shall allow for all components to be operational and checked prior to shipment of the pumping equipment. The engineer, at his/her choice, shall be invited to witness the factory testing. All travel expenses associated for this testing would be by the engineer and/or owner.

A test report shall be included within the Owners Operation and Maintenance manual along with the manufacturer's archived files. At a minimum this test report shall include recording suction and discharge pressures at pump dead head, suction and discharge pressure at specified pumping conditions, volts and amp readings at specified pumping conditions, and operation of environmental equipment.

3.6 INSTALLATION AND SERVICE INSTRUCTIONS

Installation of the water booster station shall be in accordance with the written instructions furnished by the manufacturer, and as recommend by the Engineer. In addition to the installation instructions, the manufacturer shall furnish six complete and detailed Operating Instructions, Service and Repair Sheets in a bound manual. This manual shall cover the initial start-up, operating procedures, maintenance and servicing procedures on the major component parts provided in the pump station. One manual shall be shipped in the station, the rest shall be sent direct to the contractor.

3.7 START-UP

The manufacturer shall provide the services of a factory-trained representative for a maximum period of one day, to assist the contractor with the initial start-up of the pump station. It shall be the responsibility of the contractor to inform all parties of this initial start-up, and to insure their attendance. The manufacturer's representative shall instruct all personnel attending the start-

up in the correct and required operation, maintenance and service procedures for the water booster station.

3.8 GUARANTEE

The manufacturer shall guarantee the booster station to be free from defects in materials and workmanship for a period of one year from the date of start-up or for a period of fifteen months from the date of shipment. All consumable parts such as pump seals, filters, light bulbs, oil, grease, etc., shall be considered part of routine maintenance and shall not be covered under the terms of the manufacturer's warranty.

SECTION 11900

INTEGRATION OF TELEMETRY CONTROLS

1.0 GENERAL

This specification section is for information purposes only to clarify the Contractor's responsibility regarding the telemetry controls.

The telemetry for this project shall operate as follows:

Bee Creek Solenoid Valve Vault

The existing telemetry equipment located at the existing Oak Grove pump station will be moved to the proposed solenoid control valve vault near the intersection of US25E/KY 1277 to operate in concert with the existing telemetry equipment at Bee Creek Tank to control the Bee Creek Tank fill/drawdown cycle. The contractor and telemetry provider shall be responsible for moving the existing RTU and for installing the relocated RTU into the new Bee Creek Solenoid Valve Vault and for wiring the pilot operated solenoid controlled main valve into the RTU. A new antenna will be furnished for installation at the Bee Creek Vault.

New Corbin Booster Pump Station

New telemetry equipment, as described in specification section 11210 will be provided for the proposed underground pump station on US25E to operate in concert with the existing telemetry equipment at the Corbin Tanks to control the fill/drawdown cycle of the Corbin Tanks.

There shall be a remote digital display of flow in gallons per minute (GPM) and totalized flow in gallons in the pump station. Additionally, there shall be a remote digital read out, from the electromagnetic flow meter in the underground pump station, to a location outside the pump station to enable reading the totalized flow quantity without the need to enter the pump station.

The above described equipment shall be compatible for integration into a future system wide computer based SCADA system.

2.0 INTEGRATION OF TELEMETRY CONTROLS

The Cumberland Falls Highway Water District in concert with Synergy Electric/Merus Automations, the supplier of the existing SCADA system, will be responsible for providing a fully wired 24" x 24" NEMA 12 enclosure for the telemetry facilities required for the operational control of the pump station and future data acquisition and integration within

a future SCADA system. This NEMA 12 enclosure will be provided to the pump station manufacturer for inclusion in the pre-built pump station.

The pump station manufacturer/contractor shall be responsible for furnishing and installing the conduit, wiring, antenna and incidentals for connections from the data collection elements in the pump station to the telemetry cabinet and continuing as necessary, to the Motor Control Center/VFD's and other end locations as necessary for a fully operational system. See Specification Section 11210.

The Contractor shall coordinate the integration of the telemetry facilities with the Water District and telemetry provider.

3.0 PUMP STATION START-UP

The Water District and the telemetry provider will be present during pump station start-up to coordinate the telemetry equipment operation with the operational elements of the pump station.

END OF SECTION

DIVISION 13

SPECIAL CONSTRUCTION

SECTION 13100

IN-PLANT AND VAULT PIPING

1.0 GENERAL

1.1 SCOPE OF WORK

Provide all labor, materials, equipment and services required to furnish and install all plant process piping as shown on the Drawings and specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Valves: Section 13500.

2.0 PRODUCTS

2.1 DUCTILE IRON PIPE/DUCTILE AND CAST IRON FITTINGS

Unless otherwise noted or required, all inside ductile iron piping shall be flanged pipe with threaded flanges in accordance with ANSI A21.51 (AWWA C151) and ANSI A21.15 (AWWA C115). All piping shall be rated for 250 psi unless otherwise noted and shall have full face gaskets, 1/8-inch thick, equal to TORUSEAL as manufactured by American Cast Iron Pipe Company.

All exposed iron pipe to be field painted shall be furnished with an external coating of rust inhibitive primer, Koppers Pug Primer, Tnemec 77 Chem-Prime, Degraco #91453 Phenolic Primer, or equal. Contractor and pipe manufacturer shall be responsible for compatibility of shop allied coatings with the field paint systems and products specified in Division 9, Section 09900. Do not apply asphalt or bituminous coatings on pipe to be painted.

The interior of all ductile iron pipe shall be cement-mortar lined with bituminous seal coat in accordance with AWWA C 104.80. Thickness of the lining shall be as set forth in Section 4-10.1 of the aforementioned specification unless otherwise directed by the Engineer.

Ductile iron fittings shall conform to ANSI A21.10 AWWA C110 with flanges faced and drilled 125-pound. Fittings shall be 250 psi ductile iron. Fittings shall have interior lining and exterior coating same as the pipe.

2.2 PLASTIC PIPE AND FITTINGS

All inside PVC plastic process piping (unless noted otherwise) shall be ASTM D 1785, Schedule 80, threaded with ASTM D 2464, Schedule 80, threaded fittings. Use threaded flanged connections where required for flanged appurtenances or where indicated on the Drawings. All plastic pipe, fittings and joints shall be suitable for minimum 150 psi operating pressure.

2.3 WALL PIPE AND SLEEVES

All wall pipe shall be furnished with cast or welded collar waterstops. Welding of water stop collars on pipe shall be accomplished by the wall pipe manufacturer in their shop. All centrifugally cast wall pipe shall be ductile iron meeting the requirements of AWWA C151 for the pipe barrel, conforming to the pressure rating of the pipeline in which installed, and in no case be lighter than Class 53. All statically cast wall pipe shall be gray or ductile iron meeting the requirements of AWWA C110 for fittings. Mechanical joint end and cast-on flange end wall pipe shall conform to AWWA C110 and threaded flange wall pipe shall conform to AWWA C115. Where flanged or mechanical joint bell ends are flush with the wall, they shall be drilled and tapped for study bolts which are to be of 300 Series stainless steel. The length of all wall pipe shall be not less than the thickness of the wall in which installed. Wall pipe shall have the same pressure rating as connecting pipe. All wall pipe shall be cement-mortar lined per AWWA C104. The exposed end of wall pipe inside structures shall be shop primed for field painting; embedded portion left uncoated; exterior buried portion coated with standard bituminous coating.

Contractor may have the option to install wall pipe flush face-to-face of wall in lieu of the dimensioned length wall pipe shown on the Drawings, in order to eliminate form penetrations. This option will be subject to Engineer's review at each wall pipe location and covers both flanged and mechanical-joint bell-end wall pipe. Embedded flanged and M.J. bell-end bolt holes shall be tapped for stud bolts; tapped bolt holes in embedded flanges shall be plugged for protection during concrete pouring.

All pipe wall sleeves shall be plain end galvanized steel pipe of diameter noted on Drawings and length to fit flush face-to-face of wall.

2.4 INTERLOCKING LINK PIPE SEALS

In all locations indicated on the Drawings, interlocking link pipe seals shall be used in lieu of lead packing a pipe wall sleeve. Seals shall be modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall sleeve. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut. After the seal assembly is

positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely water-tight seal between the pipe and wall sleeve.

The Contractor shall determine the required diameter of each individual wall opening according to the manufacturer's recommendations before ordering and installing the seal. Pipe shall be accurately centered in the sleeve and the link seals shall be sized, installed and tightened in accordance with the manufacturer's instructions.

2.5 COUPLING AND ADAPTERS

Flexible couplings shall be of the sleeve type with a middle ring, two round-wedge shaped rubber gaskets at each end, two following rings together and compress the gasket against the pipe. Flexible couplings shall be steel with minimum wall thickness of the middle ring or sleeve installed on pipe being 5/16-inch for pipe smaller than 10 inches, 3/8-inch for pipe 10 inches or larger. The minimum length of the middle ring shall be 5-inches for pipe sizes up to 10 inches and 7 inches for pipe 10 inches to 30 inches. The pipe stop shall be removed. Gaskets shall be suitable for 250 psi pressure rating or at rated working pressure of the connecting pipe. Coupling shall be harnessed as shown on the Drawings and be designed for 250 psi. Provide reducing couplings where indicated.

Flanged adapters shall have one end suitable for bolting to a pipe flange and the other end of flexible coupling similar to that described hereinbefore. All flanged adapters shall be harnessed. The adapters shall be furnished with bolts of an approved corrosion resistant steel alloy, extending to the adjacent pipe flanges. The harness shall be designed for axial thrust due to a working pressure of not less than 250 psi. Not less than four special bolts shall be furnished for each adapter. Flanges on flanged adapter (unless otherwise indicated or required) shall be faced and drilled ANSI B16.1 Class 125.

Flexible couplings and flanged adapters shall be as manufactured by Dresser, Rockwell, or equal, per the following, unless otherwise specified and/or noted on the Drawings:

Steel couplings for joining same size, plain-end, steel, cast iron, and PVC plastic pipe -

Dresser	Rockwell
Style 38	411

Transition couplings for joining pipe of different outside diameters -

Dresser	Rockwell
Style 162 (4" - 12")	413 steel (2" - 24")
Style 62 (2" - 24")	415 steel (6" - 48")
	433 cast (2" - 16")
	435 cast (2" - 12")

Flanged adapters for joining plain-end pipe to flanged pipe, fittings, valves and equipment; (use lock pins or anchor studs when noted on Drawings) -

Dresser	Rockwell
Style 127 cast (3" - 12")	912 cast (3" - 12")
Style 128 steel (3"-48" C.I. pipe)	913 steel (3" and larger)
Style 128 steel (2"-96" steel pipe)	

2.6 FLANGED JOINTS

Flange bolts and nuts shall be ASTM A 307, Grade B and shall have hexagonal heads. All bolts, nuts and studs for flanged pipe in submerged locations shall be of 300 Series stainless steel. The flanges shall be drawn together until the joint is perfectly tight, with bolts of a length such that they will not project greater than 1/4-inch from the nut nor fall short of the end of the nut when drawn up. No washer shall be used. Gaskets shall be carefully fabricated prior to installation and must be suitable for pressure rating for the pipe for which it is used.

All flanges (unless otherwise indicated or required) shall be faced and drilled ANSI A21.15 125-pound for ductile iron and rated for 250 psi.

2.7 METAL PIPE SUPPORTS AND HANGERS

The Contractor shall furnish and install all pipe hangers, inserts, brackets, plates, anchors, and other supports not specifically included under other items. Generally pipe supports are not shown on the Drawings, but shall be supplied as specified herein. However, any bracing or support details shown on the Drawings shall be followed.

Supports and hangers shall be as manufactured by Grinnell, Elcen, or Fee & Mason, or fabricated by the Contractor. Field fabricated supports may be used only for special conditions where manufactured items may not be suitable. In such cases, details of proposed supports shall be submitted to the Engineer for review. All such supports shall be galvanized.

Except as shown on the Drawings or as directed by the Engineer, supports and hangers shall be as follows:

A. Pipes with centerlines less than 24 inches from a wall shall be supported by a typical wall support bracket. Pipes with centerlines less than 6 feet above a floor shall be supported from below. All other pipes shall be hung from above. Piping shall be supported at no greater than 10 feet 0 inches on centers.

B. Pipe supported from underneath shall have adjustable pipe saddle supports on properly sized pipe stanchions. The saddle assembly shall be of cast iron.

C. Hangers are to be suspended from concrete work. Hangers shall be supported from approved metal inserts placed in concrete before the concrete is placed.

D. All pipe hangers, inserts, clamps, supports and other like items shall be submitted for review by the Engineer prior to installation.

E. All inside horizontal flanged piping shall be supported with approved split ring type adjustable hangers of malleable iron with suitable hanger rods unless shown otherwise on the Drawings. Special supports shall be constructed in accordance with details shown on the Drawings. Wall supports and/or hangers shall be placed not over 10 feet apart. All piping shall be rigidly supported to prevent loosening under vibration.

F. Pipe, valve operating stems, fixtures and conduits shall be bracketed or suspended from walls, ceilings, and beams at or near valves and fittings and where needed for firm support, by standard brackets, rods, turnbuckles, and rings made especially for pipe of sizes supported. Perforated strap iron and/or copper will not be acceptable.

G. Clevis hangers for "iron pipe size" O.D. pipe shall be Grinnell Figure 65, Elcen Figure 12, Fee & mason Figure 239, or equal. Clevis hangers for Cast Iron O.D. pipe shall be Grinnel Figure 260, Elcen Figure 12C, Fee & Mason Figure 104, or equal.

H. Turnbuckles shall be forged steel. Rods shall be of black steel, machine threaded of following sizes:

Pipe Size	Rod Diameter
1/2" - 2"	3/8"
2 1/2" - 3"	1/2"
4" - 5"	5/8"
6"	3/4"
8" - 12"	7/8"
14" - 16"	1"
18"	1 - 1/8"
20" - 24"	1 - 1/4"

I. Brackets shall be of standard castings of fabricated steel and shall be reviewed by the Engineer.

J. Column type pipe supports shall consist of pipe columns of size required to carry the full pipe and standard cast iron bases and saddles as required. Saddles shall be of proper size to fit the pipe being supported.

3.0 EXECUTION

3.1 INSTALLATION

A. All materials shall be new.

B. Each piece of iron pipe and each fitting shall be plainly marked at the foundry with class number and weight.

C. Where indicated on the Drawings, plain-end pipe shall be joined by means of flanged adapters or flexible couplings which shall be Rockwell, Dresser, or equal.

D. All pipe couplings shall be designed to safely withstand the operating pressure of the lines in which they are installed. All couplings shall be shop primed with an approved rust inhibitive primer.

E. Taps and connections to piping shall be made as required to connect equipment, sample lines, etc., and where otherwise shown on the Drawings.

F. Piping shall be installed straight and true, parallel or perpendicular to walls, with approved offsets around obstructions. Standard pipe fittings shall be used for changing direction of piping. No mitered joints or field fabricated pipe bends are permitted unless accepted by the Engineer.

G. All piping, fittings, valves and other accessories shall be thoroughly cleaned of dirt, chips and foreign matter before joint connections are made.

H. All plastic pipe shall be adequately supported and braced. Support spacing shall not exceed the recommendations of the Plastics Pipe Institute.

I. Teflon tape shall be used on all plastic pipe threaded connections.

J. Field cut male threads on plastic pipe shall be made with plastic pipe threading dies.

K. The annular space of plain wall sleeves shall be packed tight with lead wool to within 3/4" of wall face and then patch grouted flush to wall face with non-staining non-shrink grout, masterflow 713 by Master Builders, Sonogrout by Sonneborn-Contech, or equal.

L. All pipe sleeves passing through walls or floors of chlorine feed and storage areas shall be provided with gas tight seals.

M. All pipe threads shall conform to ANSI B2.1.

N. Piping shall be erected to provide for expansion and contraction.

O. Screwed or soldered unions shall be provided in all small piping as required to permit convenient removal of equipment, valves and piping accessories from the piping system.

P. Dielectric insulating couplings or brass adapters shall be used whenever the adjoining materials being connected are of dissimilar material such as connections between copper tubing and steel pipe.

Q. All inside piping shall be color coded, stenciled and label tagged for identification as specified in Section 09900.

4.0 MEASUREMENT AND PAYMENT

No measurement of this item will be made. Payment will be included in the work to which it is subsidiary as described in the bid documents.

SECTION 13104

YARD PIPING AND VALVES

1.0 GENERAL

1.1 SCOPE OF WORK

Provide all labor, materials, equipment and services required for furnishing and installing all yard piping and appurtenances specified herein.

2.0 PRODUCTS

2.1 DUCTILE IRON PIPE

Ductile iron pipe shall conform to AWWA C151-76, (ANSI A21.51), Class 250, with push-on or mechanical joints.

The interior of the pipe shall be cement-mortar lined with bituminous seal coat in accordance with AWWA C104-80 (ANSI A21.4). Thickness of the lining shall be set forth in Section 4.10.1 of the aforementioned specification unless otherwise directed by the Engineer. The exterior of all pipe, unless otherwise specified, shall receive either coal tar or asphalt base coating a minimum of 1 mil thick.

Each piece of pipe shall bear the manufacturer's name or trademark, the year in which it was produced and the letters "DI" or the word "DUCTILE". Pipe manufacturer shall furnish notarized certificate of compliance to the above AWWA or ANSI specifications.

Fittings shall be 350 psi rated (through 24" size) ductile iron in accordance with AWWA C110-77 (ANSI A 21.10) and shall conform to the details and dimensions shown therein. Fittings shall have mechanical joints meeting the requirements of AWWA C111- 80 (ANSI A 21.11). Fittings shall have the same interior cement-mortar lining and exterior coating as specified for the pipe.

Joints shall be of the mechanical joint type conforming to AWWA C111-72 (ANSI A21-11). Mechanical joints shall be bolted and of the stuffing box type and shall consist of a bell, with exterior flange and interior recess for sealing gasket, a pipe or fitting plain end, a sealing gasket, a follower gland, tee-head bolts and hexagon nuts. Below floor slabs and on all high pressure lines, the mechanical joints shall also be fitted with retainer glands.

The cleaning and assembly of pipe and fitting joints shall be in accordance with the manufacturer's recommendations.

2.2 PVC SEWER PIPE

P.V.C. gravity sewer pipe shall be ASTM D 3034, SDR 35, with ASTM D 32123 integral bell and spigot rubber gasketed joints.

2.3 POLYVINYLE CHLORIDE (PVC) PIPE AND FITTINGS

Polyvinyl chloride plastic pipe shall be Class 200 (SDR 21) pressure rated pipe. All PVC pipe shall conform to the latest revisions of the following:

ASTM Specification D2241
Department of Commerce PS22-70 (SDR-PR) (pressure rate pipe)
National Sanitation Foundation Testing Laboratories (NSF)
Standard Dimensional Ratio SDR-21 (200 psi)
Health Properties - The seal of the National Sanitation Foundation Testing Laboratory must appear on each pipe.

Cast or ductile iron mechanical joint or push-on type fittings shall be used with PVC pipe. Fittings shall conform to the Section 15100, Article 2.1,D of these Specifications.

Adapters or specials shall be furnished, as required, to connect the plastic pipe to the cast iron mechanical joint valves, fittings and pipe.

Jointing material shall be non-toxic. Joints shall be made with the use of rubber gasket couplings. Couplings shall be supplied with the pipe (not a pay item).

Pipe and fittings shall be visually inspected on the project site for proper markings which shall include manufacturer's name or trademark, nominal pipe size, class pressure rating for water at 73.4^{O}F, plastic pipe material designation (e.g. PVC 1120), ASTM Designation D2241 and the NSF Logo.

2.4 POST HYDRANTS

Post hydrants shall be Dresser/M & H Style 133 or equal. Hydrants shall be 2-1/4" post type designed for 150 PSI working pressure. Hydrants shall have 3-9 inch mechanical joint bottom connection and 1-1/2" hose nozzle with cap and cap chain.

2.5 FIRE HYDRANTS

The Contractor shall furnish and install fire hydrants where shown on the Drawings or directed by the Engineer. Hydrants are specified in specifications Section 15105.

2.6 BUTTERFLY VALVES

Butterfly valves shall conform to the specifications of Section 13500 except be designed for buried service, have mechanical joint ends, have all exterior surfaces shop painted with two coats of Fed. Spec. TT-V-51F Asphalt Varnish, with 2-inch square AWWA Class 150B nut operator in a vertical position for use in a valve box.

2.7 GATE VALVES

Gate Valves shall conform to the specifications of Section 13500 except be designed for buried service, have mechanical joint ends, have all exterior surfaces shop painted with two coats of Fed. Spec. TT-V-51F Asphalt Varnish, with 2-inch square nut operator in a vertical position for use in a valve box.

2.8 FLAP VALVES

Flap valves shall be flanged (or other suitable connection for headwall mounting), iron body, bronze mounted, Mueller A-2540-6, M & H Style 47-02, Clow F-3012 or equal.

2.9 PLUG VALVES

Plug valves shall conform to the specifications of Section 13500 except be designed for buried service; have mechanical joint ends; have all exterior surfaces shop painted with two coats of Fed. Spec. TTV-51F Asphalt varnish, with 2-inch square nut operator in a vertical position for use in a valve box.

2.10 SWING PIPES

The swing pipes in size shown on the Drawings are to be fabricated from Class 50, ductile cast iron pipe. The swing connection shall be a flanged stainless steel 90` swivel joint Style 30 as manufactured by Chicksan Weco, or equal. The swing pipes shall be controlled by 1000 lbs. capacity enclosed worm gear winches with 1/4" stainless steel cable, as manufactured by Standard Handling Devices, Inc., (Model T4-62), or equal. The winch supports shall be fabricated from structural steel and shall be equipped with 1/4" winch support plates.

2.11 VALVE BOXES

Valve boxes shall be of 5-1/4 inch standard cast iron, two-piece, screw type valve box with drop cover marked "WATER", "SEWER", "DRAIN", as applicable. Valve boxes shall be accurately centered over valve operating nut, and backfill thoroughly tamped about them. Valve box bases shall not rest on the valves but shall be supported on crushed stone fill. They shall be set vertically and properly

cut and/or adjusted so that the tops of boxes will be at grade in any paving, walk or road surface, and 2 to 3 inches above ground in grass plots, fields, woods or other open terrain. In grass areas, provide concrete pad around valve box; slightly crown in all directions to shed water.

3.0 EXECUTION

3.1 LINES AND GRADES

The Contractor will be required to accomplish any detailed layout, including that required for establishing the grade of the pipe line.

3.2 TRENCH EXCAVATION

3.2.1 General. The Contractor shall include in his bid, all trenching necessary for installation of all pipelines as planned and specified. Trenching shall include all clearing and grubbing, including all weeds, briars, small trees, stumps, etc. encountered in the trenching. The Contractor shall dispose of any such material by burning, burial, or hauling away (or as noted on the drawings), at no extra cost to the Owner. It shall be the Contractor's responsibility to notify the appropriate State and local Air Pollution Control agencies when he conducts open burning of refuse.

The Contractor shall protect existing facilities against danger or damage while pipeline is being constructed and backfilled, or from damage due to settlement of this backfill. In case of damage to any existing structures, repair and restoration shall be made at once and backfill shall not be replaced until this is done. In all cases, restoration and repair shall be such that the damaged structures will be in as good condition and serve its purpose as completely as before and such restoration and repair shall be done without extra cost to the Owner. The use of trench- digging machinery will be permitted except where its operations will cause damage to trees, buildings or existing structures above or below the ground. At such locations hand methods shall be employed to avoid such damage. All excavated material shall be piled in a manner that will not endanger the work or cause obstruction.

All excavation shall be open trenches, except where the drawings call for tunneling, boring, or jacking under structures, railroads, sidewalks and roads.

3.2.2 Clearing. The Contractor shall accomplish all clearing and/or grubbing as required for the construction under this contract. Clearing and grubbing shall include the cutting and removal of threes, stumps, brush, roots, logs, fences and other loose or projecting material and natural obstructions which, in the opinion of the Engineer, must be removed to properly prosecute the construction and operate the facilities upon completion of construction. Trees, unless designated otherwise on the plans, shall remain and be properly protected. Ornamental

shrubs, plantings, fences, walls, etc. shall be removed and replanted or replaced or protected from the construction activity. Clearing and/or grubbing shall be incidental to the various bid items and no additional compensation will be paid for same.

3.2.3 Trench Depth. Trenches shall be excavated to the line and grade required for the installation of pipe at the elevations indicated on the plans. The minimum depth of cover shall be 30 inches above the top of the pipe, unless shown otherwise on the plans or on the Standard Details. When the pipe is laying in or on solid rock, the minimum depth of cover shall also be 30 inches above the top of the pipe. No additional compensation will be made for extra depth where required by the plans or due to Contractor error. Excavation, except as required for exploration, shall not begin until the proposed work has been staked out. Materials which are not required for backfill and site grading shall be removed and disposed of as directed by the Engineer. Hauling, bedding, and backfilling shall be considered incidental to the various bid items and will not be paid for directly. Excavation shall be of sufficient depth to allow the piping to be laid on the standard pipe bedding in accordance with the Section 6 of this section. The trenches shall be excavated to a minimum of six (6) inches below the bottom of the pipe barrel in rock. In all cases where lines are under traffic a minimum cover of thirty-six (36") inches shall be provided. Should it be necessary to avoid existing utilities, culverts, outlets, or other structures, the water line shall be carried deeper at no additional expense to the Owner.

Where the plans call for extra trench depth, this extra depth shall be provided at no extra cost.

3.2.4 Trench Width. Trench widths shall exceed the minimum width that will provide free working space on each side of the pipe and to permit proper backfilling around the pipe as shown in the accompanying table and unless specifically authorized by the Engineer, shall not be excavated to wider than two (2) feet plus the nominal diameter of the pipe at the top of the trench. Before laying the pipe, the trench shall be opened far enough ahead to reveal any obstruction that may necessitate changing the line and grade of the pipe. Should the CONTRACTOR fail to accomplish this, and changes are required, they shall be at his sole expense. In rock, all ledge rocks, boulders and large stones shall be removed to provide six (6) inches of clearance on each side and below all pipe and fittings.

MINIMUM TRENCH WIDTH
IN EARTH AND PAY WIDTH
FOR ROCK EXCAVATION

Size	Width	Size	Width
Up to 4" Pipe	1'-6"	16" Pipe	2'-8"
6" Pipe	2'-0"	18" Pipe	3'-0"
8" Pipe	2'-0"	20" Pipe	3'-2"
10" Pipe	2'-4"	24" Pipe	3'-8"
12" Pipe	2'-6"		
14" Pipe	2'-6"		

3.2.5 Shoring, Sheeting, and Bracing of Excavation. Where unstable material is encountered, or where the depth of the excavation in earth exceeds five (5) feet, the sides of the trench or excavation shall be supported by substantial sheeting, bracing, or shoring. The design and installation of all sheeting, sheet piling, bracing or shoring shall be based on computations of pressure exerted by the materials to be retained under retaining conditions. Adequate and proper shoring of all excavations will be the entire responsibility of the Contractor. The Standards of the Federal Occupational Safety and Health Act and the Kentucky Department of Labor shall be followed.

3.2.6 Removal of Water. The Contractor shall provide for adequate removal of all water and the prevention of surface water from entering the excavation. The Contractor shall maintain dry conditions within the excavations until the backfill is placed. No additional compensation will be paid for replacement and/or stabilization of prepared excavations due to flooding and/or deterioration from extended exposure. All water pumped or drained from the excavation shall be disposed of in a suitable manner without damage to adjacent property or to other work under construction.

3.2.7 Pavement Removal. Pavement removal shall be as indicated on the plans or directed by the Engineer. When so required, or when directed by the Engineer, only one-half (1/2) of the street crossings or road crossings shall be excavated before placing temporary bridges over the side excavated, for the convenience of the traveling public. All backfilled ditches shall be maintained in such a manner that they will offer no hazard to the passage of traffic. The convenience of the traveling public and the property Owners abutting the improvements shall be taken into consideration. All public or private drives shall be promptly backfilled or bridged at the direction of the Engineer. Pavement replacement shall be in accordance with Standard Drawings of these specifications. Excavated materials shall be disposed of so as to cause the least interference and in every case the disposition of excavated materials shall be satisfactory to the Engineer.

3.2.8 Traffic Maintenance. The Contractor must "red light" and guard all open trenches or obstructions placed on the streets or sidewalks. The lights must be burning from sunset to sunrise in order to effectually warn and safeguard the public against dangers connected with open trenches, excavations and other obstructions. The Contractor shall be held responsible for any damage that may occur to persons or property by reason of the failure of the Contractor to properly "red light" and guard all open trenches or obstructions along the routes of the water lines. This Contractor at his own expense shall also maintain warning signs, barricades and a watchmen or flagmen to control traffic at such times as his work would interfere with the flow of traffic. No excavation shall begin that may present a safety hazard unless the signs, barricades, lights, etc. are available to protect the open excavation at the conclusion of the day. The Contractor will comply with all Federal and State Occupational Safety and Health requirements for this type of construction. The Contractor shall also comply with all local and Kentucky Department of Highways requirements for signing and traffic control.

3.2.9 Line Location. The location of pipelines and their appurtenances as shown are those intended for the final construction. However, conditions may present themselves before construction on any line is started that would indicate desirable changes in location. In such cases, the Owner reserves the right to make reasonable changes in line and structure locations without extra cost, except as may be determined by extra units of materials and construction actually involved. The OWNER is under no obligation to locate pipelines so they can be excavated by machine.

3.2.10 Solid Rock Excavation. No extra payment will be made for rock excavation. Cost shall be included in the work to which it is subsidiary.

4.0 BEDDING OF PIPELINE

In all cases the foundation for pipe shall be prepared so that the entire load of the backfill on top of the pipe will be carried uniformly on the barrel of the pipe. The bells of the pipe shall not carry any of the load of the backfill. The Contractor should refer to the Standard Details for pipe bedding shown in the plans. The bedding specifications shall govern the backfill from the bottom of the trench up to the centerline or spring line of the pipe.

4.1 STABLE EARTH FOUNDATION

On all galvanized or copper lines, the Contractor may use either the "solid trench bottom method" or the "undercutting method" as shown in the Standard Details. The solid trench bottom method allows support of the pipe barrel by the trench bottom with holes dug out for the bells. The bottom must be leveled with soil and free of irregularities. The undercutting method calls for 4 inches of excavation

below the barrel and then refill with evenly spread earth cushion or other standard bedding.

On all PVC pipelines, the trench bottoms shall be smooth and free of frozen material, clodded dirt and stones over 1/2" diameter. Bottom dirt left by trenching equipment will usually provide adequate material to level the trench bottom and provide bedding support for the pipe barrel. If the trench bottom is free of dirt, soft material may be shoveled off the side walls or shoveled under the pipe to insure proper pipe barrel bedding. In areas where the trench bottom is hard, a layer of soft backfill must be provided to insure the pipe barrel is properly cushioned. See the plans for proper bedding material depth.

If the foundation is good firm earth the pipe may be laid directly on the undisturbed earth provided the pipe barrel is supported for its full length.

Bedding of No. 9 stone, fine gravel, sand or compacted finely graded select earth shall be used to correct irregularities in the subgrade. Where bell and spigot is involved, bell holes shall be excavated to prevent the bells from being supported on undisturbed earth.

As an alternative to the above method, excavation in earth may be undercut to a depth below the required invert elevation that will permit laying the pipe on a bed of granular material or finely graded select earth to provide continuous support for the pipe barrel. Bedding depth shall be as shown on the plans.

All ductile iron pipe will be installed using the undercutting method and a crushed stone or clean earth refill bedding in accordance with the Standard Details. The bedding is not a separate pay item and shall be included as incidental expense in the unit price for the pipe bid per foot of pipe or lump sum cost for the item to which it is subsidiary.

4.2 TRENCHES IN ROCK

All installation in rock will utilize the undercutting method. Bedding will be with 6 inches crushed stone as shown in the Standard Details. The only exception to this will be with PVC, copper, or galvanized iron pipe 4 inches in diameter or smaller. These may be bedded on 6 inches of evenly spread earth backfill.

4.3 UNSTABLE TRENCHES

If unstable material is encountered which may not provide a suitable foundation for the pipe, the unstable material will be removed and an adequate layer of encasement concrete or other special bedding shall be placed for the pipe foundation in accordance with the Standard Details in the plans. Such "special pipe foundation" shall only be installed if directed by the Engineer in writing or on

the plans. This special pipe foundation shall be considered a pay item and shall be paid for at the unit contract price for the type of bedding required.

5.0 PIPE LAYING

5.1 GENERAL

Proper instruments, tools and facilities satisfactory to the Engineer shall be provided and used by the Contractor for the safe and convenient prosecution of the work. Each pipe manufacturer shall have an experienced representative on the job for at least one day at the commencement of jointing and laying operations.

Before any length of pipe is placed in the trench, a careful inspection shall be made of the interior of the pipe to see that no foreign material is in the pipe. In order to properly remove any foreign materials, a swab of necessary length is to be available at all times.

All pipe shall be lowered carefully into the trench, properly aligned and properly jointed by use of suitable tools and equipment, in such a manner as to prevent damage to water line materials and protective coatings and linings. Excessive scratching of the exterior surface of the pipe will be cause for rejection of the pipe.

Under no circumstances shall pipeline materials be dropped or dumped into the trench. The pipe and fittings shall also be inspected for the purpose of determining if they are sound and free from cracks. Laying of pipe shall be commenced immediately after excavation is started. Pipe shall be laid with bell ends facing in the direction of laying.

When pipe laying is not in progress, the open ends of pipe shall be closed by approved means to prevent entrance of trench water into the line. Whenever water is excluded from the interior of the pipe, adequate backfill shall be deposited on the pipe to prevent floating. Any pipe which has floated shall be removed from the trench and relayed as directed by the Engineer. No pipe shall be laid in water or on frozen trench bottom, or whenever the trench conditions or the weather are unsuitable for such work.

If any defective pipe and fittings shall be discovered after the pipeline is laid, they shall be removed and replaced with a satisfactory pipe or fitting without additional charge to the Owner. Open ends of unfinished pipe lines shall be securely plugged or closed at the end of each day's work or when the line is left temporarily at any other time.

5.2 LAYING DUCTILE IRON PIPE

Ductile iron bolted joint, rubber ring slip joint, and ball and socket river crossing pipe shall first be thoroughly cleaned at joints, then joined according to instructions and with tools recommended by the manufacturer. Three (3) copies of instructions shall be furnished the Engineer and one (1) copy shall be available at all times at the site of the work. The lining inside ductile iron pipe must not be damaged by handling.

All pipes must be forced and held together, or "homed" at the joints, before sealing or bolting. Pipe must be aligned as each joint is placed, so as to present as nearly true, straight lines and grades as is practical, and all curves and changes in grades must be laid in such a manner that the manufacturer's recommended maximum deflection is not exceeded at any joint.

Cutting of pipe may be done by wheeled pipe cutters or saws, or by hammer and chisel, as the Contractor may elect, but the Contractor will be held responsible for breakage or damage caused by careless cutting or handling.

Ductile iron pipe shall be laid in accordance with Standard ANSI/AWWA C150/A21.50 Laying Conditions, Type 3 as shown in the Standard Drawings in these Specifications. Six (6") inches crushed stone bedding shall be used in rock. Sufficient space (limited to 2 feet longitudinally) shall be left out of 4 or 6 inch cushion for tightening of bolts where bolted joints are used. No pipe shall be laid resting on rock, blocking, or other unyielding objects. Jointing before placing in trench, and subsequent lowering of more than one section jointed together may be allowed, subject to the Engineer's approval and direction.

When using pipe with push-on joints care must be exercised to make certain that the correct gasket is being used for the type of joint installed and that the gasket faces the proper direction. Before inserting the gasket, the groove and bell socket should be carefully cleaned of all dirt. If sand or dirt is permitted to remain in the groove, leaks may occur. Lubricant must be applied to bell socket, gasket and plain- end of pipe as required by manufacturer. Plain-end must be beveled before joint is made. Deflection required at the joint shall be obtained after the joint is made.

Cut pieces of ductile iron pipe 18 inches or more in length, shall be used in fitting to special conditions, and valves and fitting changes in grade and alignment, provided cutting is even enough to make first class joints and no cracks are evident.

Bell and spigot pipe with caulked joints may be used for special cases only. Where this type of pipe is required the joints shall be made as described in this paragraph. After placing a length of pipe on the prepared grade in the trench, the yarning material shall be held around the bottom of the spigot end of the next

length so that it will enter the bell of the previously laid pipe as the pipe is shoved into position. The spigot shall be centered there with earth carefully tamped under and on each side of it, excepting at the bell holes. Care shall be taken to prevent dirt from entering the joint space. Two or more joints of pipe shall be in place ahead of each joint before it is poured. Yarning material for bell and spigot joints shall be rubber rings, asbestos rope, or treated paper rope. Joint material for bell and spigot pipe, unless otherwise shown on the drawings, shall be of the sulphur compound type "Leadite," "Mineralead", or approved equal. Jute shall not be used for joint material. Yarning material shall be thoroughly caulked into the joint to insure centering of the spigot and within the ball and prevent loss of molten joint material into the interior of the pipe, but in no event shall a depth of less than 2-1/2 inches be left for the joint compound. Each length of material shall be such as to pass completely around the pipe and provide a lap of two inches. Joint compound shall be heated in accordance with the directions of the manufacturer, care being taken to prevent under and over heating and burning. Joints shall be run with the aid of a runner and metal pouring gate thoroughly clayed to the pipe to prevent the molten compound from breaking out of the joint. Each joint shall be run full to the top of the pouring gate in one continuous pour. Material contained in the pouring gate when it is cut free from the joint may be reused. No joint shall be run in a wet trench and no water shall be allowed to come in contact with the joint until it is thoroughly hardened. If, upon inspection by the Engineers, imperfect joints are disclosed, the compound shall be cut out or otherwise removed and the joint re-run.

5.3 LAYING PLASTIC PIPE

The trench bottom must be smooth and uniform and the alignment must conform to the plans. Bedding and cover as specified herein and shown in the Standard Details is required.

To make a clean and unobstructed joint, it is necessary to wipe the ring, groove and pipe spigot free from all foreign materials at the time of assembly (welded joints will be allowed only in special cases and will be required as shown on the plans). The ring must be positioned properly in the fitting to receive the pipe by a worker who is not in contact with the lubricant. In general, the lubricant is applied to the spigot (not the ring or groove). However, the manufacturer's instructions are to be followed in all cases. Only an approved lubricant may be used in accordance with the manufacturer's recommendations. All plastic pipe shall be joined by hand.

Where good bedding conditions are attained PVC pipe smaller than 4 inches may be assembled outside the trench in longer sections (as conditions allow) and then lowered into the trench. At any time when improper bedding is discovered or the pipe is severely deflected the pipe will be removed from the trench and the condition corrected. Pipe in sizes 4 inch and above may be assembled outside the trench but must be lowered into the trench as each joint

is assembled. Regardless of installation methods all couplings must be inspected after laying in trench for proper insertion and alignment. Field cuts and bevels will be allowed in accordance with the manufacturer's recommendations for these operations. A new reference mark shall be installed before joining any field cut pipe. The same requirements for clearance from rock or other objects, thrust blocking and deflections shall apply to PVC pipe as for other pipe materials.

Municipal PVC pipe of all sizes must be assembled in the trench in strict accordance with the manufacturer's requirements.

6.0 BACKFILLING

Backfilling must be started as soon as practicable after pipe has been laid and joints hardened sufficiently, and jointing and alignment approved. Spading of crushed rock, sand, or mechanical tamping of earth, around pipe (as specifically required) between joints shall be the usual procedure as the laying progresses. This is in order to avoid danger or misalignment from slides, flooding or other causes. The Engineer shall be given a minimum of 24 hours for inspection before backfilling. The backfill shall be crushed rock, sand, or finely divided earth free from debris, organic material and stones, places simultaneously on both sides of pipe to the same level by hand.

In backfilling of the lower part of the trench beginning at the top of the bedding, the backfill material shall be carefully and solidly tamped by hand or approved mechanical methods in 6" layers around the pipe and up to a point 8 inches higher than the top of the pipe. For PVC only the backfill shall be select material and may be walked-in. Walking or working on the completed pipe line, except as necessary in tamping or backfilling, shall not be permitted until the trench has been backfilled to a point one diameter higher than the top of the pipe. The filling of the trench and the tamping of the backfill shall be carried on simultaneously on both sides of the pipe in such a manner that the completed pipe line will not be disturbed and injurious side pressures do not occur.

After the above specified backfill is hand placed, rock may be used in the backfill in pieces no larger than 18 inches in any dimension and to an extent not greater than one-half (1/2) the backfill materials used. If additional earth is required, it must be obtained and placed by the Contractor. Filling with rock and earth shall proceed simultaneously, in order that all voids between rocks may be filled with earth. Above the hand placed backfill, machine backfilling may be employed without tamping, (if not contrary to specified conditions for the location) provided caution is used in quantity per dump and uniformity of level of backfilling. Backfill material must be uniformly ridged over trench and excess hauled away, with no excavated rock over 1-1/2 inch in diameter or pockets of crushed rock or gravel in top 6 inches of backfill. Ridged backfill shall be confined to the width of the trench and not allowed to overlap onto firm original earth and its height shall not

be in excess of needs for replacement of settlement of backfill. All rock, including crushed rock or gravel from construction, must be removed from yards and fields. Streets, roadways and walks shall be swept to remove all earth and loose rock immediately following backfilling.

In the case of street, highway, railroad, sidewalk and driveway crossings or within any roadway paving or about manholes, valve and meter boxes, the backfill must be machine tamped in not over 4-inch layers, measured loose in accordance with the standard details. Where backfill is under paved driveways, streets, highways, railroads, sidewalks, paved parking areas and other areas where settlement is not allowed, crushed stone or coarse sand backfill only shall be used up to the paving surface. Crushed stone shall be Kentucky Department of Highways Standard Specification No. 78 or finer. Coarse sand backfill shall be spread in layers not over 4 inches thick and thoroughly compacted. Sand may be moistened to aide compaction. Tunnels shall be backfilled in not over 3-inch layers, measured loose, with selected material suitable for mechanically tamping. If material suitable for tamping cannot be obtained, sand, gravel or crushed rock (No. 78) shall be blown, packed or sluiced to complete fill all void spaces.

Where local conditions permit, pavement shall not be placed until 30 days have passed since placing backfill. Crushed stone is specified for roads and parking areas and sidewalks or their bases, shall be placed and compacted to the top of trench. Backfills shall be maintained easily passable to traffic at original ground level, until acceptance of project or replacement of paving or sidewalks.

Where the final surfacing is to be crushed stone, compacted earth backfill may be used in the trench to within 6 inches of the top as shown in the Standard Details.

Railroad Company and Highway Department requirements in regard to backfilling will take precedence over the above general specification where they are involved.

Excavated materials from trenches and tunnels in excess of quantity required for trench backfill shall be disposed as shown on the plans or as directed by the Engineer.

The Contractor shall protect all sewer, gas, electric, telephone, water and drain pipes or conduits, power and telephone poles and guy wires from danger of damage while pipelines are being constructed and backfilled, or from danger due to settlement of his backfill.

In case of damage to any such existing structures, repair and restoration shall be made at once and backfill shall not be replaced until this is done. In all cases, restoration and repair shall be such that the damaged structure will be in as good

condition and serve its purpose as completely as before uncovering and such restoration and repair shall be done without extra charge.

No extra charge shall be made for backfilling of any kind, except as provided in the Bid. Backfilling shall be included as a part of the unit price bid for which it is subsidiary. No extra charge shall be made for supplying outside materials for backfill.

Before completion of contract, all backfills shall be reshaped, holes filled and surplus material hauled away, and all permanent walks, street, driveway and highway paving, and sod, replaced (if such surface replacement items are included in the contract) and reseeding performed.

Any deficiency in the quantity of material for backfilling the trenches or for filling depressions caused by settlement, shall be supplied by the Contractor.

7.0 TIE-INS TO EXISTING PIPELINES

This work shall consist of connecting new water pipes to the existing system where shown on the plans and shall include the necessary fittings, tapping sleeves, valves and necessary equipment and material required to complete the connection.

Knowledge of pipe sizes in the existing system may not be accurate. Therefore, it is recommended that the Contractor check outside diameters of existing pipe and types of pipe prior to ordering the required accessories. No additional payment will be allowed for matching pipe and/or accessories when the proper size is not ordered.

Neither the Owner nor the Engineer can guarantee the location of the existing lines. The Contractor shall verify the location of all existing water mains and valves pertaining to the proposed improvements, before excavation is started.

The necessary regulation or operation of the valves on existing mains, to allow for the connections being made, shall be supervised by the Engineer. Before shutting down an existing water main or branch main for a proposed connection, prior approval for a specific time and time interval shall be obtained from a representative of the Owner. At no time shall an existing main be shut down without the Owner's knowledge and permission.

Excavation to existing water mains shall be carefully made, with care being exercised not to damage the pipe. The excavation shall not be of excessive size or depth beneath the pipe. The sides of the excavation shall be as nearly vertical as possible.

The Contractor shall be responsible for any damage to the existing system and any such damage shall be repaired to the satisfaction of the Engineer at the Contractor's expense.

The Contractor shall verify, by field inspection, the necessary sizes, lengths and the types of fittings needed for each inter-connection. Typical connections are shown on the plans and any modifications or changes shall be subject to the approval of the Engineer. The exact length of the proposed water main needed for this work shall also be determined by field measurement as required.

The probing required to locate existing mains is not a separate pay item.

8.0 PIPE ENTERING STRUCTURES

Ductile iron, steel or PVC pressure pipe, 4-inch diameter or larger, entering structure below original earth level, unsupported by original earth for a distance of more than six (6') feet, shall be supported by Class B concrete, where depth of such support does not exceed three (3') feet, and by Class B Concrete piers where depth exceeds three (3') feet. All other pressure pipe entering buildings or basins below original earth level, which have more than 3 feet span between wall and original earth and having a cover of more than 24 inches of earth, or under roadway, shall be supported on compacted granular fill, in order to prevent breakage from settlement of backfill about the structure. Concrete and reinforcing steel for such supports are to be included in the unit price of work to which it is subsidiary, and not as extra concrete, in order to discourage excessive excavation outside the limits of structures. Pipe entering structures shall have flexible joint within 16 inches of exterior of structure.

9.0 OWNERSHIP OF OLD MATERIALS

A. Pipe - Unless otherwise indicated, all existing pipe that is to be abandoned that interferes with construction or is easily removed shall become the property of the Contractor. All pipe that is not easily removed or not required to be removed as a result of the new construction, shall be abandoned in place by this Contractor.

B. Pipe Line Fittings and Appurtenances - All pipe line fittings, valves, hydrants and other like appurtenances that are removed as a result of new construction shall be removed by this Contractor but shall become the property of the Owner. All such fittings and appurtenances shall be delivered to a point by the Contractor. Said point shall be on the Owner's property and shall be designated by the Engineer.

C. Other Materials - All other materials or items that are to be removed, demolished, or abandoned as a part of this contract shall become the property of the Contractor and shall be disposed of by him.

10.0 THRUST BLOCKING AND ANCHORAGE

All angles or bends in the pipe line, either vertical or horizontal, shall be braced or anchored against the tendency of movement with concrete thrust blocking per the Standard Details, or approved equivalent joint harness or anchors to the satisfaction of the Engineer. Where joint harness is used, all component parts shall be stainless steel. Concrete thrust blocking or joint harness materials shall be considered incidental to the expense of installing the line and shall be included in the cost for the pipe line. No separate payment will be made for these items.

Thrust blocks for plastic pipe will not be attached to couplings.

Where thrust blocks are used for extra fittings ordered by the Engineer, payment shall be made using the bid price for Class "B" concrete and the thrust block dimensions shown in the Standard Details. This payment shall cover all work required for extra thrust blocks.

11.0 TESTING PRESSURE LINES

The Contractor will be required to test all pipelines and appurtenances, with water, at pressure class of pipe installed.

The pipe shall be slowly filled with water, care being taken to expel all air from the pipes. If necessary, the pipe shall be tapped at high points to vent the air. Pressure at least equal to 200 PSIG (or the operating pressure if higher) as measured at the point of lowest elevation shall be applied.

Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe, or any valved section thereof, to maintain pressure within 5 psi of the specified test pressure after the air in the pipeline has been expelled and the pipe has been filled with water. No pipe shall be accepted unless or until the leakage, determined by this test, is less than 0.08 U.S. gallons per hour, per 1,000 feet, per inch nominal diameter of pipe. The leakage test shall be applied to the pipe for a period of not less than 4 hours.

To determine the rate of leakage, the Contractor shall, as required, furnish a suitable pump, pressure gauge and water meter or other appliance for measuring the amount of water pumped. The instrument used to measure leakage shall be tested for accuracy as frequently as directed by the Engineer. The Contractor shall furnish all necessary labor and materials to make the test and to perform any work incidental thereto. Where it is impractical to test between the valves, the Contractor shall as directed, at his own expense and cost, temporarily place caps and plugs on the lines and test sections of the new line.

Where any section of the main is provided with concrete reaction blocking, the hydrostatic pressure test shall not be made until at least five days have elapsed after the concrete reaction blocking was installed. If high early strength cement is used in the reaction blocking, the hydrostatic pressure test shall not be made until at least two days have elapsed.

Should there be leakage over the allowable amount, the Contractor will be required to locate and repair the leaks and retest the section. It is suggested, but not required, that the Contractor have a geophone (underground listening device) on the job at the time of testing.

If the leakage of the section of pipeline being tested is below the allowable amount, but leakage is obvious in the opinion of the Engineer, due to water at the surface of the ground, or by listening the leak can be heard underground with a geophone, or any other means of determining a leak, the Contractor will be required to repair these leaks.

The Contractor shall furnish a meter or suction tank, pipe test plugs and by-pass piping and make all connections for conducting the above tests. The pumping equipment used shall be centrifugal pump, or other pumping equipment which will not place shock pressures on the pipeline. Power plunger or positive displacement pumps will not be permitted for use on closed pipe systems for any purpose.

Inspection of pipe laying shall in no way relieve the Contractor of the responsibility for stopping leakage or correcting poor workmanship.

12.0 DISINFECTION OF POTABLE WATER LINES

The new potable water lines shall not be placed in service either temporarily or permanently--until they have been thoroughly disinfected in accordance with the following requirements and to the satisfaction of the Engineer.

After testing, a solution of hypochlorite using HTH or equal shall be introduced into the section of the line being disinfected sufficient to insure a chlorine dosage of at least 50 ppm in the main. While the solution is being applied, the water should be allowed to escape at the ends of the line until tests indicate that a dosage of at least 50 ppm has been obtained throughout the pipe. Open and close all valves and cocks while chlorinating agent is in the piping system. The chlorinated water shall be allowed to remain in the pipe for 24 hours, after which a residual of at least 25 ppm shall be obtained. The disinfection shall be repeated until 25 ppm is obtained after which time the main shall be thoroughly flushed until the residual chlorine content is not greater than 1.0 ppm, and then may be connected to the system.

13.0 MAINTENANCE OF FLOW OF DRAINS AND SEWERS

Adequate provision shall be made for the flow of sewers, drains and water courses encountered during construction. Any structures which are disturbed shall be satisfactorily restored by the Contractor.

14.0 INTERRUPTION OF UTILITY SERVICES

No valve, switch or other control on any existing utility system shall be operated for any purpose by the Contractor without approval of the Engineer and the Utility. All consumers affected by such operations shall be notified by the Contractor as directed by the Engineer and utility before the operation and advised of the probable time when service will be restored.

15.0 CLEAN-UP

Upon completion of the installation of the piping and appurtenances, the Contractor shall remove all debris and surplus construction materials resulting from the work. The Contractor shall grade the ground along each side of pipe trenches in a uniform and neat manner leaving the construction area in a shape as near as possible to the original ground line. Cleanup shall be in accordance with Section 15102 of these Specifications.

16.0 MEASUREMENT AND PAYMENT

Yard piping and valves are generally not a separate pay item. The cost for this work shall be included in the work to which it is subsidiary unless otherwise shown in the Bid Schedule.

SECTION 13500

HOUSED VALVES

1. GENERAL

1.1 Scope of Work. Provide all materials, labor, equipment and services required to furnish and install all valves shown on the Drawings and specified herein.

1.2 Related Work Specified Elsewhere.

A. Piping is included in 13100.
B. Hangers and supports are included in 13100.
C. Valves associated with yard piping (buried service) are included in Section 13104.

2. PRODUCTS

2.1 Shear Gates. Shear gates shall be iron body bronze mounted double wedge type with pull rod and handle. Rod length is as shown on plans. Shear gates shall be M & H Figure No. 44, Clow Model F-3002 or approved equal.

2.2 Air and Vacuum Valve for Vertical Turbine Pumps. Air valves for Vertical Turbine Pumps shall be designed to allow large quantities of air to escape out the orifice when the pump is started and close water tight when the liquid enters the valve. The air valve shall also permit large quantities of air to re-enter thru the orifice when the pump is stopped to prevent a vacuum from forming in the pump column.

The valve shall consist of body, cover, baffle, float and seat. The baffle will be designed to protect the float from direct contact of the rushing air and water to prevent the float from closing prematurely in the valve. The seat shall be fastened into the valve cover, without distortion, and shall be easily removed, if necessary.

The entire float and baffle assembly must be shrouded with a perforated water diffuser to prevent the water column entering the valve, from slamming the float shut and eliminate water hammer in the system.

The discharge orifice shall be fitted with an adjustable throttling device to regulate the flow of air escaping to establish a pressure loading on the rising column of water to minimize shock to the pump and check valve.

The float shall be stainless steel, designed to withstand a minimum of 1000 psi. The float shall be center guided and not free floating for positive seating.

Valve may have either threaded or flanged inlet and outlet. The outlet shall be piped to clearwell or atmosphere as shown on the DRAWINGS.

Valve exterior to be painted with Red Oxide Phenolic Primer Paint as accepted by the FDA for use in contact with Potable Water.

All materials of construction shall be certified in writing to conform to ASTM specifications as follows:

Body, cover & baffle	Cast iron	ASTM A48 Class 30
Float	Stainless Steel	ASTM A240
Seat	Buna-N	
Water diffuser	Brass	Commercial
Throttling device	Malleable iron	Commercial

Valve to be APCO Air & Vacuum Valve for Vertical Turbine Pumps, as manufactured by Valve & Primer Corp., Schaumburg, Illinois.

An automatic air release valve shall be provided on the high service pumps to exhaust small pockets of air which may collect in the Air and Vacuum Valve. The automatic air release valve shall have a 1/2" threaded inlet and be equal to APCO Model No. 55.

2.3 Combination Air Release Valves. Combination air release valves (single body, double orifice) shall be designed to allow large volumes of air to escape out the large air vacuum orifice when filling a pipeline and to close water tight when the liquid enters the valve. During large orifice closure, the small air release orifice shall open to allow small pockets of air to escape automatically and independently of the large orifice. The large air vacuum orifice shall also allow large volumes of air to enter through the orifice during pipeline drainage to break the vacuum. The body inlet must be baffled to protect the lower float from direct contact of the rushing air and water to prevent premature valve shut off. The top float must be protected in similar manner for the same purpose. The Buna-N seat must be fastened to the valve cover without distortion for drop tight shut off. All floats shall be heavy stainless steel, hermetically sealed; designed to withstand 1000 psi or more. The upper float shall be center guided for positive shut off. Valve exterior to be painted red lead TT86B Type IV for high resistance to corrosion. Materials certified to ASTM specifications as follows:

Body & Cover & Baffle - Cast Iron
Stainless Steel Float
Buna-N Seat & Needle

Plug & Bronze Forging
Delrin Level Frame
ASTM A48 Class 30
ASTM A240
Nitrile Rubber ASTM SB 800
ASTM D638

Combination air release valves shall be as shown in the valve schedule manufactured by APCO or equal.

2.4 Check Valves.

A. Swing Check Valves. Check valves shall be iron body, bronze mounted, horizontal swing check type, spring loaded suitable for horizontal or vertical service, American Darling, M&H, Clow or equal.

B. Double Door Check Valves. Double door check valves shall be APCO Series 9000 as manufactured by Valve and Primer Corporation, Schaumburg, Illinois, or equal. Check valve shall be lug style, pressure class 150 pounds with cast iron body, aluminum bronze doors, T316 stainless steel hinge pin and stop pin, Buna-N set and T316 stainless steel spring.

C. Air Cushion Swing Check. Air Cushion Swing Check Valve body shall be cast iron per AWWA C508 having integral flanges.

The seat shall be centrifugally cast bronze with and o-ring seal and be locked in place with stainless steel lock screws and be field replaceable, without the use of special tools.

The shaft shall be single and continuous stainless steel, extending both sides of the body with a lever and weight, using an air cushion cylinder side mounted.

The air cushion cylinder shall be constructed of corrosion - resistant material and the piston shall be totally enclosed within the cylinder and not open at one end.

The cushion cylinder assembly shall be externally attached to either or both sides of the valve body and will permit adjustability to cushion the closure of the valve. Cushioning shall be by air trapped in the cushion cylinder which shall be fitted with a one way adjustable control check valve to cushion disc contact to the seat at the shut-off point. The bottom cylinder head shall be swivel mounted and not rigid to follow the change of force angles as the lever raises or lowers to open or close the check valve.

This valve shall prevent backflow of the media on normal pump shut-off or power failure, at zero velocity and be water tight.

The disc shall be cast iron utilizing a double clevice hinge connected to a Ductile iron disc arm. The disc arm assembly shall be suspended from a stainless steel shaft which passes thru a seal retainer on both sides of the valve body.

Valve exterior to be painted with Red Oxide Phenolic Primer Paint as accepted by the FDA for use in contact with Potable Water.

Materials shall be certified to the following A.S.T.M. Specifications:

Valve to be APCO Series 6000 Cushion Swing Check Valve - Air Cushion Side Mounted as manufactured by Valve & Primer Corporation, Schaumburg, Illinois, or equal.

D. Rubber Flapper Check Valve. The check valve shall be an APCO Series 100 rubber flapper serving check valve as manufactured by Valve and Primer Corporation, Schaumburg, Illinois, or approved equal. This check valve shall have a cast iron body and cover and the body shall be long pattern design with integrally cast on end flanges. The flapper shall be Buna-N having an "O"-ring seating edge and shall be internally reinforced with steel.

E. Silent Globe Check Valve. The Silent Globe Check Valve shall be a spring loaded poppet that allows the valve to close before flow reversal occurs, resulting in a silent, non-slam closure. The silent globe check valve shall consist of a heavy cast iron body, stainless steel trim and Buna-N resilient seats. The valve disc shall be center guided at both ends with an integral shaft and shall be spring loaded for silent operation. The spring shall be helical or conical and stone tumbled to achieve a micro-finish to resist mineral deposits. For ease of maintenance, the seat and disc shall be replaceable in the field. Check valve shall be capable of silent operation when installed in vertical or horizontal positions with either flow up or flow down. The flow area through the body shall be equal to or greater than the cross section area of the equivalent pipe size. Sizes 2 ½" to 10" shall allow bolting a wafer style butterfly valve directly to the outlet flange without a spool piece. Valve body shall be Cast Iron ASTM A126 Class B, with resilient "Buna" Seat and Bronze Disc ASTM B584. Spring shall be Stainless Steel ASTM A313.5. Valve shall be rated for 200 psi with 125 lb cast iron flanges and up to 400 psi for 250# Flanges. The valve shall be a Cla-Val Series 581 Silent Globe Check Valve or approved equal.

F. Electric Check Valves. Electric solenoid operated check valves shall be of cast iron body, globe pattern, with all bronze or non-corrosive trim construction. The valves shall be flanged, faced and drilled to conform to 250# Stds. B16.1. The electric check valves shall be rated for a normal working pressure of 200 psi. The valves shall be Figure No. 173-D, Globe Body as manufactured by GA Industries, Inc., Cla-val, Bermad 740Q or approved equal as specified herein.

The valves shall be constructed with complete bronze or non-corrosive lining which shall extend down to and form the seat of the valve. The liner shall be provided with cast "V" port openings. The piston shall be bronze. The pilot shall be of the 3-way type and of all bronze construction.

The design of the valve shall be such as to provide air and water cushioning to reduce hammer and shock. Speed of valve closing/opening shall be adjustable by a hand operated regulating valve. Wear on valve moving parts shall be absorbed by renewable leather composition or rubber cups and seat. The design of valve shall be such that the area above the piston shall be approximately twice the area on the small end of the piston.

The valve shall be designed to provide full pipe line flow when open, and it shall shut off tight, when closed.

Valve shall provide for normal automatic opening and closing function, plus emergency closing on electrical outage. It shall also provide for manual-hydraulic control for opening main valve.

The Sequence of operation for the electric check valve shall be as follows:

a. Valve openings:

-Pump motor starter, three-way solenoid pilot, emergency solenoid pilot simultaneously energized by control circuit.

-Valve opens as pump reaches full speed.

-Limit switch contacts close interlocking with motor starter circuit.

b. Valve closing:

-Three-way solenoid pilot de-energized by control circuit.

-Pump motor circuit and emergency solenoid pilot remain energized.

-Valve starts to close, pump running.

-As piston nears its seat, limit switch contacts open, de-energizing pump circuit and emergency solenoid pilot.

In the event of a power failure, the motor starter circuit solenoid operated three-way pilot, and the solenoid operated two-way pilot will become de-energized simultaneously. De-energizing both pilots simultaneously will cause the main valve piston to move rapidly to its seat. The speed of emergency closing is

adjustable by regulating valve. The emergency closing speed is always at a faster rate than that of the normal closing speed.

The emergency sequence of operation would also pertain in the event of motor undervoltage, motor overload, or by depressing the emergency stop button if same is used.

2.5 Pressure Relief and Surge Anticipation Valve.

A. Function. This valve shall control high pressures and power failure surges by bypassing system pressure that exceeds the high pressure control setting and also by opening a preset amount when sensed pressure decreases below a preset minimum in anticipation of a surge.

B. Main Valve. The valve shall be hydraulically operated, single diaphragm-actuated and globe pattern. The valve shall consist of three major components: the body with seat installed, the cover with bearings installed and the diaphragm assembly. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve separating operating pressure from line pressure. Packing glands and/or stuffing boxes are not permitted and there shall be no pistons operating the main valve or pilot controls.

C. Main Valve Body. No separate chambers shall be allowed between the main valve cover and body. Valve body and cover shall be of cast material manufactured in North America and shall also have NSF 61 approvals. No fabrication or welding shall be used in the manufacturing process.

The valve shall contain a resilient, synthetic rubber disc, with a rectangular cross-section contained on three and one-half sides by a disc retainer, forming a tight seal against a single removable seat insert. No O-ring type disc (circular, square or quad type) shall be permitted as the seating surface. The disc guide shall be of the contoured type to permit smooth transition of flow and shall hold the disc firmly in place. The disc retainer shall be of a sturdy one piece design capable of withstanding opening and closing shocks. No hourglass shaped disc retainers shall be permitted and no V-type or slotted type disc guides shall be used.

The diaphragm assembly containing a rifled slotted, 302 non-magnetic stainless steel valve stem shall be of sufficient diameter to withstand high hydraulic pressure and be fully guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat. The seat shall be a solid, one piece design and shall have a minimum of a five degree taper on the seating surface for a positive, drip-tight shut off. No center guides shall be permitted. The stem shall be drilled and tapped in the cover end to receive and affix such accessories as may be deemed necessary.

The diaphragm shall consist of nylon fabric bonded with synthetic rubber compatible with the operating fluid. The diaphragm shall not be used as the seating surface.

The main valve seat and the stem bearing in the valve cover shall be removable. Cover bearing, disc retainer, and seat shall be made of the same material. All necessary repairs and/or modifications other than replacement of the main valve body shall be possible without removing the valve from the pipeline.

The valve manufacturer shall warrant the valve to be free of defects in material and workmanship for a period of three years from date of shipment provided the valve is installed and used in accordance with all applicable instructions.

D. Material Specification.

Valve Size: 6"
Main Valve Body and Cover: Ductile Iron ASTM A-536
Main Valve Trim: 303 Stainless Steel
End Detail: 300 # Flg.
Pressure Rating: 400 psi
Temperature Range: -40 to +180 degrees F
Rubber Material: Buna "N"
Coating: FDA approved fusion bonded epoxy resin process applied 5-7 Mils thick
Desired Options: Stainless Steel liquid filled pressure gauge on the inlet

E. Pilot Control System.

The pressure relief pilot shall be an adjustable, spring-loaded, normally closed diaphragm control designed to permit flow when upstream pressure exceeds the control setting. The low pressure pilot shall be an adjustable, spring loaded, normally open diaphragm control designed to open when the sensed pressure falls below the control setting and close when pressures are normal. The pilot system shall contain an adjustable hydraulic limiter to limit valve travel during low pressure opening without affecting high pressure relief valve travel. The contractor shall connect the sensing/pilot supply connection to the main header with minimum ¾" pipe or tubing.

A direct factory representative shall be made available for start-up service, inspection and necessary adjustments.

Material Specification for Pilot Control:

Pressure Rating: 300 psi
Body: Bronze ASTM B-61
Trim: 303 Stainless Steel
Rubber Material: Buna "N"

High Pressure Adjustment Range: 100-300 psi
Low Wave Adjustment Range: 30-300 psi

The valve shall be a Cla-Val Co. Model No. 52G-03BKCPEK or equal. The valve shall be factory tested to relieve at 300 psi.

2.6 Gate Valves*.

A. Housed. Gate valves for fabricated pipe systems shall be resilient seat type, iron body, flanged, fully bronze mounted with O-ring seals, and suitable for working water pressures of not less than 250 PSIG unless otherwise specified on the Drawings. Housed valves shall be left uncoated to allow painting without the use of tar stop. Valves shall be of standard manufacture and of the highest quality both of materials and workmanship and shall conform to the latest revision of AWWA Specification C-500. Unless otherwise shown on the plans, all housed gate valves shall be non-rising stem. Valves shall be rated for a working pressure of not less than 250 psi and shall have flanges drilled 125 lbs. pattern unless otherwise specified on the Drawings. Unless otherwise shown on the Drawings, housed valves and valves in basins shall be handwheel operated. Handwheels shall be ANSI B16.1 Class 125. Handwheels shall have not less than the following diameters:

Size Valves	Diameter
1"	3 1/8"
1 1/2"	4 1/4"
2"	6"
3"	8"

*Buried service gate valves specified in Section 13104.

Size Valves	Diameter
4"	10"
6"	12"
8"	14"
10"	16"
12"	18"

Size Valves	Diameter
14"	20"
16"	22"
18"	24"

Valve stand handwheels and handwheels on extended stems, shall have the same minimum diameters as those shown for handwheels directly on valves. Extension stems for O.S&Y valves ahll be non-rising, with clamp to valve handwheel and hollow shaft for rising stem of valve, with adjustable cast iron guides per each eight (8) feet of extension stem length maximum. All extension stems shall be connected with suitable coupling castings for connection to and removal from valves and stands. Nuts and bolts on all extension stem connections shall be stainless steel.

2.7 Plug Valves. Plug valves shall be non-lubricated eccentric type with synthetic rubber faced plugs, corrosion resistant nickel seats, replaceable stainless steel sleeve type bearings in the upper and lower journals. Furnish with flanges faced and drilled ANSI B16.1 125-pound.

Valve shall provide drip-tight shut-off up to the full rated pressure. All plug valves shall be provided with limit stops and rotated 90 degrees from fully opened to fully closed. Plug valves shall be manually operated with worm gear operator handwheel or lever actuated. Plug valves located 6 feet or more above the floor shall be furnished with chainwheel operators.
Eccentric plug valves shall be as manufactured by DeZurik, Clow, or equal.

2.8 Butterfly Valves*. All butterfly valves shall be of tight closing, rubber or synthetic rubber seat type with seats securely fastened to valve body. No metal-to-metal seating surfaces will be permitted. Valves shall be bubble tight at the rated pressure in either direction and shall be satisfactory for applications involving throttling service and/or frequent operation and for applications involving valve operation after long periods of inactivity.

The valve discs shall rotate 90^{o} from the full open position to the tight shut position.

The valve bodies themselves shall be flanged type design except where specifically noted on the Drawings. Valve bodies shall be constructed of cast iron ASTM A 126, Class B, and shall be suitable for use with 125# ANSI flanges unless specifically specified in the Drawings with 250 # flanges. Valves shall meet the full structural requirements of the applicable classes of AWWA C 504-74.

The valve discs shall be cast iron, semi-steel or bronze with a welded nickel edge free of ribbing or protrusions which may collect solids. The disc-to-shaft connections shall be via polished 316 SS pins. Sprayed or plated discs are not acceptable. All disc seating edges shall be smooth and polished.

The shafts shall be turned, ground and polished. They shall be 300 Series or 400 Series Stainless Steel with diameters per AWWA Spec. C504-70, Class 75B. The shafts shall be of one-piece construction.

The shaft seals shall be of Hycar or Hypalon and shall be provided to prevent leakage into the bearing chest areas.

The valve bearings shall be Teflon coated, self-lubricating, stainless steel design and construction.

The valve seats shall be Neoprene or Hypalon and shall be simultaneously molded, vulcanized and bonded to the valve body or a rigid reinforcing ring.

All surfaces of the valve shall be clean, dry and free from grease before painting. The valve surfaces except for disc, seating and finished portions shall be evenly coated at the factory with a suitable rust inhibitive primer. Hydrostatic and leakage tests shall be conducted in strict accordance with AWWA C 504-74, Section 12.

The valves shall be manufactured by M & H, Dresser, Dezurik, Pratt or approved equal and supplied as listed in the valve schedule specified herein.

*Buried service butterfly valves are specified in Section 13104.

A. High Pressure Butterfly Valves. High performance butterfly valves, 2" - 12" in ANSI Class 300 design, shall be of the flanged or lugged wafer body style. Bodies shall be of carbon steel or cast 316 stainless steel construction. ANSI Class 300 valves shall provide drip tight shutoff to 740 psi.

All valves shall be furnished with upper and lower body bearings and with thrust bearings to assure disc centering in the seat. Valves to be furnished with adjustable v-ring packing of PTFE and an adjustable gland. The one piece shalft shall be high strength Condition "B" type 316 stainless steel, and shall be centerless ground and polished to minimize bearing and packing wear.

Valve seats shall be of PTFE with integral titanium control ring capable of service in temperature ranges of -100^{o}F to 300^{o}F.

Discs shall be cast 316 stainless steel with concave face to reduce dynamic torque and decrease turbulence.

Valve actuators shall provide external disc position indication. Actuators to be weather proof, factory lubed and equipped with fully ajustable mechanical open and closed position stops.

Valves shall be as manufactured by DeZURIK, M & H or approved equal.

B. Manually Operated Butterfly Valves. Manually operated valves shall be operated using a cast iron housed handwheel or chain wheel, as required, available in standard weatherproof construction. All units shall have adjustable

open and close position stops and valve position indicator with provision to prevent accidental adjustment changes. The operating shaft shall be supported, axially and radially, at the input end by permanently lubricated bronze thrust and sleeve bearings.

Manually operated butterfly valves shall be furnished and installed as listed in the Butterfly Valve Schedule contained herein.

C. Hydraulically Operated Butterfly Valves. All hydraulically operated butterfly valves shall meet the requirements of Section 2.08 contained herein.

The valves supplied with hydraulic cylinder operators shall be designed and sized according to torque requirements of the valve. The method for calculating torques shall be as outlined in AWWA, Appendix A. Operator shall produce the full AWWA Standard C504 Table 1 output torque throughout entire travel. All hydraulically operated butterfly valves shall be furnished with manual override solenoid valves.

Cylinder actuators shall have working mechanisms fully enclosed and shall be sized for operation using water supply at 40 psi to 100 psi. Contractor shall coordinate cylinder pressure requirements and settings on the plant water pressure reducing valve.

Cylinder pivots shall have bearings. All Cylinder actuators shall be provided with stationary supply connections and flexible cylinder supply lines to allow rigid supply piping to the valve.

Cylinder operator shall be of the base mounted configuration. Cylinder barrel shall be of molybdenum-disulfide lined glass fiber reinforced epoxy tubing, to provide a corrosion-free, self-lubricated high strength barrel. Rod seal shall be of urethane, molybdenum-disulfide filled, to provide a self-lubricated, long life seal.

Piston rod shall be of hard chromium plated 18-8 stainless steel, and shall be top and bottom guided in a heavy cast iron mechanism housing for positive alignment. Guiding shall be accomplished by bronze bearings at end of housing straddling all side loads imposed in operation. Entire operator including piston rod shall be fully enclosed.

The open/close valves shall be supplied with 4-way pre-piped solenoid valves with manual override - NEMA 4 115 V coils, energize to operate.

Open/Closed Valves shall be supplied with speed control for both opening and closing speeds.

Solenoids for open/hold/close (backwash) valves shall be dual coil 4-way with manual override.

Hydraulically operated butterfly valves shall be furnished and installed as listed in the Butterfly Valve Schedule contained herein.

D. Electric Motor Operators. Electric motor operators shall be designed to move the valve from fully open to fully closed with operating speeds such that no undue surge or water hammer occurs when electrical power is applied, and hold the valve disc in any intermediate position between full open and fully closed without creeping or fluttering. Valve, gear, reducer, electric motor operator and accessories shall be furnished complete, ready for installation. Accessories shall include pre-wired control stations with indicating lights, controls and integral reversing contactor furnished for remote operation, and a valve position transmitter and feedback potentiometer enclosed in a NEMA IV housing furnished for remote indication of valve disc position. The motors shall be heavy duty, operating from 120 VAC single phase input source and shall be fused locally. Control compartment shall have internal heater to prevent condensation, a thermal cut-out switch in case of motor overload and four (4) limit switches, 2 to prevent disc overtravel in each direction and 2 for signal-controlled intermediate position stop. Limit switches shall be field adjustable, independent of each other. Limit switches gearing shall be totlly enclosed, permanently lubricated. Operator housing shall be heavy, cast aluminum, fully gasketed, capable of remaining watertight for 48 hours submersion in 20 feet of water with conduit access ports sealed.

One handwheel operator shall be furnished for each valve. Operator shall have manual over-ride in which the motor is disconnected when handwheel is in use and the handwheel is not engaged when the motor is in operation.

Motor operation and controls shall be Henry Pratt, AUMA Actuators, or equal.

All valves to be integrated to a flow tube to provide means of rate of flow control shall be equippend with a proportional positioning system to be internally wired to the electric operator for remote indication and control of position of the disc. This system shall be capable of converting a DC milliapere output signal from rate of flow controller to accuate the valve operator to the position required. All valves equipped with electric operators for open and close service shall have on and off position indicators and transmitters.

2.9 Solenoid Control Valve. The function of the valve is to open and close via telemetry activation to control the fill/drawdown cycle of a water storage tank.

The valve shall be an on-off control valve which either opens fully or closes drip-tight upon receiving an electrical signal to the solenoid pilot control. The valve shall consist of a Hytrol main valve, a three way solenoid and high capacity three way pilot valve. The solenoid control shall operate the three way valve which alternately applies pressure to or relieves pressure from the diaphragm chamber

of the main valve. Furnish normally closed (energize solenoid to open). The minimum pressure class shall be 150.

The materials shall be as follows:

Component	**Material**
Body and Cover	Ductile Iron
Disc Retainer & Diaphragm Washer	Cast Iron
Trim: Disc Guide, Seat and Cover	Buma-N Rubber
Bearing	
Diaphragm	Nylon Reinforced Buma-N Rubber
Stem, Nut & Spring	Stainless Steel

The valve shall be equal to Cla Val Model 136-03.

3. EXECUTION

3.1 Installation. Installation shall be in accordance with manufacturer's recommendations.

4. MEASUREMENT AND PAYMENT

Valves are included in the fabricated piping of a structure or specific bid item and separate payment will not be made unless provided for in the Bid Schedule. Costs are to be included in the work to which they are subsidiary.

SPECIFICATIONS AND CONTRACT DOCUMENTS

FOR

CUMBERLAND FALLS HIGHWAY WATER DISTRICT

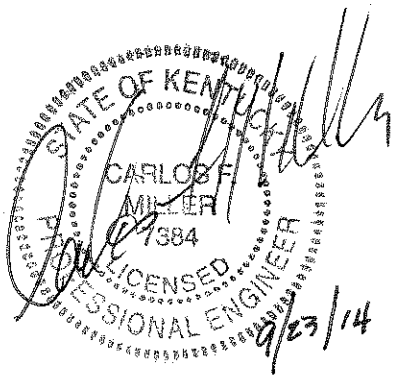
HIGHWAY 25 TRANSMISSION PIPELINE AND PUMP STATION

Prepared By:

KENVIRONS, INC.
452 VERSAILLES ROAD
FRANKFORT, KENTUCKY 40601

PROJECT NO. 2012059

SEPTEMBER 2014



DIVISION 15

MECHANICAL

SECTION 15100

WATER LINES

1.0 GENERAL

The CONTRACTOR shall furnish all labor, materials and equipment to install the water lines as shown on the plans and as specified herein.

The water lines may either be pressure-rated plastic pipe (PVC), municipal plastic pipe (MPVC) or ductile iron (DI), all as specified hereinafter. The bid documents shall show the amounts of each type and class of pipe to be provided by the CONTRACTOR.

The OWNER will obtain all rights-of-way for operations through private property. It will also secure building permits and the permits for all pipe laid in highway rights- of-way. Any charges for inspections or other fees required will be the responsibility of the CONTRACTOR since the amounts of these are dependent upon the operation of the CONTRACTOR.

1.1 Department of Transportation Bonding. The Kentucky Department of Transportation will require that the OWNER post a bond for all work accomplished on their right-of-way. Each contract on which work is to be performed will be a separate application and will require a separate bond. Each permit will have conditions attached and these conditions will vary depending on the area where work is to be performed. In areas where traffic control may pose a problem, working hours may be limited. A copy of the encroachment permit will be provided to the CONTRACTOR. The CONTRACTOR will be responsible for knowledge of the permit's content and conditions in order that the construction may be accomplished in accordance with the specified requirements.

Should any additional bonds or requirements be imposed by the Kentucky Department of Transportation, the OWNER shall also be responsible for the bonding of the additional requirements.

2.0 PIPE AND FITTINGS

2.1 Polyvinyl Chloride Rigid Pipe and Fittings. This specification covers rigid, pressure-rated, polyvinyl chloride pipe and fittings, hereinafter called PVC pipe and PVC fittings, for sizes 1/2 inch through 12-inch. Pipe shall be as manufactured by North American, Diamond, J-M or approved equal.

2.1.2.1 PVC Pipe. PVC pipe shall be extruded from Type 1, Grade 1, polyvinyl chloride material with a hydrostatic design stress of 2,000 psi for water at 73.4^{o}F, designated as PVC 1120, meeting ASTM Specifications D-1784 for

material and D- 2241 for pipe, latest revisions. Pipe shall also meet all applicable provisions of the Product Standards and shall bear the National Sanitation Foundation (NSF) seal of approval in compliance with NSF Standard No. 14. PVC pipe having a maximum hydrostatic working pressure of 160 psi (SDR26), 200 psi (SDR21), 250 psi (SDR17), or 315 psi (SDR13.5) shall be used as shown in the Bid Documents and Plans.

Samples of pipe and physical and chemical data sheets shall be submitted to the ENGINEER for review and determination of compliance with these specifications before pipe is delivered to job. The pipe shall be homogeneous throughout and free from cracks, holes, foreign inclusions or other defects.

The workmanship, pipe dimensions and tolerances, outside diameters, wall thickness, eccentricity, sustained pressures (ASTM D-1598), burst pressures (ASTM D-1599), flattening, extrusion quality (ASTM D-2152), marking and all other requirements of the Product Standard PS 22-70 shall be with in all respects. No pipe, 2 inches in diameter or larger, with a wall thickness less than 0.090 inches may be used.

Pipe shall be furnished in 20 feet or 40 feet lengths. The pipe shall be bell on one end. Male ends of pipe must be beveled on the outside. Pipe shall have a ring painted around the male end or ends in such a manner as to allow field checking of setting depth of pipe in the socket. This requirement is made to assist construction superintendents and inspectors in visual inspection of pipe installation.

Pipe must be delivered to job site by means which will adequately support it, and not subject it to undue stresses. In particular, the load shall be so supported that the bottom rows of pipe are not damaged by crushing. Pipe shall be unloaded carefully and strung or stored as close to the final point of placement as is practical. Pipe must not be exposed to the direct rays of the sun for an extended period of time. If pipe is not to be installed shortly after delivery to the job site, it must be stored in a shaded location and strung as needed.

2.1.2 PVC Pipe Jointing. Pipe shall be joined with slip-type joints with rubber gaskets. Pipes with bells shall have all parts of the bell, including the gasket groove, made from the same extruded piece, integral with the pipe, and shall be thickened to meet standard dimension ratios of wall thickness to outside diameter. This manufacturing procedure shall be the normal practice of the pipe manufacturer and proven by past performance of pipe in service. The gasket groove shall be constructed such that gasket rollout will not occur. Rubber gasketing shall conform to ASTM 3139.

The pipe manufacturer shall have an experienced representative on the job for a minimum of one day at the commencement of joining and laying operations. Joint lubrication shall be of a type recommended by the manufacturer for their pipe subject to the Engineer's approval. Lubricant shall be water soluble, non-toxic and have no objectionable properties.

2.1.3 PVC Couplings. Where PVC couplings are used, they shall be of the same material as the pipe and may be of the molded, or extruded type. PVC couplings shall have a minimum rating of 200 psi for continuous operation at 73.4 degrees F.

2.1.4 Fittings Ductile iron mechanical joint type fittings with appropriate adaptors as manufactured by Tyler, U.S. Pipe, Clow, Union Foundry or approved equal, shall be used with PVC pipe. All such fittings shall be approved by the pipe manufacturer, and complete data sent to the ENGINEER, including the manufacturer's approval, for review. Fittings shall comply with AWWA C-110 or C-153 and shall be manufactured for the size and pressure class of the line on which they are used. Use of transition gaskets will not be allowed unless specifically approved by the pipe manufacturer. Coatings and lining shall be in accordance with 2.3.7.F of this section of the Specifications.

2.1.5 Service Connections. All service connections on PVC lines shall be made by means of tees, factory tapped couplings, or bronze service clamps manufactured specifically for use with PVC pipe as manufactured by Ford or approved equal. Whenever possible, corporation stops shall be installed in plastic lines before conducting hydrostatic tests.

2.2 Municipal Polyvinyl Chloride (MPVC) Pressure Pipe. This specification covers the requirements for AWWA approved Polyvinyl Chloride Pressure Pipe for water supply and distribution systems.

2.2.1 MPVC Pipe. MPVC Pipe shall meet the requirements of AWWA C900-75, latest revision, "Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4" through 12" for water" and shall be furnished in cast-iron pipe equivalent outside diameters with rubber gasketed separate couplings. Pipe shall be as manufactured by North American, Diamond, J-M or approved equal.

MPVC Pipe and couplings shall be made from Class 12454-A or Class 12454-B virgin compounds as defined in ASTM D-1784. The standard code designation shall be PVC 1120. The PVC compounds shall be tested and certified as suitable for portable water products by the NSF Testing Laboratory and shall carry the NSF approval marking.

Solvent-cement couplings or joints shall not be used. PVC joints using elastomeric gaskets shall be tested as assembled joints and shall meet the laboratory performance requirements specified in ASTM D-3139.

Pipe and coupling shall be pressure Class 100, DR 25 (Dimension Ratio), pressure Class 150, DR 18, or pressure Class 200, DR 14 as shown on the plans or the bid form.

Pipe and couplings shall be marked as follows:

a. Nominal size and OD base.
b. Material code designation (PVC 1120).
c. Dimension ratio number.
d. AWWA pressure class.
e. AWWA designation number (AWWA C900).
f. Manufacturers name or trade-mark and production record code.
g. Seal of the NSF Laboratory.

Sustained Pressure DR	ASTM D-1598 (1000 Hrs.) Sustained Pressure
14	650 psi
18	500
25	350

Burst Pressure DR	ASTM D-1599 (60-70 seconds) Minimum Burst Pressure
14	985
18	755
25	535

Hydrostatic Integrity - Each standard and random length of pipe shall be proof-tested at four times its rated class pressure for a minimum of 5 seconds. Bells or couplings shall be tested with pipe.

Flattening - The pipe shall not split, crack, or break when tested by the parallel-plato method as specified by ASTM D- 2241.

Extrusion quality - The pipe shall not flake or disintegrate when tested by the acetone-immersion method as specified in ASTM D-2241.

Standard length - Pipe shall be furnished in standard laying lengths of 20 ft. $\pm$ 1 in. A maximum of 15 percent of each pipe size may be furnished in random lengths of not less than 10 ft. each.

2.2.2 MPVC Pipe Jointing. Pipe shall be joined with slip-type joints with rubber gaskets. Manufacturing and installation procedures shall be as recommended by the manufacturer and as described for PVC Pipe in Section 2.1.2 of this specification.

2.2.3 Fittings. Fittings for municipal PVC shall be ductile iron only. Fittings shall be mechanical joint. Fittings shall be manufactured for the size and pressure class of the line on which they are used and shall comply with AWWA C-110 or C-153. Coatings and lining shall be in accordance with subsection 2.3.7.F of this

section of the Specifications. Fittings shall be as manufactured by Tyler, Clow, U.S. Pipe, Union Foundry or approved equal.

2.2.4 Service Connections. Service connections shall be made by means of bronze service clamps manufactured specifically for use with municipal PVC pipe. Clamps shall be Ford S90 Series or approved equal.

2.2.5 Underground Marking for PVC Pipe. Underground marking for PVC pipe shall be one of the following types. The type required for this project is specified in the notes on the Drawings.

2.2.5.1 Underground Marking Wire. At all locations where PVC pipe is utilized, a detectable underground marking wire shall be placed in the trench as shown on the miscellaneous drawings. The wire used shall be No. 12 insulated solid copper wire. Copper split bolt screw connectors shall be used for splice connections, see miscellaneous drawings. Extreme care shall be exercised in connecting and taping splices and joints to assure continuity. At each valve box the wire shall be looped to the surface extending 12-inches above the concrete valve box pad (see Std. Dwg. for valve). When the entire project or pipeline segment is complete, including meter installation and leak repairs, the locating wire system shall be checked for continuity.

2.2.5.2 Underground Marking Tape. At all locations where PVC pipe is utilized, a detectable underground marking tape shall be placed in the trench approximately twelve inches below the finished grade. The tape used shall be mylar encased aluminum foil with the printing "CAUTION - Buried Water Line Below". Printing shall be readable through the clear mylar and surface printing is not acceptable. Tape size shall be 2 inch width as provided by Lifeguard, Inc. or approved equal. Color of the tape shall be blue.

2.3 Ductile Iron Pipe. These specifications cover ductile iron pipe (3-inch diameter and greater) to be used in water transmission systems with mechanical joints, rubber ring slip type joints or flanged joints.

2.3.1 General. Ductile iron pipe shall be designed in accordance with AWWA H3 (ASA A21.50) and for pressures and conditions as stated in these specifications or called for on the plans. Ductile iron pipe shall conform to AWWA C-151 (ASA A21.51).

2.3.2 Minimum Nominal Thickness. The specified thickness will be determined for the given internal and external loading requirements in accordance with ASA A21.50. The class of pipe, wall thickness, and coatings required will be shown on the plans or the bid form for all ductile iron pipe installation.

2.3.3 River Crossing Pipe. River crossing pipe shall be ductile iron, Flex-Lok as manufactured by the American Cast Iron Pipe company or equal conforming to the appropriate requirements of AWWA C150/ANSI A21.50 and ANSI/AWWA C151/A21.5 with a thickness class of 54.

2.3.4 Lengths. Pipe may be furnished in 12, 16, 16 1/2, 18 or 20 feet nominal laying lengths.

2.3.5 Tests. Hydrostatic and acceptance tests shall be in accordance with AWWA Standard C-106 for "Cast Iron Pipe Centrifugally Cast In Metal Molds" or C-108 for sand molds. The ENGINEER shall be provided with five (5) copies of each of the following tests for each contract involved:

a. Talbot strip test.
b. Ring and full length bursting tests.
c. Chemical analysis of pipe.
d. Certification that pipe was hydrostatically tested.

Any pipe not meeting the AWWA Standard quoted above shall be rejected in accordance with the procedure outlined in the particular specifications.

2.3.6 Marking. The net weight, class or nominal thickness and sampling period shall be marked on each pipe.

2.3.7 Pipe Joints for Ductile Iron Pipe. Pipe joints shall be mechanical joint, rubber ring slip joint, flanged, or locked mechanical joint as shown on the plans.

A. Mechanical Joint

Mechanical joints are to be furnished according to AWWA Standrads C-111. All pipe joints must be furnished complete with all accessories. Mechanical joint bolts and nuts shall be of alloy cast iron or alloy steel (Corten type such as U.S. Alloy) or approved equal. Rubber gaskets shall be made of plain first grade rubber, free of imperfections and porosity. Hardness shall be 70 to 75 durometer.

B. Rubber Ring Slip Joint

Rubber ring slip joint shall be equal to AWWA C-111-64 or latest revision. The joints shall be of the following materials:

a. Rubber ring gasket compressed in groove in bell of pipe.

b. Beveled spigot end of pipe for initial centering into rubber gasket in bell.

C. Locked Mechanical Joint

Locked mechanical joints shall be equal to Clow Corporation's "Locked Mechanical Joint".

D. Ductile Iron Flanged Pipe and Special Coupling

a. Flanged Pipe. All ductile iron flanged pipe shall have flanges faced and drilled, 125 pound in accordance with ASA A21.10 (AWWA C-110) unless

otherwise specified on the Drawings. Flanges may be cast integrally with the pipe or they may be screwed on specially designed long hub flanges, refaced across both face of flange and end of pipe. Flanged pipe shall be in accordance with ASA A21.6 (AWWA C-106) Standard, latest revision, and be the class called for on the plans or bid forms. Where plain ends of flanged and plain end pipe fit into mechanical joint bells, centrifugally cast pipe shall be used. Flanged pipe for water service shall be cement lined and bituminous coated the same as written herein for bell-joint pipe.

b. Special Coupling. Flexible couplings for flanged pipe shall be a mechanical joint cast to a special flanged joint using a neoprene O-ring in place of the usual 1/16 inch rubber ring gasket. The mechanical bell and special flanged joint piece shall be of high grade gray cast iron (ASTM A48-56, AWWA C-100-54T) with bolt circle, bolt size and spacing according to ASA Specifications. Mechanical joint follower flange shall be of ductile iron ASTM A399 or malleable iron ASTM A47, Grade 35018 or 32510, latest revision with high strength/weight ratio design.

Bolts shall be fine grained high tensile malleable iron with malleable iron hexagon nut. Stainless steel nuts shall be used in vaults and wet wells. Where pressures may exceed 20 pounds, anchor studs shall be included with spigots of pipes connected drilled to receive ends of studs.

E. All items used for jointing pipe shall be furnished with the pipe and tested before shipment. The joints shall be made with tools and lubricant in strict conformity with the manufacturer's instructions. Three (3) copies of such instruction shall be delivered to the ENGINEER at start of construction.

F. Coatings and Lining. All buried ductile iron pipe shall have manufacturer's outside coal tar or asphaltic base coating and a cement lining and bituminous seal coat on the inside. Cement mortar lining and a bituminous seal coat inside shall conform to ANSI A21.4 (AWWA C-104) latest revision.

All pipe and fittings housed and in vaults shall be lined and coated on the inside as specified herein for buried ductile iron pipe and fittings, but shall be left uncoated on the outside so that it may be painted without the use of tar stop.

G. Fittings for Ductile Iron Pipe. Ductile iron mechanical, rubber ring slip and flanged joints shall conform to ASA Specifications A21.10 (AWWA C-110) for centrifugally cast iron water pipe. Mechanical joints shall also conform in all respects to ASA 21.11 (AWWA C-111). All fittings shall be manufactured for the size and pressure class of the pipeline in which they are to be used. All fittings shall be furnished complete with all joint accessories. All ductile iron pipe fittings for water, sewer, air, gas and force main service shall be bituminous coated outside and lined on the inside same as the line on which they are installed.

2.4 Polyethylene Pipe. This pipe is used primarily for stream crossings and other special applications in locations indicated on the DRAWINGS. The required pressure class shall be as shown on the DRAWINGS.

The pipe shall be PE 3408 high density, high molecular weight polyethylene pipe equal to Performance Pipe or Endopoly Premium. The pipe shall meet or exceed the following standards:

a. ASTM 3350 having a cell classification of PE34534C
b. ASTM F714 - Dimensions and Workmanship
c. AWWA C901 - Potable Water Pipe
d. ASTM D1248 - Type III, Class C, Category 5, Grade P34
e. ASTM D3261 - Fittings Standard
f. NSF - Listed, Standard #14

The pipe shall be joined by the butt fusion technique utilizing controlled temperatures and pressures to produce a fused, leak-free joint that has equal or greater strength than the pipe itself in both tension and hydrostatic loading. The joining system shall be equal to Phillips butt fusion joint system.

Transitions to the continuing pipeline shall be made with the appropriate fittings to maintain the integrity of the piping system as recommended by the pipe manufacturer.

Drawings showing details of the installation shall be submitted to the ENGINEER for approval prior to installation.

3.0 HAULING AND STORAGE

The CONTRACTOR shall notify the ENGINEER when pipe will be received on the job so that proper arrangements may be made for inspecting the unloading and stringing, as well as inspecting and examining the pipe materials.

All pipe shall be covered with tarpaulin during hauling from the manufacturer to the job site. It is acceptable for the front end only to covered. The intent is to prevent diesel exhaust residue from coating the pipe and/or contaminating the gaskets.

Care must be exercised in the handling of all materials and equipment and the CONTRACTOR will be held responsible for all breakage or damage to same caused by his workmen, agents, or appliances for handling or moving. Pipes and other castings shall in no case be thrown or dropped from cars, trucks, or wagons to the ground, but same shall be lowered gently and not allowed to roll against or strike other castings and unyielding objects violently. Pipe and other castings may be distributed at places that will not interfere with other building operations and unloaded, or yarded and distributed as required, as the CONTRACTOR may elect.

Valves, castings, fabricated metal, reinforcing steel, etc. shall be yarded or housed in some convenient location by the CONTRACTOR and delivered on the ground as required. All equipment and materials subject to damage from the weather, dampness, changes in temperature, or exposure shall be protected by a dry, weatherproof enclosure until ready for installation or use. The cost of all hauling, handling, and storage shall be included in the prices bid for equipment and materials in place. The OWNER takes no risk or responsibility for fire, flood, theft, or damage until after the final acceptance of the work.

4.0 LINES AND GRADES

The CONTRACTOR will be required to accomplish any detailed layout, including that required for establishing the grade of the pipe line.

5.0 TRENCH EXCAVATION

5.1 General. This section describes the acceptable methods of trenching for the installation of pressure pipe and casing pipe in an open trench.

Trenching may be accomplished by means of a backhoe, trenching machine or by hand depending on the construction area.

At the CONTRACTOR'S option, trenching, by a trenching machine or by backhoe is acceptable except as noted below:

Where the pipe line is being constructed close to other utilities, structures, building, or large trees, and it is reasonable to anticipate possible damage from the use of a backhoe, then trenching shall be made by hand methods.

The CONTRACTOR shall include in his unit price bid, all trenching necessary for installation of all pipelines as planned and specified. Trenching shall include all clearing and grubbing, including all weeds, briars, small trees, stumps, etc. encountered in the trenching. The CONTRACTOR shall dispose of any such material by burning, burial, or hauling away (or as noted on the drawings), at no extra cost to the OWNER. It shall be the CONTRACTOR'S responsibility to notify the appropriate State and local Air Pollution Control agencies when he conducts open burning of refuse. Ornamental shrubs shall be removed, protected, and replanted. Trenching also includes such items as minor street, road, sidewalk, pipe and small creek crossings; cutting, moving or repairing damage to fences, poles, or gates and other surface structures regardless of whether shown on the plans.

The CONTRACTOR shall protect existing facilities against danger or damage while pipeline is being constructed and backfilled, or from damage due to settlement of this backfill. In case of damage to any existing structures, repair and restoration shall be made at once and backfill shall not be replaced until this is done. In all cases, restoration and repair shall be such that the damaged structures will be in as good condition and serve its purpose as completely as

before and such restoration and repair shall be done without extra cost to the OWNER. The use of trench- digging machinery will be permitted except where its operations will cause damage to trees, buildings or existing structures above or below the ground. At such locations hand methods shall be employed to avoid such damage. All excavated material shall be piled in a manner that will not endanger the work and will avoid obstructing sidewalks and driveways. Gutters shall be kept clear or other satisfactory provisions made for street drainage.

All excavation shall be open trenches, except where the drawings call for tunneling, boring, or jacking under structures, railroads, sidewalks and roads. The construction procedure for these types of excavation is described elsewhere in these specifications.

All trench excavation shall be termed unclassified and costs shall be included in the unit price bid for the pipe.

5.2 Clearing. The CONTRACTOR shall accomplish all clearing and/or grubbing as required for the construction under this contract. Clearing and grubbing shall include the cutting and removal of threes, stumps, brush, roots, logs, fences and other loose or projecting material and natural obstructions which, in the opinion of the ENGINEER, must be removed to properly prosecute the construction and operate the facilities upon completion of construction. Trees, unless designated otherwise on the plans, shall remain and be properly protected. Ornamental shrubs, plantings, fences, walls, etc. shall be removed and replanted or replaced or protected from the construction activity. Clearing and/or grubbing shall be incidental to the various bid items and no additional compensation will be paid for same.

5.3 Trench Depth. Trenches shall be excavated to the line and grade required for the installation of pipe at the elevations indicated on the plans. The minimum depth of cover shall be thirty inches (30") above the top of the pipe, unless shown otherwise on the plans or on the Standard Details. When the pipe is laying in or on solid rock, the minimum depth of cover shall also be thirty inches (30") above the top of the pipe. No additional compensation will be made for extra depth where required by the plans or due to CONTRACTOR error. Excavation, except as required for exploration, shall not begin until the proposed work has been staked out. Materials which are not required for backfill and site grading shall be removed and disposed of as directed by the ENGINEER. Hauling, bedding, and backfilling shall be considered incidental to the various bid items and will not be paid for directly. Excavation shall be of sufficient depth to allow the piping to be laid on the standard pipe bedding in accordance with the Section 6 of this section. The trenches shall be excavated to a minimum of six inches (6") below the bottom of the pipe barrel in rock. In all cases where lines are under traffic a minimum
cover of thirty-six inches (36") shall be provided. Should it be necessary to avoid existing utilities, culverts, outlets, or other structures, the water line shall be carried deeper at no additional expense to the OWNER.

Where the plans call for extra trench depth, this extra depth shall be provided at no extra cost.

5.4 Trench Width. Trench widths shall exceed the minimum width that will provide free working space on each side of the pipe and to permit proper backfilling around the pipe as shown in the accompanying table and unless specifically authorized by the ENGINEER, shall not be excavated to wider than two feet (2') plus the nominal diameter of the pipe at the top of the trench. Before laying the pipe, the trench shall be opened far enough ahead to reveal any obstruction that may necessitate changing the line and grade of the pipe. Should the CONTRACTOR fail to accomplish this, and changes are required, they shall be at his sole expense. In rock, all ledge rocks, boulders and large stones shall be removed to provide six inches (6") of clearance on each side and below all pipe and fittings.

MINIMUM TRENCH WIDTH

Size	Width	Size	Width
Up to 4" Pipe	2'-0"	15" Pipe	2'-8"
6" Pipe	2'-0"	16" Pipe	2'-8"
8" Pipe	2'-0"	18" Pipe	3'-0"
10" Pipe	2'-4"	20" Pipe	3'-2"
12" Pipe	2'-6"	21" Pipe	3'-4"
14" Pipe	2'-6"	24" Pipe	3'-8"

5.5 Shoring, Sheeting, and Bracing of Excavation. Where unstable material is encountered, or where the depth of the excavation in earth exceeds five feet (5'), the sides of the trench or excavation shall be supported by substantial sheeting, bracing, or shoring. The design and installation of all sheeting, sheet piling, bracing or shoring shall be based on computations of pressure exerted by the materials to be retained under retaining conditions. Adequate and proper shoring of all excavations will be the entire responsibility of the CONTRACTOR. The Standards of the Federal Occupational Safety and Health Act and the Kentucky Department of Labor shall be followed.

The ENGINEER will not be responsible for determining requirements for bracing or sheeting.

5.6 Removal of Water. The CONTRACTOR shall provide for adequate removal of all water and the prevention of surface water from entering the excavation. The CONTRACTOR shall maintain dry conditions within the excavations until the backfill is placed. No additional compensation will be paid for replacement and/or stabilization of prepared excavations due to flooding and/or deterioration from extended exposure. All water pumped or drained from the excavation shall be disposed of in a suitable manner without damage to adjacent property or to other work under construction.

5.7 Pavement Removal. Pavement removal shall be as indicated on the plans or directed by the ENGINEER. When so required, or when directed by the ENGINEER, only one-half (1/2) of the street crossings or road crossings shall be excavated before placing temporary bridges over the side excavated, for the convenience of the traveling public. All backfilled ditches shall be maintained in such a manner that they will offer no hazard to the passage of traffic. The convenience of the traveling public and the property OWNERS abutting the improvements shall be taken into consideration. All public or private drives shall be promptly backfilled or bridged at the direction of the ENGINEER. Pavement replacement shall be in accordance with Section 15102 of these specifications. Excavated materials shall be disposed of so as to cause the least interference and in every case the disposition of excavated materials shall be satisfactory to the ENGINEER.

5.8 Traffic Maintenance. The CONTRACTOR must "red light" and guard all open trenches or obstructions placed on the streets or sidewalks. The lights must be burning from sunset to sunrise in order to effectually warn and safeguard the public against dangers connected with open trenches, excavations and other obstructions. The CONTRACTOR shall be held responsible for any damage that may occur to persons or property by reason of the failure of the CONTRACTOR to properly "red light" and guard all open trenches or obstructions along the routes of the water lines. This CONTRACTOR at his own expense shall also maintain warning signs, barricades and a watchmen or flagmen to control traffic at such times as his work would interfere with the flow of traffic. No excavation shall begin that may present a safety hazard unless the signs, barricades, lights, etc. are available to protect the open excavation at the conclusion of the day. The CONTRACTOR will comply with all Federal and State Occupational Safety and Health requirements for this type of construction. The CONTRACTOR shall also comply with all local and Kentucky Department of Highways requirements for signing and traffic control.

5.9 Line Location. The location of pipelines and their appurtenances as shown are those intended for the final construction. However, conditions may present themselves before construction on any line is started that would indicate desirable changes in location. In such cases, the OWNER reserves the right to make reasonable changes in line and structure locations without extra cost, except as may be determined by extra units of materials and construction actually involved. The OWNER is under no obligation to locate pipelines so they can be excavated by machine.

6.0 BEDDING OF PIPELINE

In all cases the foundation for pipe shall be prepared so that the entire load of the backfill on top of the pipe will be carried uniformly on the barrel of the pipe. The bells of the pipe shall not carry any of the load of the backfill. The CONTRACTOR should refer to the Standard Details for pipe bedding shown in the plans. The bedding specifications shall govern the backfill from the bottom of the trench up to the centerline or spring line of the pipe.

6.1 Stable Earth Foundation. On all PVC pipelines, the trench bottoms shall be smooth and free of frozen material, clodded dirt and stones over 1/2" diameter. Bottom dirt left by trenching equipment will usually provide adequate material to level the trench bottom and provide bedding support for the pipe barrel. If the trench bottom is free of dirt, soft material may be shoveled off the side walls or shoveled under the pipe to insure proper pipe barrel bedding. In areas where the trench bottom is hard, a layer of soft backfill must be provided to insure the pipe barrel is properly cushioned. See the plans for proper bedding material depth.

If the foundation is good firm earth the pipe may be laid directly on the undisturbed earth provided the pipe barrel is supported for its full length.

Bedding of No. 9 stone, fine gravel, sand or compacted finely graded select earth shall be used to correct irregularities in the subgrade. Where bell and spigot is involved, bell holes shall be excavated to prevent the bells from being supported on undisturbed earth.

As an alternative to the above method, excavation in earth may be undercut to a depth below the required invert elevation that will permit laying the pipe on a bed of granular material or finely graded select earth to provide continuous support for the pipe barrel. Bedding depth shall be as shown on the plans.

The bedding is not a separate pay item and shall be included as incidental expense in the unit price for the pipe bid per foot of pipe.

6.2 Trenches In Rock. All installation in rock will utilize the undercutting method. Bedding will be with six inches (6") crushed stone as shown in the Standard Details.

6.3 Unstable Trenches. If unstable material is encountered which may not provide a suitable foundation for the pipe, the unstable material will be removed and an adequate layer of encasement concrete or other special bedding shall be placed for the pipe foundation in accordance with the Standard Details in the plans. Such "special pipe foundation" shall only be installed if directed by the ENGINEER in writing or on the plans.

All ductile iron pipe shall be installed in accordance with Standard ANSI/AWWA C150/ANSI A21.50 Laying Condition Type 3 unless otherwise noted.

7.0 PIPE LAYING

7.1 General. Proper instruments, tools and facilities satisfactory to the ENGINEER shall be provided and used by the CONTRACTOR for the safe and convenient prosecution of the work. Each pipe manufacturer shall have an experienced representative on the job for at least one day at the commencement of jointing and laying operations.

Before any length of pipe is placed in the trench, a careful inspection shall be made of the interior of the pipe to see that no foreign material is in the pipe. In order to properly remove any foreign materials, a swab of necessary length is to be available at all times.

All pipe shall be lowered carefully into the trench, properly aligned and properly jointed by use of suitable tools and equipment, in such a manner as to prevent damage to water line materials and protective coatings and linings. Excessive scratching of the exterior surface of the pipe will be cause for rejection of the pipe.

Under no circumstances shall pipeline materials be dropped or dumped into the trench. The pipe and fittings shall also be inspected for the purpose of determining if they are sound and free from cracks. Laying of pipe shall be commenced immediately after excavation is started. Pipe shall be laid with bell ends facing in the direction of laying.

When pipe laying is not in progress, the open ends of pipe shall be closed by approved means to prevent entrance of trench water into the line. Whenever water is excluded from the interior of the pipe, adequate backfill shall be deposited on the pipe to prevent floating. Any pipe which has floated shall be removed from the trench and relayed as directed by the ENGINEER. No pipe shall be laid in water or on frozen trench bottom, or whenever the trench conditions or the weather are unsuitable for such work.

If any defective pipe and fittings shall be discovered after the pipeline is laid, they shall be removed and replaced with a satisfactory pipe or fitting without additional charge to the OWNER. Open ends of unfinished pipe lines shall be securely plugged or closed at the end of each day's work or when the line is left temporarily at any other time.

7.2 Laying Ductile Iron Pipe. Ductile iron pipe shall first be thoroughly cleaned at joints, then joined according to instructions and with tools recommended by the manufacturer. Three (3) copies of instructions shall be furnished the ENGINEER and one (1) copy shall be available at all times at the site of the work. The lining inside ductile iron pipe must not be damaged by handling.

All pipes must be forced and held together, or "homed" at the joints, before sealing or bolting. Pipe must be aligned as each joint is placed, so as to present as nearly true, straight lines and grades as is practical, and all curves and changes in grades must be laid in such a manner that the manufacturer's recommended maximum deflection is not exceeded at any joint.

Cutting of pipe may be done by wheeled pipe cutters or saws, or by hammer and chisel, as the CONTRACTOR may elect, but the CONTRACTOR will be held responsible for breakage or damage caused by careless cutting or handling.

All ductile iron pipe shall be installed with Standard ANSI/AWWA C150/A21.50 Laying Condition Type 3 unless otherwise noted, six (6") inches crushed stone bedding shall be used in rock. Sufficient space (limited to 2 feet longitudinally) shall be left out of 4 or 6 inch cushion for tightening of bolts where bolted joints are used. No pipe shall be laid resting on rock, blocking, or other unyielding objects. Jointing before placing in trench, and subsequent lowering of more than one section jointed together may be allowed, subject to the ENGINEER'S approval and direction.

When using pipe with push-on joints care must be exercised to make certain that the correct gasket is being used for the type of joint installed and that the gasket faces the proper direction. Before inserting the gasket, the groove and bell socket should be carefully cleaned of all dirt. If sand or dirt is permitted to remain in the groove, leaks may occur. Lubricant must be applied to bell socket, gasket and plain- end of pipe as required by manufacturer. Plain-end must be beveled before joint is made. Deflection required at the joint shall be obtained after the joint is made.

Cut pieces of ductile iron pipe 18 inches or more in length, shall be used in fitting to special conditions, and valves and fitting changes in grade and alignment, provided cutting is even enough to make first class joints and no cracks are evident.

7.3 Laying Plastic Pipe. The trench bottom must be smooth and uniform and the alignment must conform with the plans. Bedding and cover as specified herein and shown in the Standard Details is required.

To make a clean and unobstructed joint, it is necessary to wipe the ring, groove and pipe spigot free from all foreign materials at the time of assembly. The ring must be positioned properly in the fitting to receive the pipe by a worker who is not in contact with the lubricant. In general, the lubricant is applied to the spigot (not the ring or groove). However, the manufacturer's instructions are to be followed in all cases. Only an approved lubricant may be used in accordance with the manufacturer's recommendations. All plastic pipe shall be joined by hand.

Where good bedding conditions are attained PVC pipe smaller than 4 inches may be assembled outside the trench in longer sections (as conditions allow) and then lowered into the trench. At any time when improper bedding is discovered or the pipe is severely deflected the pipe will be removed from the trench and the condition corrected. Pipe in sizes 4 inch and above may be assembled outside the trench but must be lowered into the trench as each joint is assembled. Regardless of installation methods all couplings must be inspected after laying in trench for proper insertion and alignment. Field cuts and bevels will be allowed in accordance with the manufacturer's recommendations for these operations. A new reference mark shall be installed before joining any field cut pipe. The same requirements for clearance from rock or other objects,

thrust blocking and deflections shall apply to PVC pipe as for other pipe materials.

PVC pipe of all sizes must be assembled in the trench in strict accordance with the manufacturer's requirements.

7.4 Installation of River Crossing Pipe. The ball joint pipe shall be assembled and installed in accordance with manufacturer's recommendations. Installation shall be made at time of low flow, using cofferdams as necessary to divert stream flow. The ball joint pipe shall be laid and allowed to settle before joining to the pipe on each side of the stream. The ball and joint pipes shall be tested separately once in place to detect any leaks or bad joints. After connecting to the land pipe, it shall be tested the same as specified for the other water mains. See the DRAWINGS for additional installation requirements.

8.0 BACKFILLING

Backfilling must be started as soon as practicable after pipe has been laid and joints hardened sufficiently, and jointing and alignment approved. Spading of crushed rock, sand, or mechanical tamping of earth, around pipe (as specifically required) between joints shall be the usual procedure as the laying progresses. This is in order to avoid danger or misalignment from slides, flooding or other causes. The ENGINEER shall be given a minimum of 24 hours for inspection before backfilling. The backfill shall be crushed rock, sand, or finely divided earth free from debris, organic material and stones, places simultaneously on both sides of pipe to the same level by hand.

In backfilling of the lower part of the trench beginning at the top of the bedding, the backfill material shall be carefully and solidly tamped by hand or approved mechanical methods in 6" layers around the pipe and up to a point 8 inches higher than the top of the pipe. For PVC only the backfill shall be select material and may be walked-in. Walking or working on the completed pipe line, except as necessary in tamping or backfilling, shall not be permitted until the trench has been backfilled to a point one diameter higher than the top of the pipe. The filling of the trench and the tamping of the backfill shall be carried on simultaneously on both sides of the pipe in such a manner that the completed pipe line will not be disturbed and injurious side pressures do not occur.

After the above specified backfill is hand placed, rock may be used in the backfill in pieces no larger than 18 inches in any dimension and to an extent not greater than one-half (1/2) the backfill materials used. If additional earth is required, it must be obtained and placed by the CONTRACTOR. Filling with rock and earth shall proceed simultaneously, in order that all voids between rocks may be filled with earth. Above the hand placed backfill, machine backfilling may be employed without tamping, (if not contrary to specified conditions for the location) provided caution is used in quantity per dump and uniformity of level of backfilling. Backfill material must be uniformly ridged over trench and excess hauled away, with no excavated rock over 1-1/2 inch in diameter or pockets of

crushed rock or gravel in top 6 inches of backfill. Ridged backfill shall be confined to the width of the trench and not allowed to overlap onto firm original earth and its height shall not be in excess of needs for replacement of settlement of backfill. All rock, including crushed rock or gravel from construction, must be removed from yards and fields. Streets, roadways and walks shall be swept to remove all earth and loose rock immediately following backfilling.

In the case of street, highway, railroad, sidewalk and driveway crossings or within any roadway paving or about manholes, valve and meter boxes, the backfill must be machine tamped in not over 4-inch layers, measured loose in accordance with the standard details. Where backfill is under paved driveways, streets, highways, railroads, sidewalks, paved parking areas and other areas where settlement is not allowed, crushed stone or coarse sand backfill only shall be used up to the paving surface. Crushed stone shall be Kentucky Department of Highways Standard Specification No. 78 or finer. Coarse sand backfill shall be spread in layers not over 4 inches thick and thoroughly compacted. Sand may be moistened to aide compaction. Tunnels shall be backfilled in not over 3-inch layers, measured loose, with selected material suitable for mechanically tamping. If material suitable for tamping cannot be obtained, sand, gravel or crushed rock (No. 78) shall be blown, packed or sluiced to complete fill all void spaces.

Where local conditions permit, pavement shall not be placed until 30 days have passed since placing backfill. Crushed stone is specified for roads and parking areas and sidewalks or their bases, shall be placed and compacted to the top of trench. Backfills shall be maintained easily passable to traffic at original ground level, until acceptance of project or replacement of paving or sidewalks.

Where the final surfacing is to be crushed stone, compacted earth backfill may be used in the trench to within 6 inches of the top as shown in the Standard Details.

Railroad Company and Highway Department requirements in regard to backfilling will take precedence over the above general specification where they are involved.

Excavated materials from trenches and tunnels in excess of quantity required for trench backfill shall be disposed as shown on the plans or as directed by the ENGINEER.

The CONTRACTOR shall protect all sewer, gas, electric, telephone, water and drain pipes or conduits, power and telephone poles and guy wires from danger of damage while pipelines are being constructed and backfilled, or from danger due to settlement of his backfill.

In case of damage to any such existing structures, repair and restoration shall be made at once and backfill shall not be replaced until this is done. In all cases, restoration and repair shall be such that the damaged structure will be in as good

condition and serve its purpose as completely as before uncovering and such restoration and repair shall be done without extra charge.

No extra charge shall be made for backfilling of any kind, except as provided in the Bid. Backfilling shall be included as a part of the unit price bid for which it is subsidiary. No extra charge shall be made for supplying outside materials for backfill.

Before completion of contract, all backfills shall be reshaped, holes filled and surplus material hauled away, and all permanent walks, street, driveway and highway paving, and sod, replaced (if such surface replacement items are included in the contract) and reseeding performed.

The line CONTRACTOR shall be responsible for clean-up, grading, seeding, sodding or otherwise restoring all areas that he disturbs within the work limits of other CONTRACTORS on this project.

Any deficiency in the quantity of material for backfilling the trenches or for filling depressions caused by settlement, shall be supplied by the CONTRACTOR.

9.0 TIE-INS TO EXISTING PIPELINES

This work shall consist of connecting new water pipes to the existing system where shown on the plans and shall include the necessary fittings, tapping sleeves, valves and necessary equipment and material required to complete the connection.

Knowledge of pipe sizes in the existing system may not be accurate, therefore, it is recommended that the CONTRACTOR check outside diameters of existing pipe and types of pipe prior to ordering the required accessories. No additional payment will be allowed for matching pipe and/or accessories when the proper size is not ordered.

Neither the OWNER nor the ENGINEER can guarantee the location of the existing lines. The CONTRACTOR shall verify the location of all existing water mains and valves pertaining to the proposed improvements before excavation is started.

The necessary regulation or operation of the valves on existing mains, to allow for the connections being made, shall be supervised by the ENGINEER. Before shutting down an existing water main or branch main for a proposed connection, prior approval for a specific time and time interval shall be obtained from a representative of the OWNER. At no time shall an existing main be shut down without the OWNER'S knowledge and permission.

Excavation to existing water mains shall be carefully made, care being exercised not to damage the pipe. The excavation shall not be of excessive size or depth

beneath the pipe. The sides of the excavation shall be as nearly vertical as possible.

The CONTRACTOR shall be responsible for any damage to the existing system and any such damage shall be repaired to the satisfaction of the ENGINEER at the CONTRACTOR'S expense.

The CONTRACTOR shall verify, by field inspection, the necessary sizes, lengths and the types of fittings needed for each inter-connection. Typical connections are shown on the plans and any modifications or changes shall be subject to the approval of the ENGINEER. The exact length of the proposed water main needed for this work shall also be determined by field measurement as required.

The probing required to locate existing mains is not a separate pay item.

10.0 PIPE ENTERING STRUCTURES

Ductile iron, steel or PVC pressure pipe, 4-inch diameter or larger, entering structure below original earth level, unsupported by original earth for a distance of more than six (6') feet, shall be supported by Class B Concrete, where depth of such support does not exceed three (3') feet, and by Class B Concrete piers where depth exceeds three (3') feet in accordance with the Standard Details. All other pressure pipe entering buildings or basins below original earth level, which have more than 3 feet span between wall and original earth and having a cover of more than 24 inches of earth, or under roadway, shall be supported as shown on Standard Detail drawings, in order to prevent breakage from settlement of backfill about the structure. Concrete and reinforcing steel for such supports are to be included in the unit price of work to which it is subsidiary, and not as extra concrete, in order to discourage excessive excavation outside the limits of structures. Pipe entering structures shall have flexible joint within 16 inches of exterior of structure.

11.0 OWNERSHIP OF OLD MATERIALS

Pipe - Unless otherwise indicated, all existing pipe that is to be abandoned that interferes with construction or is easily removed shall become the property of the CONTRACTOR. All pipe that is not easily removed or not required to be removed as a result of the new construction, shall be abandoned in place by this CONTRACTOR.

Pipe Line Fittings and Appurtenances - All pipe line fittings, valves, hydrants and other like appurtenances that are removed as a result of new construction shall be removed by this CONTRACTOR but shall become the property of the OWNER. All such fittings and appurtenances shall be delivered to a point by the CONTRACTOR. Said point shall be on the OWNER'S property and shall be designated by the ENGINEER.

Other Materials - All other materials or items that are to be removed, demolished, or abandoned as a part of this contract shall become the property of the CONTRACTOR and shall be disposed of by him.

12.0 THRUST BLOCKS AND ANCHORAGE

Thrust blocks shall be installed whenever the pipe line changes direction, as at tees, bends, crosses, stops, as at a dead end; or at valves. The locations of thrust blocks depend on the direction of thrust and type of fitting. Their size and type depends on pressure, pipe size, kind of soil, and the type of fitting. Where thrusts act upward (as at vertical curves) the weight of the pipe, the water in the pipe and the weight of the soil over the pipe should be determined to make certain that the total weight is sufficient to resist upward movement. If there is not enough soil or if it will not compact over the pipe or it is too soft and mushy to resist movement, then ballast or concrete may be placed around the pipe in sufficient weight and volume to counteract the thrust. Where a fitting is used to make a vertical bend, the fitting may be anchored to a concrete thrust block designed to key in to undisturbed soil and to have enough weight to resist upward and outward thrust, since the newplaced backfill may not have sufficient holding power.

Thrust blocks shall be constructed of not less than Class B concrete conforming to KTC Specification 601 and placed between the fitting and the trench wall. It is important to place the concrete so it extends to undisturbed (freshly cut) trench wall.

13.0 MAINTENANCE OF FLOW OF DRAINS AND SEWERS

Adequate provision shall be made for the flow of sewers, drains and water courses encountered during construction. Any structures which are disturbed shall be satisfactorily restored by the CONTRACTOR.

14.0 INTERRUPTION OF UTILITY SERVICES

No valve, switch or other control on any existing utility system shall be operated for any purpose by the CONTRACTOR without approval of the ENGINEER and the Utility. All consumers affected by such operations shall be notified by the CONTRACTOR as directed by the ENGINEER and utility before the operation and advised of the probable time when service will be restored.

15.0 FENCING

Where water supply line is being constructed in fields where stock is being grazed, CONTRACTOR shall provide temporary fence as approved by the ENGINEER around open trenches to prevent stock from falling in trenches. Where trenching operations should isolate grazing stock from their source of water, CONTRACTOR will either provide temporary bridging over trench or else provide water for such stock.

Where trench crosses near sound existing corner posts and existing fence is in good condition, fence may be taken loose, rolled back and stored until pipe line is completed at this point, then replaced by stretching tightly and thoroughly stapling. Additional posts will be provided and additional new fence shall be provided when it is necessary to place the fence crossed by the water line in a condition equal to existing fence before water line was constructed.

Where it is necessary to cut existing fence, new end posts shall be installed on each side of the water line and the old fence thoroughly stapled to these new posts before cutting. After pipe line is completed at this point, a new fence of galvanized wire (No. 9 gauge with No. 11 filler wires) shall be stretched between these new end posts and thoroughly stapled to existing posts and any new intermediate posts necessary to provide a good fence. Replacement of fences shall be on a replacement in-kind basis, and shall be considered incidental to laying of the lines and any additional cost shall be included in the unit price bid per lineal foot of pipe. Contractor shall notify property owner prior to cutting fence.

16.0 PROTECTION OF ADJACENT LANDSCAPE

Reasonable care shall be taken during construction of the water lines to avoid damage to vegetation. Ornamental shrubbery and tree branches shall be temporarily tied back, where appropriate, to minimize damage. Trees which receive damage to branches shall be trimmed of those branches to improve the appearance of the tree. Tree trunks receiving damage from equipment shall be treated with a tree dressing.
In the course of construction, the CONTRACTOR may deflect horizontal alignment of the water line to avoid trees and to keep from damaging their roots. The CONTRACTOR shall be fully responsible for settling all claims by private property owners concerning damage to trees and shrubs.

17.0 COORDINATION WITH UTILITIES

The Plans show the general location of existing utilities, such information having been determined from the utilities. However, such information shall be considered general and is not guaranteed by OWNER, ENGINEER or the UTILITY.

Prior to construction, the CONTRACTOR shall arrange to meet with representatives of all utilities, and provide them with his anticipated work schedule. The CONTRACTOR shall have the utilities make their best determination of utility locations in the areas in which he is working. Throughout the progress of the work, such field markings of utilities shall be kept current.

Repairs to any utilities damaged by the CONTRACTOR shall normally be performed by the utility at the CONTRACTOR'S expense, unless the CONTRACTOR and the utility negotiate other understandings and/or procedures.

18.0 BLASTING AND ROCK EXCAVATION

The CONTRACTOR shall make his own investigation as he deems necessary to ascertain the sub-surface conditions to be encountered in the work.

All blasting operations shall be conducted in accordance with municipal ordinances, state and federal laws and Section 9, Explosives, of the "Manual of Accident Prevention in Construction", published by the Associated General Contractors of America, Inc. Soil particle velocity shall not exceed limit set by Kentucky law. All explosives shall be stored in conformity with said ordinances, laws and safety regulations. No blasting shall be done within five feet of any water mains, sewer lines, natural or manufactured gas lines, liquid petroleum product lines or other utilities. Any damage done by blasting is the responsibility of the CONTRACTOR and shall be promptly and satisfactorily repaired by him.

The CONTRACTOR shall use delay caps or other approved methods to reduce earth vibrations and noise. Mud capping, as defined in the above manual, will not be permitted as a method of breaking boulders. No blasting shall be permitted on Sundays or after dark.

Prior to commencing with the work, the CONTRACTOR shall, during a preconstruction conference with the OWNER and ENGINEER, state clearly his approach to performing the excavations on the project. He shall be familiar with the laws and ordinances covering blasting and shall also give consideration to the use of hydraulically operated rock breaking devices in lieu of blasting where considered necessary. If blasting is not handled in an expert manner at all times, the ENGINEER reserves the right to suspend blasting and require the work to proceed without it.

Prior to blasting, the CONTRACTOR shall make his own detailed preblast survey of adjacent walks, curbs, retaining walls, house foundations, etc. to determine conditions prior to the work. Such a file of information, including photographs, may be certified in such a manner as the CONTRACTOR believes necessary since this information that may stand in his defense.

19.0 MEASUREMENT AND PAYMENT

Payment for supplying, transporting and storing pipe, trenching, standard bedding, pipe installation, fittings, thrust- blocking, pipe locating wire or tape, testing, backfilling, disinfection, seeding, crop damage, regular stream crossings, clean-up, tie-ins to other structures and other incidental items in this section shall be made on the basis of the unit price per lineal foot for the type and size of pipe installed. Payment will include all those items not specifically covered by another proposal. Pipe will be measured along the centerline of the pipe as installed with no deduction for valves and fittings.

SECTION 15101

INSTALLATION OF WATERLINE ACCESSORIES

1. GENERAL

The CONTRACTOR is to supply and install all valves, hydrants, blow offs and other equipment at the locations shown on the plans in complete accordance with these specifications.

2. GATE VALVES

All underground gate valves shall be the resilient seat-type, iron body, non-rising steam, fully bronze mounted, tar-coated outside and suitable for working water pressures of not less than 200 PSIG unless a higher pressure class is specified on the Drawings. Valves shall be of standard manufacture and of the highest quality both of materials and workmanship and shall conform to the latest revision of AWWA Specification C-509. Valves shall be furnished with flanged (exposed piping) or mechanical joint (buried piping) end connections suitable for connection to the pipe with which they are to be used. Gate valves shall have a clear water way equal to the nominal diameter, and shall be opened by turning to the left. The operating nut or wheel shall have an arrow cast in the middle, indicating the direction of opening. Each valve shall have the maker's initials, pressure rating and the year in which manufactured; cast on the body. Prior to shipment from the factory each valve shall be tested by hydraulic pressure of at least 300 pounds per square inch.

Underground valves shall be nut operated, unless otherwise shown on the plans. Valve supplier shall furnish two standard stem iron wrenches for turning nut operated valves. All underground valves which have nuts deeper than 30 inches below the top of valve box shall have extended stems with nuts located within 2 feet of valve box cap.

The valve maker is to supply the ENGINEER, through the bidder, within one week after award is made, completes catalogs or other material giving complete details and dimensions of valves and accessories. The ENGINEER's approval shall be received by manufacturer prior to shipment of materials.

Gate valves installed in underground piping systems may be installed in the vertical position for sizes to 12-inch. Gate valves 14-inch and larger shall be installed in the horizontal position with bevel gear operators unless otherwise noted on the drawings. Gear operators shall be the totally enclosed type, oil filled and designed for buried and submerged service. Gear housing shall be ductile iron. Gears shall be steel. Pinion shafts shall be stainless steel. Shaft bearings shall be Teflon with "O"-Ring bearings.

Pressure ratings for 18-inch through 36-inch shall be 150 psi unless otherwise specified on the drawings.

Gate valves shall be Mueller, Kennedy or equal.

3. BUTTERFLY VALVES

All butterfly valves shall be of tight closing, rubber or synthetic rubber seat type with seats securely fastened to valve body. No metal-to-metal seating surfaces will be permitted. Valves shall be bubble tight at the rated pressure in either direction and shall be satisfactory for applications involving throttling service and/or frequent operation and for applications involving valve operation after long periods of inactivity.

Valves shall be Class 350 suitable for working water pressure of 350 psi unless otherwise specified or noted on the plans.

Cast Markings: valve size, manufacturer's name, class, direction of opening, and year of casting.

The valve discs shall rotate 90^{o} from the full open position to the tight shut position.

The valve discs shall be cast/ductile iron with a welded nickel edge free of ribbing or protrusions which may collect solids. The disc-to-shaft connections shall be via polished 316 SS pins. Sprayed or plated discs are not acceptable. All disc seating edges shall be smooth and polished.

The shafts shall be turned, ground and polished. They shall be 300 Series or 400 Series Stainless Steel with diameters per AWWA Spec. C504-70, Class 75B. The shafts shall be of one-piece construction.

The shaft seals shall be of Hycar or Hypalon and shall be provided to prevent leakage into the bearing chest areas.

The valve bearings shall be Teflon coated, self-lubricating, stainless steel design and construction.

The valve seats shall be Neoprene or Hypalon and shall be simultaneously molded, vulcanized and bonded to the valve body or a rigid reinforcing ring.

3.1 OPERATORS

The valve operating mechanisms shall be for counterclockwise opening. There shall be no external moving parts on valve or operator except the operator input shaft. Input shaft is to be operated by a 2-inch square operating nut. Maximum

required input force on the operator shaft to open and close the valve shall be 40 pounds. The total number of turns applied to the operating nut required to completely open the valve from a completely closed position shall be not less than twice the nominal valve diameter. An extension stem shall be furnished if required to bring the operating nut within 3 1/2 feet of finished grade. Extension stems shall be securely fastened to the valve stem. A stainless steel collar, 6-inches high, shall be welded to the operating gear box housing centered on the operating nut to hold the valve box in place and seal it against dirt. The diameter of the collar shall be such that it will accept the valve box.

The valves shall be manufactured by M & H, Dresser, Dezurik or approved equal.

4. AIR VALVES

4.1 AIR RELEASE VALVES

A valve designed to allow exhaust of small pockets of air from the water main while in use shall be installed where shown on the plans or where directed by the ENGINEER. The air release valve shall have an iron pipe thread inlet in sizes shown in the valve schedule, cast iron body construction, bronze trim, with all internal parts of stainless steel or bronze. The valve shall have an orifice size as shown in the valve schedule. Valves shall be suitable for a working water pressure of 300 PSIG. The air release valve shall be mounted on Schedule 80, galvanized steel riser pipe. The riser pipe shall be connected to the water main by use of a service clamp and a corporation stop as shown in the standard details. The riser shall also have a bronze gate valve with a tee-handle, solid wedge type, inside I.P. threads, suitable for a 300 PSIG working water pressure. Equipment shall be as manufactured by Val-Matic or approved equal.

4.2 COMBINATION AIR VALVES (CAV)

Combination air release valves (single body, double orifice) shall be designed to allow large volumes of air to escape out the large air vacuum orifice when filling a pipeline and to close water tight when the liquid enters the valve. During large orifice closure, the small air release orifice shall open to allow small pockets of air to escape automatically and independently of the large orifice. The large air vacuum orifice shall also allow large volumes of air to enter through the orifice during pipeline drainage to break the vacuum. The body inlet must be baffled to protect the lower float from direct contact of the rushing air and water to prevent premature valve shut off. The top float must be protected in similar manner for the same purpose. The Buna-N seat must be fastened to the valve cover without distortion for drop tight shut off. All floats shall be heavy stainless steel, hermetically sealed; designed to withstand 1000 psi or more. The upper float shall be center guided for positive shut off. Valve

exterior to be painted red lead TT86B Type IV for high resistance to corrosion. Materials certified to ASTM specifications as follows:

Body & Cover & Baffle - Cast Iron
Stainless Steel Float
Buna-N Seat & Needle
Plug & Bronze Forging
Delrin Level Frame
ASTM A48 Class 30
ASTM A240
Nitrile Rubber ASTM SB 800
ASTM D638

Combination air release valves shall be as shown in the valve schedule manufactured by APCO or equal. The valve shall be built for 300 psi service.

4.3 CUSTOM COMBINATION AIR VALVES (CCAV)

Custom combination air valves (double body, double orifice) allow large volumes of air to escape out the large orifice when filling a pipeline, then close when liquid enters the valve. The small orifice Air Release Valve shall be an independent valve body, side connected to the large orifice Air and Vacuum Valve body with piping, and a 1" brass gate valve for isolation. While the large orifice is closed, the small air release orifice will open to allow small pockets of air to escape automatically and independently of the large orifice. The small orifice air release valve shall be an independently operated compound lever mechanism of cast stainless steel or bronze.

The large air and vacuum orifice shall also open and allow large volumes of air to enter the pipeline during pipeline drainage to break the vacuum. The large orifice float must be surrounded by a baffle for protection against direct forces of rushing air and water to prevent premature valve shutoff. The baffle must be a heavy integral cast part of the main valve body, not a loose piece.

The Buna-N seat shall be compression molded, a minimum 1/2" thick and fastened to the valve cover with shoulder screws to lock the seat in place without distortion, for drop tight shutoff. Both floats shall be heavy stainless steel, hermetically sealed. The large orifice float shall have a one piece rod to center guide it through stainless steel bushings into shut-off against seat.

The custom combination air valve shall be rated 300 psi. The small orifice shall operate (open) up to 150 psi.

All materials of construction shall be certified in writing to conform to ASTM specifications as follows:

Body & Cover	Cast Iron	ASTM A48, Class 30
Floats	Stainless Steel	ASTM A240
Needle & seat	Buna-N	ASTM A296 T316
Leverage Mechanism	Stainless Steel	FDA Approved for Potable Water
Exterior paint	Phenolic Primer Red Oxide	Contact

Valve to be APCO Series 1800 custom combination air valve, as manufactured by Valve and Primer Corporation, or equal.

5. VALVE BOXES

All valves (gate, air release, check, etc.) installed underground shall be installed in an approved valve box. Each gate valve shall be installed in a vertical position with a valve box. Valve boxes shall be of a cast iron, two or three-piece, slip-type consisting of a base, a center section and a top section with a cover marked "water". Where valve box is constructed in a paved area the box shall be a screw type box. The entire assembly shall be adjustable for elevation and shall be set vertically and be properly adjusted so that the cover will be in the same plane as the finished street surface (no more than 1/2" above ground in yards or pastures or 2" in unsodded areas). The assembly must provide for the required cover over the pipe at the installation site and shall rest on concrete pads as shown in the Standard Details. The CONTRACTOR shall furnish 2 valve wrenches for the project.

6. BLOW-OFF VALVES

Blow-off valves shall be installed in accordance with the details and the specifications at locations shown on the plans and in other locations as directed by the ENGINEER. In some instances fire hydrants serve as blow-off valves. In general, blow-off valves are located at the end of mains for the purpose of clearing the main of sediment, obstacles or impure water. The CONTRACTOR should refer to the Standard Details for blow-off installation.

The blow off pipe from the main to the flush valve shall be connected to the main by means of a tee. Do not use a corporation stop for this connection. The gate valve for the blow-off connection shall be a double disc gate valve in conformance with AWWA C500 for sizes under 4" and resilient seat gate valves in conformance with AWWA C509 for sizes 4" and larger. All pipe shall be galvanized pipe, Schedule 80, with Class 300 malleable iron fittings. CONTRACTOR shall install a length of hose in each valve box as shown in the Standard Details. The valve enclosure shall be a Mueller Meter Box or equal with appropriate risers. The cover shall be of cast iron construction, 4 inches

deep with a non-recessed lid, with cast letter "WATER" and a pentagon lock nut.

7. TAPPING SLEEVE AND VALVE

A Mueller H-615 MJ ductile iron tapping sleeve or equal shall be used for making wet taps and shall be rated for a minimum working water pressure of 200 psi unless otherwise specified on the Drawings. CONTRACTOR shall ascertain the type and size of pipe to which the connection is to be made prior to selection. The associated valve shall be an MJ resilient seat gate valve equal to Mueller or Kennedy.

8. MEASUREMENT AND PAYMENT

Payment for gate/butterfly valves, check valves and other special valves installed underground shall include all work necessary for a complete installation and shall include all valve stem boxes or other valve boxes and box covers. Payment will be made at the unit price bid for the type and size of valve installation.

Blow offs and air release valves will be paid for under their respective bid price and is to include box and six (6) feet of pipe for blow-offs only. Excess pipe will be paid under bid price for pipe installed.

SECTION 15102

SPECIAL ITEMS OF CONSTRUCTION IN WATERLINE INSTALLATION

1. GENERAL

These specifications govern special crossings, installations and construction procedures required to deal with unusual construction items or special requirements of governing agencies.

2. STATE HIGHWAY CROSSINGS

In all cases, these crossings will be made in compliance with the requirements of the State Highway Department. Such requirements will normally be described by the appropriate District Highway Office. In general, unless otherwise shown on the plans or directed otherwise by the ENGINEER, the crossing of all State Highways shall be accomplished by boring under the roadway. In addition, the crossing of service lines 1-1/2 inches and greater under rigid and flexible surfaced paved roads shall be accomplished by boring and jacking a casing pipe under said roadway. In certain cases, as shown on the plans, service lines of all sizes will require casing pipe installed with the crossing.

2.1 Materials. In general, the diameter, thickness, style, joints and materials selected for casing pipe shall be as shown on the plans and shall be considered as "minimum" requirements, all subject to prior approval of the ENGINEER. In all cases, the approval for construction by agreement with the private company and/or construction permit issued by the State, County, or Municipal agency will be required before construction starts.

Steel casing pipe for road and railroad crossings using the boring and jacking method shall be steel, plain end, uncoated and unwrapped, and shall be furnished in at least 18-foot lengths. Steel pipe shall meet the requirements of ASTM Specification A-120 and AWWA C200. Pipes up to and including 4 inches in diameter shall be Schedule 40. Pipe larger than 4 inches shall have a wall thickness equal to or greater than 0.312 inches under railroads and 0.250 for all other uses or as specifically stipulated on the plans. The inside diameter of all casing pipes shall be a minimum of four (4") inches greater than the largest outside diameter of the carrier pipe, joint or coupling.

The steel casing pipe shall be bored and/or jacked in place at the locations as shown on the plans or as directed by the ENGINEER. All joints between lengths shall be solidly welded with a smooth non-obstructing joint inside. Any field welding shall be performed by a certified welder and shall be in accordance with AWWA C206. The casing pipe may be extended beyond the boring limits by

open trenching as shown in the Standard Details. This would apply when the casing is required from right-of-way to right-of-way or ditch line to ditch line. Open trenching at jacked or bored locations will be allowed no closer than 3 feet from edge of pavement.

Positioning guides (insulators) shall be utilized on all carrier pipe which is within the casing pipe. Positioning shall be accomplished by the use of prebuilt spacers such as those manufactured by CALPICO or an approved equal. The CONTRACTOR shall submit the type of position guide proposed for use for the approval of the ENGINEER. Spacing of the positioning guides shall be in accordance with the Standard Drawings.

The ends of the casing pipe shall be plugged and made watertight in a manner acceptable to the ENGINEER prior to backfilling. Casing seals as manufactured by Pipeline Seal & Insulator, Inc. (PSI), Advance Products & Systems, Inc. (APS) or equal shall be used.

Where road crossings are made using plastic pipe or copper, the location of joints under the roadway should be avoided by using lengths of adequate dimension for the crossing. This principle also applies to other types of pipe where sufficiently long lengths are available.

2.2 Boring and Jacking. The work is herein defined as the operations in which both the boring by auger and the jacking of the casing pipe are done mechanically and in which the diameter of the casing pipe is too small to permit hand working at the heading of the casing pipe. Two basic methods are; (1) pushing the casing pipe into the fill or earth simultaneously as the boring auger drills out the ground; and (2) drilling the hole through the fill or earth and pushing the casing or carrying pipe into the hole after the drill auger has completed the bore.

A suitable approach trench shall be opened adjacent to the slope of the embankment, or adjacent to point of bored and jacked section as shown on the plans. The approach trench shall be long enough to accommodate the selected working room. Guide timbers or rails for keeping the casing pipe on line and grade shall be accurately set and maintained in the bottom of the approach trench and with heavy timber back-stop supports installed at the rear of the approach trench to adequately take thrust of the jacks without any movement or distortion. It is paramount to the securing of acceptable tolerance limits of workmanship in the boring and jacking operation that extreme care be taken in the setting of all guides, rails and jacks to the end that the casing pipe in final position be within the limits of acceptability for the placing and laying of the carrier pipe. The minimum cover of 36 inches under the roadway must be maintained. Additional depth may be required as shown on the plans.

2.3 Open Trench Crossings. The trench shall be excavated to a minimum width that will allow the pipe installation. The trench walls shall be kept as nearly vertical as possible. The minimum specified cover above the pipe shall be maintained. The Standard Details section shows the requirements for open trench crossings.

The backfill in the trench under any roads, driveways, or parking areas where the open trench method is used shall be of the type shown in the Standard Details and shall be deposited and compacted in uniform layers not to exceed the depth shown in the Standard Details.

The surface of the road, driveway, or parking area shall be replaced with the same type of material as specified under pavement replacement.

3. RAILROAD CROSSINGS

At all railroad crossings, cover pipe (casing) for water lines (carrier pipe) shall be jacked or pushed beneath tracks and the carrier pipe jointed and pushed through the cover pipe. Detailed drawings of railroad crossings including the length of casing and depth below track are shown in the plans. CONTRACTOR shall obtain and pay for services of a representative of the railroad to direct the CONTRACTOR's operations while on the railroad property when required by the railroad.

4. STREAM CROSSINGS

4.1 No-Flow Condition. Where required on the plans or instructed by the ENGINEER, the CONTRACTOR shall construct a special creek crossing as shown in the Miscellaneous Drawings. Crossings shall be scheduled for construction in times of no flow or very low flow, if practicable, otherwise the stream shall be directional bored. Concrete shall not be placed under water and CONTRACTOR shall provide suitable pumps to keep water out of trench excavation during stream crossing construction. Special creek crossings shall be designated as Type A or Type B as contained in the Standard Drawings.

4.2 Normal Earthen Stream Crossing. Where the stream crossing is made in earth or other beds which are stable (no casing or anchorage required), then the pipe will be laid in a narrow trench at the depth specified in the Standard Details to maintain the required cover between pipe and stream bed. Initial backfill will be mechanically compacted. Trench backfill in any stream crossing area from one (1) foot above the top of the pipe shall consist of trench excavated rock, if available. No extra payment will be made above normal construction for this type of creek crossing.

4.3 Blue Line Stream Crossings. All crossing of streams that appear as a blue line on a USGS 7.5 minute topographical map shall be accomplished in accordance with:

GENERAL CERTIFICATION
NATIONWIDE PERMIT #12
UTILITY LINE BACKFILL AND BEDDING

This document is bound in front of the specifications. The Contractor shall read, understand and comply with the requirements and procedures.

Stream size, for purposes of this specification, is differentiated as large or small. A stream is classified as small when the distance across the stream channel at top of banks is 15 L.F. or less. A stream is classified as large when this measurement is greater than 15 L.F.

It is the intent of the plans to identify a stream crossing at each blue line stream. Small stream crossings may frequently be accomplished by trenching when the stream is in a no-flow condition. If the stream is in a flow condition, irregardless of the size classification, the crossing shall be accomplished by directional boring or other method that complies with the General Certification and is approved by the Engineer. Specific details for stream crossings are contained in the Miscellaneous Drawings.

See Section 14 for Basis of Payment.

5. RIVER OR LAKE CROSSINGS

Crossings in rivers or lakes where the pipe cannot be laid in a trench shall normally be made with ductile iron pipe having ball and socket joints or polyethylene pipe or directional bored as indicated on the DRAWINGS. Details for any required installations of this type including pipe required; number, size and location of anchors; and, installation technique are shown in the plans and Miscellaneous Drawings. See Section 15100 for installation requirements.

6. BRIDGE CROSSINGS

Wherever possible bridges will not be utilized for stream crossings. However, where it is necessary for the water line to be attached to bridges, the pipe shall be securely fastened to bridge stringers or beams using supports as dimensioned and located in the plans. The carrier pipe shall be insulated with Vermiculite or other approved material to prevent freezing. Expansion joints to allow for movement of the bridge will be required as shown on the plans.

7. WATER LINE AND SEWER LINE SEPARATION

7.1 General. Wherever sewer lines cross, or are adjacent to, each other, special precautions shall be taken.

7.2 Parallel Water and Sewer Lines. Water lines must, if possible, be located a minimum lateral distance of 10 feet from any existing or future sewer lines measured from outside diameters. Where water lines and sewer lines must be placed in the same trench, the water line must be located on a shelf, 2 feet above and 2 feet to the side of the sewer line. Whenever this condition cannot be met, and upon direction from the ENGINEER, the water line shall be uncovered and encased with concrete per the standard encasement detail.

7.3 Crossing Water and Sewer Lines. Wherever sewer lines and water lines cross, it is desirable, if practical, that the sewer line be at least 24 inches below the water line.

Where it is not practical to provide such a separation, care shall be taken to ascertain that the existing water line or existing sewer line is in good sound condition and that no evidence of joint leakage is known in that vicinity. If any such evidence does exist, the existing line shall be exposed by the CONTRACTOR at least 10 feet each side of the new pipe crossing, carefully examined and any defects positively corrected. The OWNER will arrange for examining and correcting any defects in the existing lines, but the CONTRACTOR shall cooperate in every way possible.

When the water line must be below or less than 2 feet above the sewer line, the CONTRACTOR shall encase the water line 10 feet in each direction from the crossing as directed by the ENGINEER. This encasement should only be accomplished when directed by the ENGINEER and shall be accomplished in accordance with the details shown on the drawings. The encasement is a separate pay item.

8. CLEANUP, SEEDING AND SODDING

8.1 General. Upon completion of the installation of the work, the CONTRACTOR shall remove all debris and surplus construction materials resulting from the work. The CONTRACTOR shall fine grade all the disturbed surfaces around the area of the work in a uniform and neat manner leaving the construction area in a condition as near as possible to the original ground line or to the lines as directed by the ENGINEER. The Contractor shall provide effective cleanup of the work as it progresses. Procrastination of cleanup will not be to berated.

8.2 Rough Grade Work and Cleanup. Rough Grade Work and Cleanup (Rough Cleanup) shall be defined to include the final backfill and windrowing of

the ditch line, disposal of excess excavated material, level grading of the disturbed areas adjacent to the ditch line, filling and leveling street and driveway cuts, cleaning up and removal of rubbish, repair of fences and structures, and any other such work that may be required to result in a neat, orderly project area. Rough Cleanup shall be performed as other construction progresses and must be completed within **one week** of the adjacent pipeline construction.

Rough Cleanup is not a separate pay item. The cost for this work shall be included in the unit bid price for water lines. If Rough Cleanup is not performed as specified, the OWNER, after notification to the CONTRACTOR, will refuse payment for additional pipeline installation until the Rough Cleanup is accomplished.

8.3 Final Cleanup. Final cleanup, grade work and seeding shall be performed on each line when backfilled trenches have had adequate time to settle, but at least within **30 days** from the date each line is constructed. Final grade work and seeding on Kentucky Transportation Cabinet rights-of-way shall be done in accordance with said Cabinet specifications and the permit granted to the OWNER specifically for this project.

Where work was performed on private property in lawns, earth of good quality, free from rock shall be spread over the disturbed area and graded and compacted to match adjacent ground contours. The graded and seed bed area shall be prepared with a power landscape rake and further hand raked if necessary, until smooth and free from rock, potholes, and bumps. The disturbed area shall then be seeded with the seed variety used on the original lawn (e.g., a bluegrass lawn shall be reseeded with bluegrass seed). In the case of no preference by the OWNER, the mixture of grasses shall consist of one-third (1/3) Rye grass, one-third (1/3) Kentucky Fescue and one-third (1/3) Kentucky Bluegrass by weight and shall be applied in accordance with the supplier's recommendations. The area shall be fertilized with 12-12-12 fertilizer applied at a rate of 6 pounds per 1,000 square feet of area. After the seed and fertilizer have been applied, the CONTRACTOR shall then lightly cover the seed by use of a drag or other approved device. The seeded area shall then be covered with clean straw to a depth of approximately one inch (1").

Where work was performed on private property and not in lawns the trench line shall be graded and filled if necessary to match adjacent contours. All rock larger than 1-1/2" in diameter shall be removed from the disturbed area. In general, pasture and fallow land shall be fertilized and seeded with Kentucky 31 Fescue and plowed fields shall be left unseeded, however, the desire of each property owner shall govern regarding seeding. The entire pipeline length that is seeded shall be strawed.

In all cases on private property the rate of seed and fertilizer application shall be that recommended by the material supplier or the University of Kentucky

Cooperative Extension Service for new plantings of the variety of grass seed used.

If the trench line settles following final grade work or if grass seed fails to germinate within a reasonable time, the CONTRACTOR shall regrade or reseed the area in question as specified above and as directed by the ENGINEER.

Final cleanup is a separate pay item.

9. PAVEMENT AND OTHER STRUCTURE REPLACEMENT

The CONTRACTOR shall replace all pavement cut or disturbed, with pavement similar in all respects to existing pavement in accordance with the Standard Details and at those locations approved by the ENGINEER. Every effort shall be made to avoid cutting the pavement. In restoring pavement, new pavement is required, except that granite paving blocks, sound brick or sound asphalt paving blocks may be reused. No permanent paving shall be placed within thirty (30) days after the backfilling has been completed. All concrete and asphalt paving materials shall be in conformance with the Standard Details shown in the plans. The pipeline trench through all paved areas (parking lots, driveways, roads, etc.) shall be fully backfilled with crushed stone.

9.1 Classification of Pavements

A. Concrete Pavement Replacement - This pavement replacement shall be Portland cement concrete construction in accordance with the requirements shown in the Standard Details. It shall include all pavement replacement on concrete surfaced roads, concrete driveways, concrete sidewalks and concrete parking areas, both public and private.

B. Heavy-Duty Bituminous Pavement Replacement - This type of asphalt pavement replacement shall be bituminous concrete surface over concrete base in accordance with the details. This type of pavement replacement shall be used on all heavily trafficked roads having an existing pavement greater than 2", whether public or private, or in other locations as directed by the ENGINEER.

C. Light-Duty Bituminous Pavement Replacement - This type of pavement replacement shall be bituminous concrete constructed in accordance with the details. This item shall include all light-duty bituminous concrete roadways, bituminous driveways and bituminous parking lots, both public and private.

D. Crushed Stone Surface Replacement - This type of surface replacement shall include all graveled roadways, driveways, parking areas, or other gravel surfaced areas, both private and public. This type of surfacing may also be required as a base course for other pavement replacement.

9.2 Materials. The crushed stone backfill as noted on the drawings shall be dense graded aggregate per Kentucky Department of Highways Specifications or as noted on the Drawings. The CONTRACTOR shall continuously be responsible for the maintenance of the aggregate and the surface of the trenches until the pavement replacement is completed.

Portland cement concrete for pavement replacement shall contain a minimum of 6 sacks of cement per cubic yard, the maximum free water content shall be 6 gallons per sack of cement, the slump shall be between 2 and 4 inches, and the concrete shall have minimum 28-day compression strength of at least 3,500 PSI. Cement, aggregate and water shall be described in these specifications for Class "A" concrete. A set of cylinders shall be made and tested for each 25 cubic yards of concrete placed, or fraction thereof, to supply representative sampling and testing of the concrete, upon the direction of the ENGINEER. The CONTRACTOR shall produce a broomed, or burlaped uniformly smooth and nonskid surface, consistent with the existing pavement.

Bituminous materials and mixes shall be consistent with the recommended practice of the asphalt institute and it shall conform to the requirements of the Kentucky Department of Highways for prime coat and Class 1 bituminous concrete. The bituminous concrete shall consist of a binder or base course and a surface course.

9.3 Installation of Pavement Replacement. The CONTRACTOR shall cut back the surfacing adjacent to the trench for 12 inches on both sides of the trench and shall cut down the dense graded aggregate he has placed to a depth required for either type of pavement replacement. The resulting surface shall be rolled to yield a smooth, dense surface and a uniform depth.

The concrete shall be placed in accordance with standard practice, with the welded wire mesh if required in proper position and thoroughly vibrated into place. The CONTRACTOR shall produce a surface consistent with the existing pavement. The CONTRACTOR shall apply a liquid curing component, sprayed on the surface of the concrete, and shall provide adequate protection to the pavement until it has set.

For bituminous concrete, the CONTRACTOR shall clean and broom the prepared surface, then apply the prime coat at the rate of 0.20 to 0.25 gallons per square yard, with a pressure distributor or approved pressure spray method. When the prime coat has become tacky but not dry and hard, the bituminous binder course, or base course, whichever applies, shall be placed and compacted. The CONTRACTOR shall then apply the surface course. It is recommended, but not required, that the base course remain in place for approximately one week before placing the surface course. The finished course shall be compacted and the completed surface shall match the grades and

slopes of the adjacent existing surfacing and be free of offsets, depressions, raised places and all other irregular surfaces.

9.4 Seasonal and Weather Limitations for Pavement Replacement. In the event the progress and scheduling of the work is such that the bituminous pavement replacement would occur in the winter months, during adverse cold weather and/or during such times the asphalt plants are not in operation, then the final pavement replacement shall be postponed until favorable weather occurs in the spring and the asphalt plants resume normal operations. No bituminous concrete shall be laid when the temperature is below 40°F. except by written permission of the ENGINEER.

Concrete pavement shall not be placed when the temperature is such that the pavement placed will freeze before it has had adequate time to set and shall be placed in conformance with the temperature conditions specified in these specifications.

The CONTRACTOR shall be responsible for replacement of pavement which he has placed which has been damaged by cold weather or freezing without additional compensation.

In the meantime, the CONTRACTOR will be required to maintain the temporary surfacing until the permanent pavement is placed. Such labor, materials and equipment as is required for temporary maintenance of the streets, roadways and driveways shall be provided at the CONTRACTOR'S expense and is not a pay item. The CONTRACTOR will be required to use a cold mix asphaltic concrete as a temporary surface for trenches under heavy traffic use.

9.5 Guarantee. The one year guarantee as specified in the contract documents is also applicable to trench settlement and pavement replacement.

10. SIDEWALK AND DRIVEWAY REPLACEMENT

Sidewalks and driveways will be replaced if damaged by the CONTRACTOR in any way. Payment will be made for those pavements necessarily damaged by the line installation in accordance with the Standard Details. No pavements are to be replaced over a backfilled trench for at least 30 days after filling. Pavements damaged otherwise are to be replaced immediately at the CONTRACTOR'S expense.

Materials and dimensions are to be at least equal to existing pavement and are to conform with the Standard Details.

11. PAYMENT FOR WATER

All water used from the UTILITY shall be metered with meters supplied by the CONTRACTOR. The CONTRACTOR shall pay for such water monthly at the rates published by the District. Unmetered water lost through water line breakage shall also be paid at the rates published by the District. The quantity lost shall be computed on the basis of a discharge velocity of 7 feet/second, the diameter of the line, and the estimate duration of free uncontrolled discharge.

12. FINAL CLEAN-UP

The CONTRACTOR shall provide effective cleanup of the work as it progresses. Procrastination of cleanup will not be tolerated. At the time of final inspection, no trenches shall show any undue evidence of the previous construction. All areas shall be left free of ruts due to construction equipment and shall have a clean and neat appearance without rubble or debris. The areas shall not be mounded up and shall be completely restored, and all yards and fields shall be reseeded so land may be cultivated, mowed, etc. Straw and fertilizing shall accompany the seeding in accordance with Item 8 - Cleanup, Seeding and Sodding of this section. If necessary to hasten proper restoration of terraces, principally along ditch lines, the CONTRACTOR shall sod such areas at the ENGINEER'S direction. For all line segments, final cleanup shall be performed within 30 days from day of installation.

13. PROTECTION OF ADJACENT LANDSCAPE

Reasonable care shall be taken during construction of the water lines to avoid damage to vegetation. Ornamental shrubbery and tree branches shall be temporarily tied back, where appropriate, to minimize damage. Trees which receive damage to branches shall be trimmed of those branches to improve the appearance of the tree. Tree trunks receiving damage from equipment shall be treated with a tree dressing.

In the course of construction, the CONTRACTOR may deflect horizontal alignment of the water line to avoid trees and to keep from damaging their roots. The CONTRACTOR shall be fully responsible for settling all claims by private property owners concerning damage to trees and shrubs.

14. MEASUREMENT AND PAYMENT

14.1 Payment for crushed stone, black top and concrete pavement replacement will not be based on the quantities purchased by the CONTRACTOR. Payment for surfacing will be paid on the basis of linear feet installed in accordance with the STANDARD DRAWINGS with a maximum width of pipe diameter plus 24 inches. Crushed stone or concrete sub-grade under paving and crushed stone trench backfill shall be included in paving price and

not paid for separately. Any additional cost estimated by the CONTRACTOR must be included in the cost of pipe in place.

14.2 STREAM CROSSINGS

14.2.1 No-Flow Crossings

Payment for no-flow stream crossings delineated on the plans (excluding directional bores) will be at the unit price bid per lineal foot for that item and shall include encasement pipe, crushed stone, concrete, solid rock excavation and all other work necessary for a satisfactory installation. The carrier pipe installed in the casing shall be paid separately under the unit price bid for pipe installed.

14.2.2 Directional Bores. Payment shall be "Lump Sum" for specific individual Bid Items for Directional Bores of large stream crossings and/or some streams classified as small where the physical crossing characteristics differ significantly from the other small streams in the project. Determination of the required length to accomplish the bore is the responsibility of the Contractor.

Payment shall be "Each" for directional bores of small stream crossings with the exception of individual small streams covered in a specific bid item. All small stream crossings in the project shall be considered the same for payment regardless of width (up to 15 L.F.) or depth. It is the responsibility of the Contractor to determine an average unit price that will be used for payment in each instance a blue line stream is crossed. Small stream crossings may be added, for extended lines beyond those shown on the plans, at the same unit price providing the crossings are reasonably similar to those in the initial project. Stream crossings may be deleted, without affecting the unit price, if a line is deleted or shortened.

Payment shall include the directional bore, encasement pipe if specified on the plans, the carrier pipe as specified on the plans and the transition fittings. Payment limits are shown on the Miscellaneous Drawing for Directional Bore for Stream Crossings.

14.3 Additional costs for normal earth creek crossings shall be included in the unit price bid for pipe installation and no special payment will be made for these crossings.

14.4 Casing pipe unit price bids shall include the cost of boring or jacking under railroads and highways and shall include the cost of steel casing pipe. Carrier pipe will be paid for under the unit price bid for installing lines as described in Article 2.2 of this section.

14.5 Sidewalk /driveway crossings when included as a bid item shall include the extra cost of free-boring or the removal and disposal of existing pavement

and replacement with new construction. Payment for pavement replacement will be on the basis of linear feet installed. Width for payment for a standard trench crossing is shown in the Standard Details. When sidewalk/driveway crossings or replacement are not included as a bid item, their costs shall be considered subsidiary to the bid for pipe installation.

14.6 Where required by the Special Provisions or the Bid Proposal, the cost of pavement replacement, boring, crossings of all types and other incidental construction shall be included in the unit price bid for pipe line installation and shall comprise total compensation for all such work.

14.7 Final Cleanup. Payment for the performance of Final Cleanup work shall be made at the contract unit price per linear foot as specified on the Bid form. However, quantities for Final Cleanup shall be added to partial payment estimates only after Final Cleanup work is totally completed for an entire water line. (In this case and entire water line shall be defined as all of the facilities along and appurtenances to a line with a particular identification designation such as "Line A" or "Name").

The unit price specified on the Bid form is an assigned allotment for the work specified in Specifications, Section 15102, Subsection 8.3, "Final Cleanup". The BIDDER shall not modify either the unit price or extended total for this item and modification of these figures may be cause for rejection of the Bid. It is expressly understood and agreed, by and between the CONTRACTOR and the OWNER that the assigned allotment for Final Cleanup work is a reasonable amount for the work to be performed.

SECTION 15103

SWABBING, PRESSURE TESTING AND STERILIZATION OF POTABLE WATER PIPELINES

1. SWABBING

1.1 General

Swabbing of the pipeline shall be done when directed in the General Notes on the Drawings.

1.2 Execution

The CONTRACTOR shall insert a flexible polyurethane foam "swab" (2 lb. per cubic foot density) complete with rear polyurethane drive seal into the first section of pipe. The "swab" shall remain in its initial position until construction of the specific pipeline segment is completed. Cleaning and flushing shall be accomplished by propelling the "swab" down the pipeline to the exit point with potable water. Flushing shall continue until the water is completely clear.

The maximum operational distance for each individual "swab" shall not exceed 1.0-1.5 miles.

Pressure testing and sterilization, as stipulated in this section of the specifications, shall follow cleaning and flushing.

1.3 Materials

The "swab" shall be Aqua-Swab as manufactured by GIRARD Industries or approved equal.

2. TESTING

2.1 After the pipe has been laid, all newly laid pipe or any valved section thereof shall be subjected to a hydrostatic pressure test of at least 1.5 times the working pressure at the point of testing, but in no case less than that required by other sections herein. In addition, a leakage test shall be conducted concurrently with the pressure test.

2.2 Pressure Test

2.2.1 Test pressure shall:

2.2.1.1 Not be less than 1.25 times the working pressure at the highest point along the test section.

2.2.1.2 Not exceed pipe or thrust restraint design pressures at the lowest point along the test section.

2.2.1.3 Be of at least six (6) hour duration unless otherwise stipulated by owner.

2.2.1.4 Not vary by more than plus or minus 5 psi.

2.2.1.5 Not exceed twice the rated pressure of the valves or hydrants when the pressure of the test section includes closed gate valves or hydrants.

2.2.1.6 Not exceed the rated pressure of resilient seat butterfly valves when used.

2.2.2 Each valved section of pipe shall be filled with water slowly and the specified test pressure, based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the ENGINEER.

2.2.3 Before applying the specified test pressure, air shall be expelled completely from the pipe, valves, and hydrants. If permanent air vents are not located at all high points, the contractor shall install corporation cocks at such points so that the air can be expelled as the line is filled with water. After all the air has been expelled, the corporation cocks shall be closed and the test pressure applied. At the conclusion of the pressure test, the corporation cocks shall be removed and plugged, or left in place at the discretion of the ENGINEER.

2.2.4. All exposed pipe, fittings, valves, hydrants, and joints shall be examined carefully during the test. Any damage or defective pipe, fittings, valves or hydrants that are discovered following the pressure test shall be repaired or replaced with sound material and the test shall be repeated until it is satisfactory to the ENGINEER.

2.3 Leakage Testing

2.3.1 Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe, or any valved section thereof, to maintain pressure within 5 psi of the specified test pressure after the air in the pipeline has been expelled and the pipe has been filled with water.

2.3.2 No pipe installation will be accepted if the leakage is greater than that determined by the following formula:

$$L = ND(P \text{ exp } 1/2)/7400$$

In which L is the allowable leakage, in gallons per hour; N is the number of joints in the length of pipeline tested; D is the nominal diameter of the pipe, in inches; and P is the average test pressure during the leakage test, in pounds per square inch gauge.

2.3.2.1 Allowable leakage at various pressures is shown in TABLE K-1.

2.3.2.2 When testing against closed metal-seated valves, an additional leakage per closed valve of 0.0078 gal/hr/in of nominal valve size shall be allowed.

2.3.2.3 When hydrants are in the test section, the test shall be made against the closed hydrant.

2.3.3 Acceptance shall be determined on the basis of allowable leakage. If any test of pipe laid discloses leakage greater than that specified in Section 2.3.2 the contractor shall, at his own expense, locate and repair the defective material until the leakage is within the specified allowance.

2.3.3.1 All visible leaks are to be repaired regardless of the amount of leakage.

TABLE K-1
ALLOWABLE LEAKAGE PER 1,000 FT. OF PIPELINE (gph)

Avg. Test Pressure	Nominal Pipe Diameter (Inches)								
psi	2	3	4	6	8	10	12	14	16
450	0.32	0.48	0.64	0.95	1.27	1.59	1.91	2.23	2.55
400	0.30	0.45	0.60	0.90	1.20	1.50	1.80	2.10	2.40
350	0.28	0.42	0.56	0.84	1.12	1.40	1.69	1.97	2.25
300	0.26	0.39	0.52	0.78	1.04	1.30	1.56	1.82	2.08
275	0.25	0.37	0.50	0.75	1.00	1.24	1.49	1.74	1.99
250	0.24	0.36	0.47	0.71	0.95	1.19	1.42	1.66	1.90
225	0.23	0.34	0.45	0.68	0.90	1.13	1.35	1.58	1.80
200	0.21	0.32	0.43	0.64	0.85	1.06	1.28	1.48	1.70
175	0.20	0.30	0.40	0.59	0.80	0.99	1.19	1.39	1.59
150	0.19	0.28	0.37	0.55	0.74	0.92	1.10	1.29	1.47
125	0.17	0.25	0.34	0.50	0.67	0.84	0.01	1.18	1.34
100	0.15	0.23	0.30	0.45	0.60	0.75	0.90	1.05	1.20

Avg. Test Pressure psi	Nominal Pipe Diameter (Inches)							
	18	20	24	30	36	42	48	54
450	2.87	3.18	3.82	4.78	5.73	6.69	7.64	8.60
400	2.70	3.00	3.60	4.50	5.41	6.31	7.21	8.11
350	2.53	2.81	3.37	4.21	5.06	5.90	6.74	7.58
300	2.34	2.60	3.12	3.90	4.68	5.46	6.24	7.02
275	2.24	2.49	2.99	3.73	4.48	5.23	5.98	6.72
250	2.14	2.37	2.85	3.56	4.27	4.99	5.70	6.41
225	2.03	2.35	2.70	3.38	4.05	4.73	5.41	6.03
200	1.91	2.12	2.55	3.19	3.82	4.46	5.09	5.73
175	1.79	1.98	2.38	2.98	3.58	4.17	4.77	5.36
150	1.66	1.84	2.21	2.76	3.31	3.86	4.41	4.97
125	1.51	1.68	2.01	2.52	3.02	3.53	4.03	4.53
100	1.35	1.50	1.80	2.25	2.70	3.15	3.60	4.05

3. STERILIZATION

3.1 General. It is the intent of this section to present essential procedures for disinfecting new and repaired water mains. The section is patterned after AWWA C651. The basic procedure comprises:

3.1.1 Preventing contaminating materials from entering the water mains during construction or repair and removing by flushing materials that may have entered the water main.

3.1.2 Disinfecting any residual contamination that may remain.

3.1.3 Determining the bacteriologic quality by laboratory test after disinfection.

3.2 Preventive Measures During Construction

3.2.1 Precautions shall be taken to protect pipe interiors, fittings, and valves against contamination. Pipe delivered for construction shall be strung so as to minimize entrance of foreign material. When pipelaying is not in progress, as, for example, at the close of the day's work, all openings in the pipe line shall be closed by water tight plugs. Joints of all pipe in the trench shall be completed before work is stopped. If water accumulates in the trench, the plugs shall remain in place until the trench is dry.

If dirt, that, in the opinion of the ENGINEER, will not be removed by the flushing operation (ARTICLE 3.3) enters the pipe, the interior of the pipe shall be cleaned and swabbed as necessary, with a five (5%) percent hypochlorite disinfecting solution.

3.2.2 Gaskets and Joints - No contaminated material or any material capable of supporting prolific growth of micro-organisms shall be used for sealing joints. Gaskets shall be handled in such a manner as to avoid contamination. Gasket packing materials must conform to AWWA standards. The lubricant used in the installation of sealing gaskets shall be suitable for use in potable water. It shall be delivered to the job in enclosed containers and shall be kept clean.

3.3 Preliminary Flushing. The main shall be swabbed and flushed prior to disinfection. It is recommended that the flushing velocity be not less than 2.5 ft/sec. The rate of flow required to produce this velocity in various diameters is shown in Table K-2. No site for flushing should be chosen unless it has been determined that drainage is adequate at the site.

TABLE K-2
REQUIRED OPENINGS TO FLUSH PIPELINES
(40-psi Residual Pressure)

Pipe Size (in)	Flow Required to Produce 2.5 fps Velocity (gpm)	Orifice Size (in)	Hydrant Outlet Nozzles Size Number	(in)
4	100	15/16	1	2 1/2
6	220	1 3/8	1	2 1/2
8	390	1 7/8	1	2 1/2
10	610	2 5/16	1	2 1/2
12	880	2 13/16	1	2 1/2
14	1,200	3 1/4	2	2 1/2
16	1,565	3 5/8	2	2 1/2
18	1,980	4 3/16	2	2 1/2

3.4 Form of Chlorine for Disinfection. The most common forms of chlorine used in the disinfecting solutions are liquid chlorine (gas at atmospheric pressure), calcium hypochlorite granules, sodium hypochlorite solutions.

3.4.1 Liquid Chlorine

3.4.1.1 Use: Liquid chlorine shall be used only when suitable equipment is available and only under the direct supervision of a person familiar with the physiological, chemical, and physical properties of this element and who is properly trained and equipped to handle any emergency that may arise. Introduction of chlorine-gas directly from the supply cylinder is unsafe and shall not be permitted.

NOTE: The preferred equipment consists of a solution fed chlorinator in combination with a booster pump for injecting the chlorine-gas water mixture into the main to be disinfected. Direct feed chlorinators are not recommended because their use is limited to situations where the water pressure is lower than the chlorine cylinder pressure.

3.4.2 Hypochlorites

3.4.2.1 Calcium Hypochlorite: Calcium hypochlorite contains seventy (70%) percent available chlorine by weight. It is either granular or tabular in form. The tablets, 6-8 to the ounce, are designed to dissolve slowly in water. Calcium hypochlorite is packaged in containers of various types and sizes ranging from small plastic bottles to one hundred (100) pound drums.

A chlorine-water solution is prepared by dissolving the granules in water in the proportion requisite for the desired concentration.

3.4.2.2 Sodium Hypochlorite: Sodium hypochlorite is supplied in strengths from five and one-quarter (5.25%) to sixteen (16%) percent available chlorine. It is packaged in liquid form in glass, rubber, or plastic containers ranging in size from one (1) quart bottles to five (5) gallon carboys. It may also be purchased in bulk for delivery by tank truck.

The chlorine-water solution is prepared by adding hypochlorite to water. Product deterioration must be reckoned with in computing the quantity of sodium hypochlorite required for the desired concentration.

3.4.2.3 Application: The hypochlorite solutions shall be applied to the water main with a gasoline or electrically powered chemical feed pump designed for feeding chlorine solutions. For small applications, the solutions may be fed with a hand pump, for example, a hydraulic test pump. Feed lines shall be of such material and strength as to withstand safely the maximum pressures that may be created by the pumps. All connections shall be checked for tightness before the hypochlorite solution is applied to the main.

3.5 Methods of Chlorine Application

3.5.1 Continuous Feed Method: This method is suitable for general application.

3.5.1.1 Water from the existing distribution system or other approved sources of supply shall be made to flow at a constant, measured rate into the newly-laid pipe line. The water shall receive a dose of chlorine, also fed at a constant, measured rate. The two rates shall be proportioned so that the chlorine concentration in the water in the pipe is maintained at a minimum of 50 mg/l available chlorine. To assure that this concentration is maintained, the chlorine residual should be measured at regular intervals in accordance with the

procedures described in the current edition of Standard Methods and AWWA M12--Simplified Procedures for Water Examination.

NOTE: In the absence of a meter, the rate may be determined either by placing a pitot gauge at the discharge or by measuring the time to fill a container of known volume.

TABLE K-3 gives the amount of chlorine residual required for each one hundred (100) feet of pipe of various diameters. Solutions of one (1%) percent chlorine may be prepared with sodium hypochlorite or calcium hypochlorite. The latter solution requires approximately one (1) pound of calcium hypochlorite in eight and five tenths (8.5) gallons of water.

TABLE K-3
CHLORINE REQUIRED TO PRODUCT 50 Mg/l CONCENTRATION
IN 100 FT. OF PIPE (BY DIAMETER)

Pipe Size (in)	100 Percent Chlorine (lb)	1 Percent Chlorine Solutions (gal)
4	0.027	0.33
6	0.061	0.73
8	0.108	1.30
10	0.170	2.04
12	0.240	2.88

3.5.1.2 During the application of the chlorine, valves shall be manipulated to prevent the treatment dosage from flowing back into the line supplying the water. Chlorine application shall not cease until the entire main is filled with the chlorine solution. The chlorinated water shall be retained in the main for at least twenty-four (24) hours during which time all valves and hydrants in the section treated shall be operated in order to disinfect the appurtenances. At the end of this twenty-four (24) hour period, the treated water shall contain no less than 25 mg/l chlorine throughout the length of the main.

3.5.2 Slug Method: This method is suitable for use with mains of large diameter for which, because of the volumes of water involved, the continuous feed method is not practical.

3.5.2.1 Water from the existing distribution system or other approved source of supply shall be made to flow at a constant, measured rate (see ARTICLE 3.5.1.1) into the newly laid pipe line. The water shall receive a dose of chlorine also fed at a constant, measured rate. The two rates shall be proportioned so that the concentration in the water entering the pipe line is maintained at no less than 300 mg/l. The chlorine shall be applied continuously and for a sufficient period to develop a solid column or "slug" of chlorinated water that will, as it

passes along the line, expose all interior surfaces to a concentration of at least 300 mg/l for at least three (3) hours. The application shall be checked at a tap near the upstream end of the line by chlorine residual measurements.

3.5.2.2 As the chlorinated water flows past tees and crosses, related valves and hydrants shall be operated as to disinfect appurtenances.

3.6 Final Flushing.

3.6.1 Clearing the Main of Heavily Chlorinated Water. After the applicable retention period, the heavily chlorinated water shall not remain in prolonged contact with the pipe. This water shall be flushed from the main until the chlorine concentration in the water leaving the main is no higher than that generally prevailing in the system, or less than 1 mg/l. Chlorine residual determination shall be made to ascertain that the heavily chlorinated water has been removed from the pipe line.

3.6.2 Disposing of Heavily Chlorinated Water. The environment into which the chlorinated water is to be discharged shall be inspected. If there is any possibility that the chlorinated discharge will cause damage to the environment, then a neutralizing chemical shall be applied to the water to be wasted to neutralize thoroughly the chlorine residual remaining in the water. (See Appendix B of ANSI/AWWA C651-92 for neutralizing chemicals.) Federal, state, provincial, and local regulatory agencies should be contacted to determine special provisions for the disposal of heavily chlorinated water.

3.7 Bacteriologic Tests

3.7.1 After final flushing, and before the water main is placed in service, a sample or samples shall be collected from the end of the line and tested for bacteriologic quality and shall show the absence of coliform organisms. If the number and frequency of samples is not prescribed by the public health authority having jurisdiction, at least one sample shall be collected from chlorinated supplies where a chlorine residual is maintained throughout the new main. From unchlorinated supplies at least two samples shall be collected at least twenty-four (24) hours apart.

3.7.2 Samples for bacteriologic analysis shall be collected in sterile bottles treated with sodium thiosulphate. No hose or fire hydrant shall be used in collection of samples. A suggested sampling tap consists of a standard corporation cock installed in the main with a copper tube gooseneck assembly. After samples have been collected, the gooseneck assembly may be removed, and retained for future use.

3.8 Repetition of Procedure. If the initial disinfection fails to produce satisfactory samples, disinfection shall be repeated until satisfactory samples have been obtained. The tablet method cannot be used in these subsequent

disinfections. When the sample tests indicate that disinfection has been effective, the main may be placed in service.

3.9 Procedure After Cutting Into or Repairing Existing Mains. The procedures outlined in this Article apply primarily when mains are wholly or partially dewatered. Leaks or breaks that are repaired with clamping devices while the mains remain full of water under pressure present little danger of contamination and require no disinfection.

3.9.1 Trench "Treatment": When an old line is opened, either by accident or by design, the excavation will likely be wet and may be badly contaminated from nearby sewers. Liberal quantities of hypochlorite applied to open trench areas will lessen the danger from such pollution. Tablets have the advantage in such a situation because they dissolve slowly and continue to release hypochlorite as water is pumped from the excavation.

3.9.2 Main Disinfection: The following procedure is considered as a minimum that may be used.

3.9.2.1 Swabbing With Hypochlorite Solution: The interior of all pipe and fittings used in making the repair (particularly couplings and tapping sleeves) shall be swabbed with a five (5%) percent hypochlorite solution before they are installed.

3.9.2.2 Flushing: Thorough flushing is the most practical means of removing contamination introduced during repairs. If valving and hydrant locations permit, flushing from both directions is recommended. Flushing shall be started as soon as the repairs are completed and continued until discolored water is eliminated.

3.9.2.3 Slug Method: Where practicable, in addition to the procedures of ARTICLE 3.9.2.1, a section of main in which the break is located shall be isolated, all service connections shut off, and the section flushed and chlorinated as described in ARTICLE 3.5.2, except that the dose may be increased to as much as 500 mg/l, and the contact time reduced to as little as one-half (1/2) hour. After chlorination, flushing shall be resumed and continued until discolored water is eliminated.

3.9.3 Sampling: Bacteriologic samples shall be taken after repairs to provide a record by which the effectiveness of the procedures used can be determined. If the direction of flow is unknown, samples shall be taken on each side of the main break.

4. PAYMENT

Payment for swabbing, pressure testing and sterilization of pipelines shall be included in the unit price for pipeline installation unless otherwise itemized on the Bid Schedule. Pipeline swabbing may be included in the Bid Schedule as a separate Bid Item.

SECTION 15104

METERS, SERVICES AND INDIVIDUAL PRESSURE REDUCING VALVES

1.0 GENERAL

The CONTRACTOR shall furnish all labor, tools, equipment and materials for installing water services as shown on the plans and as directed.

2.0 WATER METER SETTINGS

2.1 Materials. Meter settings shall include meter box and cover, coppersetter (including cut-off valve), four feet of pipe, saddle and corporation stop, iron pipe or rod to hold meter plumb, plus two feet of pipe and plug or cap on the customer's side of meter. (This latter item is to prevent the customer or his plumber from disarranging or loosening the meter after the CONTRACTOR has already set the meter in its proper position.) Stainless steel inserts must be used when attaching CTS fittings to P.E. tubing. Where the main line is in the highway right-of-way, meters shall be set as close to the right-of-way fence as practicable but no meter on the same side of the road as the main line shall be set with more than 6 feet of service line unless prior approval has been obtained from the ENGINEER or his representative or as directed on the plans.

2.2 Corporation Stops, Setters and Saddles. The corporation stops shall be equal to Ford F-Series. The meter setter shall be equal to the Ford 170-Series Coppersetter VB-HH-72-7W 44-33 with seven inch rise. Saddles shall be equal to Ford S70 Series for PVC, S90 for C900 and 202 Series for Ductile Iron Pipe.

Service line connections are to be made with compression fittings only.

2.3 Meters. The meters for this project will be supplied by water district.

2.4 Meter Boxes. Meter boxes for 5/8" x 3/4" meters shall be AMETEK meter box No. 190156, Meter Lid No. 193101, 6" Riser No. 19011. Provide shop drawing or product detail before placing order.

2.5 Installation. Meters shall be set in a workmanlike manner with backfill neatly compacted in place. In yards, pastures and other grassed areas, top of meter box may be placed no higher than 1/2 inch above original ground and no lower than flush with original ground. Boxes in sidewalks or other concrete areas shall be flush with surface. In areas which have not been sodded, top of box shall be 2 inches above grade. The service line must meet the same cover requirements as the main line as described in these specifications except that the service line may be brought up to a depth of approximately 24 inches within 5 feet of each

side of the meter installation when a 24-inch deep meter box is used. In all other cases the service pipe will be brought up to a depth which accommodates installation at the bottom of the meter box. The service pipe must return to 30 inch cover (36 inches in traffic) within 5 feet from the box. If meter box area is subject to traffic a deeper box will be required to maintain 36 inches of cover over the service pipe.

2.6 Payment. The Unit Price Bid shall constitute full compensation for furnishing and installing the saddle, corporation stop, meter box, meter, cover, meter setter and valve, holding rod, and service tubing extension as shown and specified. Installation of the meters will be done by the utility.

3.0 SERVICES

3.1 General. Service lines up to four (4) feet on the inlet side of the meter and two (2) feet on the customer side is included in the meter setting. Additional service pipe is an extra pay item and must be approved by the ENGINEER or designated Construction Representative.

3.2 Service Lines Not Crossing a Road. Unless indicated otherwise on the plans, all Service Lines shall be 3/4" Type K Copper Tubing, or polyethylene plastic tubing using a corporation stop in accordance with the Standard Details. Service pipe shall meet all AWWA Specifications with a minimum pressure rating of 200 psi. Polyethylene service tubing shall be ultra high density type equal to Performance Pipe or Endopoly Premium.

3.3 Service Lines Crossing a County Road or City Streets. Same as above, except that in general all pipe shall be jacked beneath certain paved or blacktopped city streets or county roads, unless solid rock prevents using this method in which case, the open trench method may be used. The open trench method generally will be used on all unpaved city streets, county roads and private driveways. In general, blacktopped and concrete private driveways shall also be jacked under. In all cases where lines are under traffic, a minimum cover of thirty-six (36") inches shall be provided and the service line shall be encased per the Miscellaneous Drawings. All backfill shall be compacted by air tampers in layers no greater than 6-inch depth. In cases of open trench construction, crushed stone, blacktop and concrete paving shall be replaced in accordance with the specifications and the Standard Drawings.

3.4 Service Lines Crossing a State Highway. Same as Section 3.3 except the casing pipe shall be jacked or pushed under paving. If solid rock is encountered, the crossing may be relocated to permit boring or jacking. No additional compensation will be made for relocation of service crossing.

Where required and specifically noted on the DRAWINGS, service pipe shall be encased under highways. Schedule 40 steel or PVC pipe shall be used as

casing pipe unless otherwise indicated by the plans. Polyethylene pipe will normally be encased. Where permitted rigid PVC pipe will not be encased but soft connections with polyethylene pipe will be required on either side of the boring length.

3.5 Payment. The Unit Price bid for the specific service pipe size shall constitute full compensation for all materials, equipment and labor for installing the service pipe. There shall be no distinction between service pipe bored, pushed or trenched. There shall be no extra compensation for replacement of crushed stone, blacktop or concrete paving.

4.0 INDIVIDUAL METER PRESSURE REDUCING VALVES

4.1 Pressure Reducing Valves (PRV) will be installed for individual services on pipelines with operating pressures in excess of 150 psi, or as directed by the Owner and Engineer.

4.2 The PRVs shall be a Wilkins, Model No. 600-LUSC, three-fourths (3/4") inch or approved equal complete with a bronze strainer. Mueller and Watts are also acceptable. Each regulator to have an adjustable pressure range of 60-125 psi and is to be set at 70 psi. The regulators shall be installed in a separate meter box with coppersetter same as the ones utilized for the meter settings. The PRVs shall be located between the water main and meter setting. Use of tandem coppersetters or burying the PRV will not be permitted.

4.3 Payment. Payment for individual pressure reducing valves shall be included in the Bid Item for "Meter Setting with Individual Pressure Reducing Valves" and shall constitute full compensation for furnishing and installing the PRV, meter box and lid, unions, fitting adapters, holding rod, and service tubing extension complete and operative.

SECTION 15105

FIRE HYDRANTS

1.0 WORK INCLUDED

Under this Item, the CONTRACTOR shall provide all labor, tools, equipment and materials to furnish and install fire hydrants with gate valves as shown on the drawing and as directed by the ENGINEER.

2.0 MATERIALS

The hydrants shall be designated on the DRAWINGS as follows:

Type 1 one hose outlet
Type 2 two hose outlets
Type 3 two hose outlets and one steamer connection

All fire hydrants on lines 6-inch and larger shall have a six inch bell connection and four-inch bell connection on lines smaller than 6-inch. Hydrants shall be designed for l50 pounds working pressure or 300 pounds hydrostatic pressure and shall conform to the latest specifications of the AWWA. All working parts shall be bronze. The hose outlets and steamer nozzle shall be of such size and design that it will fit the present fire fighting equipment. Hydrants shall be designed so that no water will be lost when they are broken off and so they can be repaired with a repair kit. Design, materials, and workmanship shall be similar and equal to the latest stock pattern ordinarily produced by the manufacturer. Length of barrel shall be such to provide ample cover over the connecting line. Working drawings and full description of hydrants shall be submitted to the ENGINEER before ordering. All hydrants shall have a 4 1/4 or 5 1/4 inch valve opening against pressure. The hydrants shall be equal to Kennedy Model K81A or Mueller Model A-423. Four spanner wrenches for operation of the hydrants shall be furnished for the DISTRICT'S use.

3.0 PAINT

Hydrants shall be painted one coat of primer and two finish coats of approved paint of color **Natural Blue**. Painting shall conform to AWWA C902-85, Section 4.2 Painting.

4.0 INSTALLATION

Hydrants shall be set at such elevations that the connecting pipe will have the same depth of cover as the distribution main. The hydrant shall be set upon a

slab of stone or concrete not less than four inches thick and l5 inches square. The back of the hydrant opposite the pipe connection shall be firmly wedged against one and one-half square feet or enough of the vertical face of the trench with concrete to prevent the hydrants from blowing off the line. The entire fire hydrant piping assembly from the main line tee to the hydrant shall be joint restrained. The joint restraints shall be equal to UNI-FLANGE for mechanical joint pipe as manufactured by FORD and rated for 250 psi.

Not less than seven cubic feet of No. 9 stone shall be placed around the base of the hydrant to insure drainage. Before the No. 9 stone is placed and before it is backfilled the drain hole shall be inspected and thoroughly cleaned if necessary. The backfill around the hydrant shall be thoroughly compacted to the grade line in a manner satisfactory to the ENGINEER. Hydrants shall have the interior cleaned of all foreign matter before installation.

All hydrants will be installed with the pumper connection facing the main access road or as directed by the ENGINEER.

Stuffing boxes shall be tightened and the hydrants shall be inspected in open and closed position to see that all parts are in working condition.

5.0 PAYMENT

The unit price bid shall constitute full compensation for furnishing and installing the fire hydrants and associated gate valve as specified.

SECTION 15220
DIRECTIONAL DRILLING

1. GENERAL

Directional drilling construction methods shall be used to cross streams as shown in the plans and as directed by the Engineer.

2. POLYETHYLENE PIPE

Polyethylene pipe shall conform with ASTM D-3350 "Polyethylene Plastic Pipe and Fitting Materials" for high density pressure pipe manufactured of grade P34 resin material with a hydrostatic-design basis (HDB) rating of l,600 psi at 73.4 degrees F (23 degrees C).

High-density polyethylene pipe shall be manufactured and tested in conformance to the requirements of the latest revision of the American Society for Testing and Materials designation ASTM D-3350, "Polyethylene Plastic Pipe and Fitting Materials". High-density polyethylene pipe shall have a grade designation of PE 3408 and a cell classification designation of PE 345434C. No material shall be used in the pipe or fittings, which has been demonstrated to be detrimental to water quality.

High-density polyethylene pipe shall be joined by means of butt fusion as per the manufacturer's recommendations.

The high-density polyethylene pipe used as a carrier pipe shall be as specified on the Drawings. Polyethylene pipe used as a casing pipe shall be SDR-11. There shall be a minimum of ½" clearance in all directions between the outside diameter of the carrier pipe and inside diameter of the casing pipe. Polyethylene pipe shall be as manufactured by Phillips Driscopipe, Inc. or approved equal.

3. EXECUTION

The directional drilling shall use a bentonite type drilling fluid to act as a lubricant and to fill the void between the polyethylene casing pipe and the bore hole. The CONTRACTOR shall be careful in the depth and direction of the bore to not disturb the creek or river bottom or banks. Casing pipe will be required for all creek crossings. The casing pipe shall be pulled through the bore hole and the polyethylene carrier pipe will be pulled through the casing pipe.

4. PAYMENT

The unit price bid for directional drilling shall be full compensation for supplying the carrier pipe and casing pipe, and all material, labor, equipment, and tools for the construction of the water line by directional drilling. Payment will be made by the unit price bid for each Directional Bore Creek Crossing entered on the Bid Schedule.

SECTION 15222

V-BIO ENHANCED POLYETHYLENE ENCASEMENT FOR DUCTILE IRON PIPE

1.0 GENERAL

Polyethylene encasement shall be installed on ductile iron pipe in area locations and to plan lengths as designated on the project drawings. Polyethylene encasement for use with ductile iron pipe shall meet all the requirements for ANSI/AWWA C105/A21.5, **Polyethylene Encasement for Ductile Iron Pipe Systems** which is included herewith by reference.

2.0 INSTALLATION

Ductile iron pipe and the polyethylene encasement used to protect it shall be installed in accordance with AWWA C600 and ANSI/AWWA C105/A21.5 and also in accordance with all recommendations and practices of the AWWA M41, Manual of Water Supply Practices – Ductile Iron Pipe and Fittings. Specifically, the wrap shall be overlapped one foot in each direction at joints and secured in place around the pipe and any wrap at tap locations shall be taped tightly prior to tapping and inspected for any needed repairs following the tap.

All installations shall be carried out by personnel trained and equipped to meet these various requirements.

The installing contractor shall submit an affidavit stating compliance with the requirements and practices of ANSI/AWWA C150/A21.50, ANSI/AWWA C151/A21.51, ANSI/AWWA C105/A21.5, AWWA C600 and M41.

3.0 MATERIALS

3.1 Linear Low Density Polyethylene Film

Linear low density polyethylene film shall be manufactured from virgin polyethylene material conforming to the following:

3.1.1 Raw material requirements, per ASTM D4976
Group: 2 (Linear)
Density: 0.910 to 0.935 g/cm^3
Dielectric Strength: Volume resistivity, 10^{15} ohm-cm, minimum

3.1.2 Physical Properties of Finished Film

Tensile Strength: 3,600 psi (24.8 MPa), minimum in machine and transverse direction (ASTM D882)
Elongation: 800 percent, minimum in machine and transverse direction (ASTM D882)
Dielectric Strength: 800 V/mil (31.8 V/um) thickness, minimum (ASTM D149)
Impact Resistance: 600 g, minimum (ASTM D1709 Method B)
Propagation Tear Resistance: 2,550 gf (grams force), minimum in machine and transverse direction (ASTM D1922)

3.1.3 Polyethylene encasement for use with ductile iron pipe systems shall consist of three layers of co-extruded linear low density polyethylene (LLDPE), fused into a single thickness of not less than 8 mils.

The inside surface of the polyethylene wrap to be in contact with the pipe exterior shall be infused with a blend of anti-microbial biocide to mitigate microbiologically influenced corrosion and a volatile corrosion inhibitor to control galvanic corrosion.

3.2 Tube Size or Sheet Width

Tube size or sheet width for each pipe diameter shall be as listed in Table 1.

3.3 Marking

3.3.1 Marking Requirements
The polyethylene film supplied shall be clearly marked, at a minimum of every 2 ft along its length, containing the following information:

a. Manufacturer's name or trademark
b. Year of Manufacture
c. ANSI/AWWA C105/A21.5
d. Minimum film thickness and material type
e. Applicable range of nominal pipe diameter size(s)
f. Warning – Corrosion Protection – Repair any damage

3.3.2 Marking Height
Letters and numerals used for marking items a through e in Sec 3.5.1 shall not be less than 1 in. in height. Item f in Sec 3.5.1 shall be not less than 1.5 in. in height.

DIVISION 16

ELECTRICAL

INDEX

DIVISION 16 - ELECTRICAL

SECTION 16000 - ELECTRICAL GENERAL PROVISIONS

1. RELATED DOCUMENTS

A. General Provisions of Contract, General and Supplementary Conditions, and General Requirements, apply to this Section.

B. This Section shall be governed by alternates insofar as they apply to this work.

2. DESCRIPTION OF WORK

A. Provide labor, equipment, materials, supplies and components, including lamps and fuses; and perform all operations including cutting, channeling, chasing, trenching and backfilling necessary for installation of complete electrical system.

B. Appliances, equipment, and fixtures shall be current models for which replacement parts are available. Store and protect materials and equipment delivered to site in such a manner as to effectively prevent damage from climatic conditions, condensation, dust, and physical abuse. Install and connect materials and equipment in accordance with manufacturer's instructions and recommendations. Each major component of equipment shall have manufacturer's name, address, model number, and ratings on a plate securely affixed in a conspicuous place.

C. It is not the intent of this section to make any Contractor, other than the General Contractor alone, the single responsible party to the Owner. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be done through the General Contractor. No attempt has been made to arbitrarily assign responsibility of work, material, equipment or services to a particular trade or Contractor. Unless stated otherwise, subdivision and assignment of work shall be General Contractor's responsibility.

D. Facilities and systems of electrical work are described (but not by way of limitation) as follows:

(1) Electrical connecting of equipment not specified to be connected as work of another Division.

(2) Motor starters and control/protection work as indicated.

(3) Electric equipment and motor connections.

(4) Control/monitoring work as indicated.

E. Each CONTRACTOR bidding on the work included in these Specifications shall view the site and carefully examine the Contract Drawings and Specifications, so that he/she may fully understand what is to be done, and to document existing conditions.

3. QUALITY ASSURANCE

A. Minimum standards for all electrical work shall be latest revision of NEC. Whenever and wherever OSHA, Federal and State laws, regulations and design require higher standards than NEC, these laws, regulations, and designs shall be followed.

B. Provide electrical inspection by a licensed and recognized Electrical Inspector. Notify Electrical

(1) Inspector in writing, immediately upon start of work with a copy of notice to Engineer. Schedule inspection for rough as well as finished work. Approval from Electrical Inspector will not be allowed as reason for deviation from Contract Documents. All costs incidental to Electrical Inspection shall be borne by Contractor. Prior to final acceptance of work and release of final payment, deliver to Engineer the certificate of final inspection.

C. Obtain all permits required for entire construction of electrical system from authorities governing such work. Bear all costs of these permits.

D. All materials shall be new and best of their respective kinds unless otherwise specified and shall be listed by UL and shall be so labeled. All equipment shall conform to latest approved standards of I.E.E.E., N.E.M.A., A.N.S.I., U.L. and O.S.H.A. See individual specification sections for other specific requirements.

4. CONTRACT DOCUMENTS

A. Contract Documents are intended to cover furnishing and installing of complete electrical systems (interior and exterior) including miscellaneous systems, all tested and ready for operation.

B. Contract Documents are complementary, each to the other, and work required by either shall be included in the contract as if called for by both. Necessary items or work omitted, not clearly included, specified or indicated and material or apparatus believed inadequate or unsuitable, in violation of laws, ordinances, or rules shall be clarified by a written request to Engineer prior to bidding. In absence of such written notice, Contractor shall be responsible for approved satisfactory functioning of entire system without extra compensation.

C. Drawings other than electrical drawings, and other sections of this specification, may show or specify electrically operated equipment and wiring diagrams. Examine all such drawings and specifications. Determine characteristics and provide necessary wiring and connections for all such equipment.

D. Keep electrical record drawings up to date each day. Record drawings will be reviewed by Engineer each month with Contractor's pay request review. Entries and notes shall be made in a neat and legible manner and these drawings delivered to the ENGINEER after completion of the construction, for use in preparation of Record Drawings.

E. Naming of a certain brand or make or manufacturer in specifications is to establish style or quality standard for articles desired. Contractor is not restricted to use of specific brand of manufacturer named unless so indicated in specifications. However, where a substitution is requested, a substitution will be permitted only with written approval of Engineer. Proposed substitutions prior to bidding shall be submitted prior to bid date. Submit three bound copies of manufacturer's data showing all pertinent data, and samples, if requested.

5. COORDINATION

A. Coordinate work of different trades so that:

(1) Interference between mechanical, electrical, architectural, and structural work including existing services shall be avoided.

(2) Within limits indicated on Drawings, the maximum practicable space for operation, repair, removal, and testing of electrical equipment shall be provided.

B. All electrical materials and equipment shall be kept close as possible to ceiling, walls and columns, to take up a minimum amount of space.

C. Provide all offsets, fittings and similar items necessary in order to accomplish requirements of coordination without additional expense to Owner.

D. Drawings are diagrammatic and indicate general location of material and equipment. Refer to architectural and structural drawings and specifications for general construction of building, for floors and ceiling heights and for locations of walls, partitions, beams, and equipment, and be guided accordingly for setting of all equipment. Do not scale electrical drawings to determine exact locations.

E. Motor horsepowers and apparatus wattage ratings indicated on Drawings or specified herein are estimated values, and corresponding sizes of feeders and other electrical equipment indicated to serve them are minimum sizes. Motors of greater horsepower and apparatus with larger wattage ratings may be provided if necessary to meet requirements of various sections of specification in which they are specified. Where larger motors or apparatus with larger wattage ratings are provided, feeders and other electrical equipment serving them shall be increased in capacity to correspond. Increase in capacity of feeder and other apparatus shall be furnished at no additional cost to the Owner.

F. Be responsible for locating all openings required in walls, floors, ceilings or roof, for all materials and equipment provided under Electrical sections.

(1) Check with other trades on scope of their work and coordinate on all locations of various items of equipment and outlets before they are finally placed and connected. Relocation of material or equipment necessitated by failure to coordinate work shall be at no cost to Owner.

(2) Do not cut work of any other trade without first consulting Engineer's representative. Repair work damaged employing services of trade whose work is damaged. Where openings or sleeves have been omitted, they shall be drilled or sawed as directed by Architect. All cutting and patching shall be responsibility of this Section.

(3) Wherever slots, sleeves or other openings are provided in floors or walls, for the passage of conduits or other forms of raceway, including bus ducts, such openings, if unused, or spaces left in such openings after installation of conduit or raceway shall be filled. Filling materials for openings in walls and floors generally shall be fire resistive and constructed and installed so as to prevent passage of water, smoke and fumes. Where conduits passing through openings are exposed in finished rooms, finishes of filling materials shall match and be flush with adjoining floor, ceiling or wall finishes.

(4) Provide exposed conduit passing through floors, walls, or ceilings of finished rooms with chrome plated escutcheons. Plates shall be split, hinged type of sufficient outside diameter to amply cover up sleeve openings for pipe.

6. WARRANTY

A. Contractor shall be responsible for warranting all work, including equipment, materials, and workmanship provided under this section. This warranty shall be against all defects of the above and shall run a minimum period of one (1) year from date of acceptance of the work, concurrent with the one year guarantee period designated for the general construction contract under which electrical work is performed. Date of acceptance shall be considered to be the date on which all "punchlist" items are completed ("punchlist" is defined to be the written listing of work that is incomplete or deficient that must be finished or replaced/repaired before the CONTRACTOR receives final payment).

B. Defective work, equipment, materials and workmanship that develops within warranty period, which is not caused by ordinary wear, damage or abuse by others, shall be replaced or corrected without additional cost to Owner.

C. Repair or maintenance for the guarantee period is the responsibility of the CONTRACTOR and shall include all repairs and maintenance other than that which is considered as routine. (That is replacement of lamps, oiling, greasing, etc.)

7. EXCAVATING FOR ELECTRICAL WORK

A. Include whatever excavating and backfilling is necessary to install electrical work. Coordinate work with other excavating and backfilling in same area, including dewatering, flood protection provisions and other temporary facilities. Coordinate work with other work in same area, including other underground services (existing and new), landscape development, paving, and floor slabs on grade. Coordinate with weather conditions and provide temporary facilities needed for protection and proper performance of excavating and backfilling.

B. Except as otherwise indicated, comply with applicable provisions of Section 02200 for electrical work excavating and backfilling. Refer instances of uncertain applicability to Engineer for resolution before proceeding.

C. Where conduit is less than 2' 6" below surface of roadway, provide encasement in Class 2500 concrete, 4" minimum coverage all around.

D. After backfilling has been completed disturbed areas shall be returned to their original condition and shall match adjoining area, or in areas to be covered under site work, area shall be finished as directed by Engineer.

E. Where it is necessary to remove and replace landscape work, pavement, flooring and similar exposed finished work, engage original installer to install replacement work; except where work existed prior to work of this Contract, engage only experienced and expert firms and tradespersons to replace work.

8. CONCRETE FOR ELECTRICAL WORK

A. Work of this article is defined to include whatever concrete work is necessary or indicated specifically to install electrical work. Except as otherwise indicated, comply with applicable provisions of Division 3 for electrical work concrete, including formwork, reinforcement, mix design, materials (use mix designs and materials accepted for Division 3 work where possible), admixtures, accessories (including waterstops), placing of wet concrete, finishing, curing, protecting, testing, submittals, and other requirements of the concrete work. Refer instances of uncertain applicability to Engineer for resolution before proceeding.

B. Except as otherwise indicated, provide strength classes as follows, with the following cement content and water/cement ratios; for the indicated applications and similar required applications.

(1) 4000 psi Class: 565 lbs. cement/yd. (6.0 sacks); 0.57 water/cement ratio. Provide 4000 Class for vaults, beam type foundations and similar structures.

(2) 3000 psi Class: 500 lbs. cement/yd. (5.25 sacks); 0.68 water/cement ratio. Provide 3000 Class for miscellaneous underground structural concrete, reinforced encasement, block type foundations (with smallest dimension at least 0.2 x largest dimension), curbs, pads, and similar structural support work.

(3) 2500 psi Class: 450 lbs. cement/yd. (4.75 sacks); 0.75 water/cement ratio. Provide 2500 Class for plain encasement, filling steel framed units, and similar work.

(4) Rough Grouting Class: 565 lbs. cement/yd. (6.0 sacks); 0.75 water/cement ratio; adjust aggregate sizes to facilitate placement. Use for rough grouting, not for setting equipment bases.

(5) Backfill Class (Lean Concrete): 375 lbs. cement/yd. (4.0 sacks); 0.87 water/cement ratio. Use for backfilling where excavations are extended below point of support for electrical work.

C. Anchor Bolts-Concrete: Provide all anchor bolts required for equipment furnished under Contract. Set anchor bolts in a substantial manner so they will not be displaced. Anchor bolts shall be set in new concrete construction before pouring. Anchor bolts shall be stainless steel.

9. TESTING AND BALANCING

A. Feeders and branch circuits shall have their insulation tested after installation, and before connection to fixtures and equipment. Perform with a 500 volt megger. Conductors shall test free from short circuits and grounds. Test conductors phase to phase and phase to ground. Test readings shall be recorded and delivered to Engineer.

B. Verify rotation of all three phase motors with trade furnishing equipment. Bump or run these motors uncoupled in presence of trade furnishing equipment to insure proper rotation.

C. Circuit numbers are indicated on Drawings for reference; however Contractor shall make corrections as necessary to obtain proper phase balance under operating conditions.

D. After the wiring system is completed, and at such time as the ENGINEER may direct, the CONTRACTOR shall conduct an operating test for acceptance. The equipment shall be demonstrated to operate in accordance with the requirements of these Specifications and the Contract Drawings. The test shall be performed in the presence of the ENGINEER or his authorized representative. The CONTRACTOR shall furnish all instruments and personnel required for the tests, as well as the necessary electrical power.

E. Before energizing the system, the CONTRACTOR shall check all connections and set all relays and instruments for proper operation. He shall obtain all necessary clearances, approvals, and instructions from the serving utility company prior to placing power on the equipment.

1.10 TRAINING

A. All manufacturers supplying equipment for this division shall provide the OWNER'S operations staff with training in the operation and maintenance on the equipment being furnished. The training shall be conducted at the project site by a qualified representative of the manufacturer.

B. The cost of this training shall be included in the bid price.

C. The required training shall consist of both classroom and hands-on situation. Classroom training shall include instruction on how the equipment works, its relationship to all accessories and other related units, detailed review of shop drawings, detailed presentation of written O&M instructions, troubleshooting and record-keeping recommendations. Hands-on training shall include a review of the manufacturer's O&M instructions, check out of each operator to identifying key elements of the equipment, tear down as appropriate, calibration, adjustment, greasing and oiling points, and operating manipulations of all electrical and mechanical controls.

D. The training shall be scheduled through the CONTRACTOR with the OWNER. The timing of the training shall closely coincide with the startup of the equipment, but no training shall be conducted until the equipment is operational.

E. The minimum number of training hours to be provided by manufacturer supplying equipment on this project shall be in accordance with the following tables:

Item	**Training Hours**	
	Classroom	**Hands-on**
Motor Control Systems	3	3

F. At least 60 days prior to the training the manufacturer shall submit through the CONTRACTOR to the ENGINEER an outline of the training proposed for the ENGINEER'S review and concurrence.

G. The OWNER reserves the right to videotape all training sessions.

1.11 STORAGE AND CLEANING

A. All work, equipment, and materials shall be protected against dirt, water, or other damage during the period of construction.

B. Sensitive electrical equipment such as light fixtures, motor starters and controls, delivered to the job site, shall be protected against damage or corrosion due to atmospheric conditions or physical damage by other means. Protection is interpreted to mean that equipment shall be stored under roof, in a structure properly heated in cold weather and ventilated in hot weather. Provision shall be made to control the humidity in the storage area to 50 percent relative. The stored equipment shall be inspected periodically, and if it is found that the protection is inadequate, further protective measures shall be employed.

C. The CONTRACTOR shall not store submersible pump units in the wet well. If it is absolutely necessary to do so, the open power cable ends are to be suspended above the maximum flood elevation or maximum expected water level. If not stored in this manner, the CONTRACTOR may be called upon to replace the pump motors and cables with new units to ensure that water has not penetrated the cable and entered the motor housing.

D. At completion of work required under this Contract and just prior to acceptance by Owner, thoroughly clean all exposed equipment fittings, fixtures and accessories.

E. During construction, cover all OWNER equipment and furnishings subject to mechanical damage or contamination in any way.

1.12 SUPPORT OF ELECTRICAL ITEMS

A. Unless otherwise indicated, all electrical items or their supporting hardware, including but not limited to, conduits, raceways, cable trays, busways, cabinets, panelboards, wall mounted transformers, starters, boxes, and disconnect switches shall be securely fastened to building structures with the following methods. Fastening shall be by wood screws or screw type nails on wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; by machine screws, welded threaded studs, or spring tension clamps on steel work. Threaded studs driven in by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts or machine or wood screws. Threaded C clamps with retainers may be used on rigid steel conduit only. Conduits or pipe straps shall not be welded to steel structures. In partitions of light steel construction, sheet metal screws shall be used.

B. Equipment supports at process structures remote from buildings shall be as detailed and/or noted on Drawings. Where a particular support type is not noted, aluminum channel (uni-strut) shall be used. Channel type supports shall not be used in lieu of other supports noted unless approved by Engineer.

(1) All mounting brackets and strut used outside shall be aluminum. Fasteners used to mount equipment outside shall be stainless steel. The only exception to the above shall be anchor bolts for area lightpoles which shall be allowed to have galvanized threads and galvanized nuts.

a. All mounting brackets and strut used inside shall be aluminum.

b. All free standing equipment shall be anchored to its foundation using expansion bolts of the size and number recommended by the equipment manufacturer.

c. The load applied to any fastener shall not exceed one of the proof test load. Fasteners attached to concrete ceilings shall be vibration and shock resistant.

C. Since this project is in Seismic Zone 1, the CONTRACTOR shall be sure that all supports are consistent with the KBC requirements in this regard.

1.13 IDENTIFICATION

A. Equipment disconnect switches, motor starters, pushbutton stations, panels, switchgear, special device plates, and similar material shall be clearly marked. Coordinate size of lettering and wording with Engineer.

B. Mark panels, giving panel designation in one half inch letters and voltage in one quarter inch letters centered above door on exterior trim. Mark equipment mounted remotely from source of power (such as roof exhaust fans) with equipment number and source of power. Where starters are remotely mounted, marking shall include equipment name and number.

C. Except as indicated, mark all equipment with engraved lamacoid plates having black foreground and white letters. Attach interior mounted plates with contact type permanent adhesive and exterior mounted plates with self tapping stainless steel screws except where screws should not penetrate substrate use waterproof contact adhesive. Align plates on equipment being marked in center near top.

(1) All control panels, disconnects, [instruments,] etc., shall be marked to indicate the circuit they control, [or variable monitored.] Marking is to be done with engraved laminated nameplates and shall bear the designation shown on the Contract Drawings where this information is given. Nameplates shall be fastened to equipment with stainless steel screws, minimum of one each side. In no way shall the installation of mounting screws void the NEMA enclosure rating of the equipment in which they are installed. If there are more than one identical unit, they shall be given consecutive numbers or other descriptions as designated by the ENGINEER. Nameplate background color shall be white, with black engraved letters, unless otherwise noted.

(2) Control panels and disconnect switches shall be labeled with vinyl self-adhesive signs that warn of "High Voltage" (state the specific voltage). Other major equipment such as transformers, transfer switches, pump control panels, etc., shall be labeled as such. The type of labels to be used shall have orange as the basic color to conform with OSHA requirements, letters shall be black. The labels shall be of proper size to fit flatly on the surface of the enclosure to make for a neat appearance and not interfere with the operating functions of the device it is attached to. These labels shall be as manufactured by the Brady Identification Systems Division, Safety Sign Company, Westline Products Company, or equal.

D. Provide warning signs where there is hazardous exposure or danger associated with access to or operation of electrical facilities, such as pad mount transformers. Provide text of sufficient clarity and lettering of sufficient size to convey adequate information at each location; mount permanently in an appropriate and effective location. Comply with recognized industry standards for color and design.

E. Bury a continuous, pre printed, bright colored plastic ribbon cable marker with each underground power or signal circuit, regardless of whether conductors are in conduit or concrete encasement. Locate each directly over cables, 6" to 8" below finished grade.

F. Provide adequate marking of conduits containing conductors operating above 600 volts, which are exposed or concealed in accessible spaces. Except as otherwise indicated use orange banding

with black lettering. Provide self adhesive or snap on type plastic markers. Indicate voltage ratings of conductors. Locate markers at ends of conduit runs, near switches and other control devices, near items of equipment served by conductors, at points where conduits pass through walls or floors or enter non accessible construction, and at spacings of not more than 50' along each run of exposed conduit.

1.14 SUBMITTALS

A. Refer to the Division 1 sections for general requirements concerning work related submittals. For electrical work, the following quantities are required for each category of submittal (in lieu of quantities specified in Division 1), unless otherwise indicated in individual work sections (quantity does not include copies required by governing authorities, or by Contractor for its own purpose.)

(1) Shop Drawings: Minimum 6 sets, including 3 for maintenance manuals.

(2) Product Data: Minimum 6 sets, including 3 sets for maintenance manuals.

(3) Samples: 4 sets for final submission.

(4) Certifications: 3 copies.

(5) Test Reports: 3 copies.

(6) Warranties (Guarantees): 6 copies, including 3 for maintenance manuals.

(7) Maintenance Manuals: 3 final copies, including wiring diagrams, maintenance and operating instructions, parts listings, and copies of other submittals indicated for inclusion.

B. Each submittal shall have a cover sheet with Contractors/Suppliers Company Name and Contact Name, Engineer's Project Name and Number, Specification Section Number, Schedule, Material and Date Submitted, indicated on its cover sheet so Engineer may readily determine particular item Contractor proposes to furnish.

C. An example of above requirements is indicated by:

(Job Name - Number)

(Contractor/Supplier Company Name and Contact Name)

Division 16 ELECTRICAL

Section 16510 Building Lighting Fixtures

Date Submitted:

D. Operating and Maintenance Manual

(1) Submit to Engineer prior to substantial completion three (3) copies of complete operating and maintenance instructions for equipment provided under this Contract. Provide complete parts lists for all new major equipment items.

(2) Organize each maintenance manual with index and thumb tab marker for each section of information; bind in 2", 3 ring, vinyl covered binder with pockets to contain folded sheets, properly labeled on spine and face of binder with the following:

TITLE: (Project Name)

Electrical System Operation and Maintenance Data

Name and Address of Architect/Engineer

Name and Address of Consultants/Contractors

(3) Index of contents shall include equipment vendor's name and address.

(4) Include Brochures, data, all approved shop drawings, parts lists, warranties, wiring diagrams and manufacturers operating and maintenance instructions.

E. Contractor shall refer to each separate section of these specifications for information on electrical items requirement shop drawing submission and additional maintenance manual documentation.

F. Electronic Submittals

(1) Submittals sent electronically shall have a cover sheet with all information as noted in items B. and C. above. Each separate section, i.e. 16120, 16155, etc., shall have a separate cover sheet for the sections submitted. Submittals/sections without cover sheets will not be reviewed.

1.15 MATERIALS

A. All materials used shall be new and at least meet the minimum standards as established by the NEC and/or National Electrical Manufacturers Association (NEMA). All materials shall be UL listed for the application, where a listing exists. Additional requirements are found in Division 1. All equipment shall meet applicable FCC requirements and restrictions.

B. The material and equipment described herein has been specified according to a particular trade name or make to set quality standards. However, each CONTRACTOR has the right to substitute other material and equipment in lieu of that specified, other than those specifically mentioned as matching or for standardization, providing such material and equipment meets all of the requirements of those specified and is accepted, in writing by the ENGINEER.

C. The reuse of salvaged electrical equipment and/or wiring will not be permitted unless specified herein or indicated on the Contract Drawings.

D. All salvaged or abandoned electrical materials shall become the property of the OWNER and shall be removed from the job site upon completion of the project as directed by OWNER.

1.16 TEMPORARY FACILITIES

A. Refer to Division 1 sections for general requirements for temporary facilities.

B. The CONTRACTOR is responsible for coordinating all activities onsite by the Power Company

C. The CONTRACTOR shall be responsible for providing temporary electrical power as required during the course of construction and shall remove temporary service equipment when no longer required. Temporary power is also addressed in Division 1.

D. All such equipment shall be removed when permanent connections have been completed. Where it is determined, during construction, that temporary facilities, as installed, interfere with construction operations, relocate said facilities in an approved manner at no cost to Owner.

Temporary connections shall be in accordance with NEC and OSHA requirements. Repair damage or injury to equipment, materials, or personnel caused by improperly protected temporary installations. The Contractor shall be responsible for all costs for materials and installation for temporary electrical facilities and energy for their operation.

1.17 ERRORS, CORRECTIONS AND/OR OMISSIONS

A. Should a piece of utilization equipment be supplied of a different size or horsepower than shown on the Contract Drawings, the CONTRACTOR shall be responsible for installing the proper size wiring, conduit, starters, circuit breakers, etc., for proper operation of that unit and the complete electrical system at no extra cost to the OWNER.

B. It is the intent of these Specifications to provide for an electrical system installation complete in every respect, to operate in the manner and under conditions as shown in these Specifications and on the Contract Drawings. The CONTRACTOR shall notify the ENGINEER, in writing, of any omission or error at least 10 days prior to opening of bids. In the event of the CONTRACTOR'S failure to give such notice, CONTRACTOR may be required to correct work and/or furnish items omitted without additional cost. Further requirements on this subject may be found in the General Requirements, Division 1.

(1) Necessary changes or revisions in electrical work to meet any code or power company requirements shall be made by the CONTRACTOR without additional charge.

1.18 MAINTAINING CONTINUOUS ELECTRICAL SYSTEM AND SERVICE

A. Existing service(s) continuity shall be maintained at all times. In no way shall the installation and/or alteration of the electrical work interfere with or stop the normal operation of the existing facilities, except when prior arrangements have been made.

B. When additions and taps to existing service(s) require electrical outages of duration in excess of a few minutes, arrangements shall be made in advance for such outages. All outages shall be held to an acceptable minimum with none exceeding 4 hours continuous duration. If necessary, work shall be performed on premium time. If performed at night, requiring a general outage, the CONTRACTOR shall furnish an auxiliary source of light and power as required. Under no circumstances shall an electrical outage of any duration be initiated until the OWNER and ENGINEER have concurred, and as far as possible in advance.

1.19 SERVICE ENTRANCE

A. Conductors and terminations for service entrances shall be furnished and installed by the CONTRACTOR. Voltage, phase, and number of wires shall be as shown on the Drawings. Clearances for overhead entrance wires shall be per Power Company, NEC, and NESC requirements.

B. Any details not shown on the Drawings or written in the Specifications pertaining to the service entrance shall be per power company requirements. It is the CONTRACTOR'S responsibility to contact the utility prior to bidding and obtain any special requirements or costs they will be imposing. Those costs shall be included in the bid.

C. On underground service entrances from pad mounted transformers, the CONTRACTOR shall be responsible for furnishing and installing all primary, secondary, and metering conduits, as well as secondary service/metering conductors. The CONTRACTOR shall be responsible for furnishing pull wires in primary conduits for use by the power company. The CONTRACTOR shall be responsible for fabricating the required concrete pad that the transformer will be mounted on. The CONTRACTOR shall also mount the meter base furnished by the power company.

END SECTION

SECTION 16051 - BASIC MATERIALS AND METHODS

1. RELATED DOCUMENTS

A. General provisions of Contract, General and Supplementary Conditions and General Requirements apply to this Section.

B. Requirements of Electrical General Provision Sections govern this Section, where applicable.

C. Requirements of the sections govern work specified in this section, where applicable.

2. DESCRIPTION OF WORK

A. Provide labor, material, equipment and services necessary for complete and proper Basic Materials and Methods.

B. Requirements of this section apply to electrical work specified elsewhere.

3. BASIC MATERIALS AND METHODS

A. Unless otherwise indicated, install all wiring in rigid metal conduit, electric metallic tubing, or flexible metallic conduit specified below or as indicated on Drawings. Do not use surface metal raceways on floor. Do not use nonmetallic sheathed cable, or armored cable (Bx or Type AC).

B. Provide complete wiring from point of service connection to all receptacles, lighting fixtures, devices, utilization equipment and outlets for future extensions, as indicated on Drawings. Provide ample slack wire for connections. Unless otherwise specified, provide No. 12 AWG or larger for all branch circuit conductors. In outlet boxes designated for future use, tape ends of wires and install blank covers. Do not install telephone signal wires unless otherwise specified.

C. Do not bend cables, either permanently or temporarily during installation, to radii less than 10 times outer diameters, except where shorter radii are approved by engineer for conditions making specified radius impracticable.

D. All conductors No. 10 and smaller located in branch circuit panelboards, signal cabinets, signal control boards, switchboards and motor control centers shall be neatly and securely bundled. For conductors larger than No. 10 located in switchboards, motor control centers and pull boxes, neatly and securely cable in individual circuits. Use nylon straps made of self extinguishing nylon having a temperature range of 65 degrees F. to + 350 degrees F. Construct each strap with a locking hub or head on one end and a taper on other.

E. Where two or more conduits have been installed in place of a single conduit because of space conditions, use duplicate conductors in each conduit, including neutrals where required, and total capacity of duplicate conductors shall be not less than capacity of conductors replaced.

F. Where length of a branch circuit , from panel to first outlet, exceeds 75 feet for a 120 volt, 20 amp. circuit or 175 feet for a 277 volt circuit, use No. 10 AWG conductor size.

G. Where homerun circuit numbers are indicated on Drawings, follow such numbers in connecting circuits to panelboards. Where homerun circuit numbers are not indicated on Drawings, divide similar types of connected loads among phase buses in such a manner that, in normal usage, phase bus currents will be approximately equal. Connect each branch circuit homerun containing two or more circuits to circuit breakers or switch in a three wire or four wire branch circuit panelboard in such a manner that no two circuits will be fed from same bus. Where panelboard cabinets are recessed, conduits with sufficient capacity to carry required number and size of future conductors for all spare branch circuit protective devices and

spaces in panelboard shall be stubbed up concealed to a junction box for future connections and extensions located as follows:

(1) In an area with removable ceiling, junction box shall be accessible above suspended ceiling.

(2) In an area with non-removable ceiling, recess junction box in ceiling directly over panelboard location.

(3) In an area without finished ceiling but with finished walls, recess junction box in wall directly above panelboard location at ceiling line.

(4) In an area without suspended ceiling but with unfinished walls, recess junction box on ceiling directly over panelboard location.

H. Provide all junction boxes in accordance with NEC as to conductor capacity for future conductors with adequate knock outs on all four sides and a blank screw cover. Plates shall match those installed in that particular area.

I. Install only one 277 volt circuit in a wall switch outlet box. Where more than one 277 volt circuit (on different phases) is indicated on drawings as being run to multi wall switch units from a ceiling branch circuit outlet box, provide individual conduit with phase and lighting fixture control wiring and separate outlet boxes with separated wall plates to segregate each phase.

END SECTION

SECTION 16110 - ELECTRICAL RACEWAYS

1.1 RELATED DOCUMENTS

A. General provisions of Contract, General and Supplementary Conditions and General Requirements.

B. Requirements of Electrical General Provision Sections govern this Section, where applicable.

C. This section shall be governed by Alternates insofar as they apply to this work.

1.2 DESCRIPTION OF WORK

A. Provide labor, materials, equipment and services necessary for proper and complete installation of electrical raceways.

B. The requirements of this section apply to electrical raceway work specified elsewhere in these specifications.

1.3 QUALITY ASSURANCE

A. Comply with applicable portions of National Electrical Manufacturers Association standards pertaining to metallic and nonmetallic conduit, duct and EMT.

B. Comply with applicable portions of Underwriters' Laboratories safety standards pertaining to electrical raceways; and provide products which have been UL listed and labeled.

C. Comply with National Electrical Code (NFPA No. 70) as applicable to construction and installation of electrical raceways.

D. Raceways shall be marked with the manufacturer's name or trademark as well as type of raceway and size. This marking shall appear at least once every 10 feet and shall be of sufficient durability to withstand the environment involved. All raceways shall be furnished and installed as outlined under the following sections of this Specification.

1.4 SUBMITTALS

A. Submit manufacturer's standard data sheets for rigid metal conduit, EMT, wireways, rigid PVC conduit, flexible metal conduit, bitumastic coatings and fittings for all types of raceways.

1.5 MATERIAL

A. Types/acceptable manufacturers of electrical raceways:

Electrical metallic tubing – Allied Tube, Wheatland Tube

Liquid tight flexible metal conduit – Allied Tube, Eastern Wire

Rigid steel conduit – Allied Tube, Maverick Tube

Rigid aluminum conduit – Wheatland Tube, Allied tube, Indalex

Raintight wireways – Square "D"; Cooper B-Line

Rigid PVC conduit – Carlon, Allied Tube, Can Tex

B. For each electrical raceway system indicated, provide assembly of conduit, tubing or duct, and fittings, including, but not necessarily limited to, connectors, couplings, offsets, elbows, straps, bushings, expansion joints, hangers, and other components and accessories needed for a complete system.

(1) Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) for each service indicated. Where types and grades are not indicated, provide proper selection determined by Installer to fulfill wiring requirements, and comply with applicable portions of National Electrical Code for electrical raceways.

a. Provide threaded steel conduit and fittings in accordance with U.L. 6 and ANSI C80.1, zinc coated or coated with and approved corrosion resistant coating on inside. Conduits not completely encased in concrete but laid directly in or in contact with ground or on a vapor barrier shall be field coated on outside with asphaltum before installation or shall have an additional outside factory coating of polyvinyl chloride or phenolic resin epoxy material or other equally flexible and chemical resistant material.

b. Provide electrical metallic tubing, EMT and fittings in accordance with U.L. 797 and ANSI C80.3, zinc coated on outside and either zinc coated or coated with an approved corrosion resistant coating on inside.

c. Liquid tight flexible metal conduit shall consist of a core of flexible galvanized steel tubing over which is extruded a liquid tight jacket of poly vinyl chloride (PVC). Liquid tight flexible conduits not larger than 1 1/4 inch size shall be provided with a continuous copper bonding conductor wound spirally between convolutions. Products shall comply with U.L. 1 and U.L. 360.

d. Flexible metal conduit (commercial Greenfield) and fittings shall be in accordance with U.L. 1 and U.L. 1479.

e. Fittings for threaded steel and thin wall (EMT type) conduit shall be either iron or steel only.

f. Compression type threadless fitting shall not be used with threaded steel conduit. Where it is impractical (due to limited working space when employing normal installation practices) to use common construction tools for installation of threaded steel conduit with standard couplings, locknuts and bushings, steel set screw connectors and couplings will be permitted provided they meet the following requirements: body of steel set screw connector and coupling shall have a wall thickness at least equal to wall thickness of conduit with which it is to be used. Set screws shall be of case hardened steel with hex head, and with cup point to firmly seat in wall of conduit for positive ground. Set screws shall be tightened to embed in conduit wall. Tightening screws with pliers will not be permitted.

1/2 through 2 inch connectors shall have one set screw each.

2 1/2 through 4 inch connectors shall have two set screws each.

1/2 through 2 inch couplings shall have two set screws each.

2 1/2 through 4 inch couplings shall have four set screws each.

Conduit nipples with running threads shall not be used.

g. Couplings and connectors for EMT shall be made of either steel or malleable iron only, shall be "Concretetight" or "Raintight" and shall be of either gland and ring compression type, or stainless steel multiple point locking type. All connectors shall have insulated throats. Fittings using indentations as a means of attachment shall not be used.

h. Bushings for threaded steel conduit and connectors for EMT shall be insulated type, designed to prevent abrasion of wires without impairing continuity of conduit grounding system. Insulating insert shall be made of thermosetting or fiber material which conforms to flame test requirements of UL 514, molded or locked into metallic body of fitting. Conduit bushings made entirely of nonmetallic material shall not be used.

i. Fittings for liquid tight flexible conduit shall be in accordance with U.L. 1 and U.L. 360 of a type incorporating a threaded grounding cone, a steel, nylon or equal plastic compression ring, and a gland for tightening. Fitting shall be made of either steel or malleable iron only, shall have insulated throats and shall be of a type having a male thread and locknut or male bushing with or without "O" ring seal.

j. Die cast zinc alloy fittings and fittings made of inferior materials, such as "pot metal", shall not be used on any type of rigid or flexible conduit or EMT.

(2) Wireways

a. Provide wireways of sizes indicated. Constructed of galvanized steel with screw on covers and knockouts approximately 6" o.c. Provide raceway fittings indicated which match and mate with raceway. Finish wireways with gray epoxy paint over corrosion resistant primer.

b. Use wireways only where indicated on Drawings.

c. Effectively ground all wireways.

(3) PVC Conduit

a. Provide nonmetallic conduit, ducts and fittings of types, sizes and weights (wall thicknesses) for each service indicated. Where types and grades are not indicated, provide proper selection determined by Installer to fulfill wiring requirements, and comply with applicable portions of National Electrical Code for electrical raceways. Products shall be in accordance with NEMA TC-2 and U.L. 651.

b. PVC Conduit and Tubing Fittings: NEMA Standards Pub. No. TC 3 and U.L. 514B.

c. Except as otherwise indicated, provide conduit, tubing and duct accessories of types, sizes, and materials indicated, including, but not necessarily limited to, hangers, clamps, rollers, traps, fasteners, brackets, expansion and deflection fittings, complying with manufacturer's published product information, and designed and constructed by manufacturer for use in applications indicated.

(4) Provide watertight hub connections at all conduits connecting to NEMA 3R or 4 enclosures. Myers or equal.

(5) Aluminum Conduit

a. Aluminum conduit shall be extruded from alloy 6063 and shall be the rigid type, non-toxic, corrosion resistant, and non-staining. It shall be manufactured per UL standards as well as listed/labeled by same.

b. Fittings, boxes and accessories used in conjunction with aluminum conduit shall be die cast aluminum, copper free type. They shall be resistant to both chemical and galvanic corrosion. All covers shall have neoprene gaskets.

c. Standard threaded couplings, locknuts, bushings, and elbows made only of aluminum alloy materials. Aluminum fittings containing more than 0.4 percent copper are prohibited.

d. Locknuts and bushings: As specified for rigid steel conduit, except of aluminum materials.

e. Set screw fittings: Not permitted for use with aluminum conduit.

C. Conduit Supports

(1) Pipe straps and supports shall be PVC coated steel in pipe galleries and chemical feed rooms. All others shall be zinc coated steel.

(2) Provide individual pipe hangers, multiple (trapeze) pipe hangers, and riser clamps as necessary to support conduits. All parts and hardware shall be zinc coated throughout. Provide all U bolts, clamps, attachments, and other hardware necessary for hanger assembly, and for securing hanger rods and conduits. Design each multiple hanger to support a load equal to or greater than sum of weights of conduits, wires, hanger itself, and 200 pounds.

(3) Fasten pipe straps and hanger rods to surfaces as specified under "Support of Electrical Items" paragraph in the `ELECTRICAL, GENERAL PROVISIONS' section.

(4) All EMT and conduits not embedded in concrete or masonry shall be securely and independently supported so that no strain will be transmitted to outlet box and pull box supports. Supports shall be rigid enough to prevent distortion of conduits during wire pulling.

(5) Support individual horizontal conduits by one hole pipe straps or separate pipe hangers for sizes 1 1/2 inch and smaller, and by separate pipe hangers for larger sizes. Spring steel fasteners may be used in lieu of pipe straps or hangers for sizes 1 1/2 inch and smaller in dry locations only. Hanger rods used with spring steel fasteners shall be not less than 1/4 inch diameter steel with corrosion resistant finish. Spring steel fasteners shall be specifically designed for supporting single conduits or EMT. Unless otherwise specified, do not use wire as a means of support.

(6) Where two or more horizontal conduits or EMT run parallel and at same elevation, they shall be supported on multiple (trapeze) pipe hangers. Secure each conduit or EMT to horizontal hanger member by a U bolt, one hole strap or other specially designed and approved fastener.

(7) Branch circuit conduits and raceways above suspended ceilings may be supported from floor construction above or from main ceiling support members, however, finished installation shall not interfere with removability of ceiling panels.

1.6 INSTALLATION

A. Install conduit, tubing and wireway products as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and complying with recognized industry practices to ensure that products serve intended functions. Handle conduit and tubing carefully to prevent bending and end damage, and to avoid scoring finish. Store pipe and tubing inside and protect from weather. When necessary to store outdoors, elevate well above grade and enclose with durable, watertight wrapping. Provide color coded end cap thread protectors on exposed threads of metal conduit.

B. Conduit buried in concrete shall be rigid steel unless otherwise indicated. Do not install EMT underground, in slabs on grade, in wet locations, in hazardous areas, or for circuits operating at more than 600 volts. Do not use EMT in concrete placements where vibrators will be used. Metallic conduit buried in concrete shall be threaded steel only. Outside diameter of conduit buried in concrete shall not exceed one third of the thickness of structural slab, wall or beam in which it is placed. Locate conduit entirely within middle third of member wherever possible. Lateral spacing of conduits buried in concrete slabs shall be not less than three diameters except where drawings definitely indicate that concrete slab has been specially designed to accommodate a closer spacing of conduits entering wire closets, panelboards, or electrical boxes or arrangements is approved by Engineer.

C. Use flexible conduits for connections to motors and other electrical equipment when it is subject to movement, vibrations, misalignment, cramped quarters or where noise transmission is to be eliminated or reduced. Flexible conduit used to meet the above requirements shall in addition be liquid tight type when installed under any of the following conditions:

(1) Exterior locations

(2) Moisture or humidity laden atmosphere where it is possible for condensation to accumulate.

(3) Corrosive atmosphere.

(4) Where water or spray due to wash down operations is frequent or possible.

(5) Wherever there is a possibility of seepage or dripping of oil, grease, or water.

D. Run concealed conduit and EMT in as direct lines as possible with a minimum number of bends of longest possible radius. Run exposed conduits and EMT parallel to or at right angles to lines of building. All bends shall be free from dents or flattening.

E. Conduit and EMT runs shall be mechanically and electrically continuous from service entrance to all outlets. Unless otherwise specified, each conduit shall enter and be securely connected to a cabinet, junction box, pull box or outlet box by means of a locknut on outside and a bushing on inside or by means of a liquid tight, threaded, self locking, cold weld type wedge adapter. Where nominal circuit voltage exceeds 250 volts, (1) in rigid conduit, an additional locknut shall be provided, one locknut being inside and one locknut outside and (2) in EMT or flexible metal conduit, the one locknut shall be made wrench tight. All locknuts shall be bonding type with sharp edges for digging into metal wall of an enclosure and shall be installed in a manner that will assure a locking installation. Locknuts and bushings or self locking adapters will not be required where conduits are screwed into tapped connections. All vertical runs of conduit or EMT terminating in bottoms of wall boxes or cabinets shall be protected from entrance of foreign material prior to installation of conductors.

F. The minimum size of threaded conduit, EMT, and flexible metallic conduit shall be 3/4" except as follows:

(1) Unless otherwise specified or indicated on drawings.

(2) Unless otherwise indicated on Drawings, telephone, telemetry and control circuit conduits shall be not less than 1 inch trade size.

G. Check size of all raceways to determine that green equipment ground conductor, specified, indicated or required can be installed in same raceway with phase and neutral conductors in accordance with percentage of fill requirements of NEC. If necessary, sizes of duct, conduit, tubing or raceway indicated or specified shall be increased to accommodate all conductors without additional cost to Owner.

H. Unless otherwise specified or indicated on Drawings, all conduit and EMT shall be installed concealed. Unless otherwise indicated on Drawings, conduit and EMT may be run exposed on unfinished walls, on unfurred basement ceilings, in penthouses, attics and roof spaces.

I. In wood construction, run conduits and EMT in rough underflooring, on top of joists or between joists. Furring strips may be notched at any point but joists may be notched only at points not more than one foot from a point of support and notches may not be deeper than 1 3/8". Conduits and EMT may be run exposed on bottoms of joists only in unfinished rooms where permitted by Engineer.

J. Horizontal cross runs of conduit or EMT may be installed in partitions only where explicitly permitted by Architect. Install exposed horizontal runs, where permitted, close to ceiling or ceiling beams and

above water, steam or other piping. Run conduits and EMT connected to wall outlets in such a manner that they will not cross water, steam or waste pipes or radiator branches. Do not run conduits and EMT through beams, except where clearly indicated on Drawings or where permitted by Architect.

K. Install every conduit system complete before conductors are drawn in.

L. Expansion Fittings: Each conduit that is buried in or rigidly secured to building construction on opposite sides of a building expansion joint and each long run of exposed conduit that may be subject to excessive stresses shall be provided with an expansion fitting. Expansion fitting shall be made of hot dipped galvanized malleable iron and shall have a factory installed packing, which will prevent entrance of water, a pressure ring, and a grounding ring.

(1) In addition to grounding ring, provide a separate external copper bonding jumper secured by grounding straps on each end of fitting.

(2) Where conduits are buried in concrete, they shall cross building expansion joints at right angles, and expansion fittings shall be installed in accordance with manufacturer's instructions. Provide free ends of conduits with insulated bushings.

M. Sealing Fittings: Sealing fittings for use with threaded steel conduits shall be threaded, zinc or cadmium coated and cast or malleable iron type fittings. Fittings used to prevent passage of water vapor shall be of the continuous drain type.

(1) Install and seal sealing fittings in accordance with manufacturer's recommendations at suitable, approved, accessible locations. In concealed work, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates.

(2) Install sealing fittings at the following points, and elsewhere as indicated.

a. Where conduits enter or leave hazardous areas equipped with explosion proof lighting fixtures, switches or receptacles to prevent passage of explosive vapors.

b. Where conduits pass from warm locations to cold locations, such as refrigerated spaces and air conditioned spaces, to prevent passage of water vapor.

c. Where required by NEC.

N. Expansion and Deflection Couplings

(1) Accommodate 1.9 cm (0.75 inch) deflection, expansion, or contraction in any direction and allow 30 degree angular deflections.

(2) Include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL, and the NEC code tables for ground conductors.

(3) Watertight, seismically qualified, corrosion-resistant, threaded for and compatible with rigid metal conduit.

(4) Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material and stainless steel jacket clamps.

1.7 SPECIAL INSTALLATION INSTRUCTIONS

A. The following installation requirements are specific to this project and shall be strictly enforced.

(1) All exterior below grade conduits shall be Schedule 80 PVC except as noted on Drawings for telephone and power company circuits. Above grade shall be rigid aluminum. Rigid steel below grade shall be asphaltum coated with minimum two (2) coats Carboline Bitumastic 50 or equal.

(2) All conduit installed within pump station building shall be rigid aluminum.

(3) Aluminum conduit in contact with concrete and/or where installed below grade or in direct contact with concrete shall have polytape applied per Section 16200.

END SECTION

SECTION 16120 - CABLE, WIRE AND CONNECTORS

1.1 RELATED DOCUMENTS

A. General provisions of Contract, General and Supplementary Conditions and General Requirements apply to work specified in this section.

B. Requirements of Electrical General Provision Sections govern this Section, where applicable.

C. This section shall be governed by Alternates insofar as they affect this work.

1.2 DESCRIPTION OF WORK

A. Provide labor, materials, equipment and services necessary for proper and complete installation of cable, wire and connectors.

B. Requirements of this section apply to cable and wire work specified elsewhere in these specifications.

1.3 QUALITY ASSURANCE

A. Comply with National Electrical Code (NFPA 70) as applicable to construction and installation of electrical cable, wire and connectors.

B. Provide electrical cable, wire and connectors which have been listed and labeled by Underwriters Laboratories.

C. Comply with National Electrical Manufacturers Association/Insulated Power Cable Engineers Association Standards publications pertaining to materials, construction and testing wire cable, where applicable.

D. Manufacturers offering products complying with requirements include:

(1) Cable and Wire:

Paige Pump Wire

Southwire Company

Triangle PWC, Inc.

Belden

Clifford of Vermont

E. Connectors:

Buchanan

Burndy Corporation

3M Company

Thomas and Betts Co.

King Innovation

1.4 SUBMITTALS

A. Submit manufacturer's product data on all 4-20MA signal cables and Telemetry System shielded cables.

B. Submit manufacturer's product data for watertight wire connectors.

1.5 MATERIALS

A. Cable and Wire

(1) Provide factory fabricated cable, wire and connectors of sizes, ratings, materials and types indicated for each service. Where not indicated, provide proper selection as determined by equipment manufacturer to comply with project's equipment installation requirements and NEC standards, including equipment control and instrumentation requirements.

(2) Use single conductor annealed copper type for all wires and cables for secondary service, feeders and branch circuits, unless specified otherwise.

(3) Use No. 12 or No. 10 solid conductor for branch circuit wiring connected to receptacles, lighting switches and snap switches.

(4) Use minimum 75 degrees C rated insulation unless specified otherwise, indicated on Drawings, or required by NEC.

(5) Wire #12 - #1 shall be applied based on a 60 degree Celsius temperature rise. Building wire larger than #1 may be applied at its 75 degree Celsius temperature rise.

(6) Use 600 volt insulation rating unless specified or indicated otherwise. Where operating voltage is less than 100 volts, wires or cables may be insulated for 300 volts provided they are isolated from higher voltage systems.

B. Use (1) 16 ga. twisted/shielded pair cable for 4-20ma signal circuits from flow, level, alarm transmitters, V.F. drives, etc. Cable shall be Belden No. 8719, or General Cable type VNTC with 100% shield coverage and stranded/tinned 18 ga. drain wire, 600V rated.

C. Valves, valve controllers, start-stop selector switches, etc. Use minimum 75 degrees C rated insulation unless specified otherwise, indicated on Drawings, or required by NEC. Use 600 volt insulation rating unless specified or indicated otherwise.

D. Connectors

(1) All circuit wire connectors for wiring #6 AWG and smaller shall be made using watertight type connectors which have been prefilled with silicone sealant. Connectors shall have lifetime guarantee and be UL 50 raintight/watertight listed. Connectors shall have a temperature rating of 105 degrees C. minimum and silicone sealant shall be rated for -45 to 400 degrees F.

(2) Watertight type wire connectors shall be King Innovation DryConn or equivalent.

E. Electrical Lugs

(1) Lugs from #6 AWG - 1000 MCM shall be compression types with barrels to provide maximum conductor contact and tensile strength. They shall be manufactured from high conductivity copper

and entirely tin plated. The lugs must have a current carrying capacity equal to the conductors for which they are rated and must also meet all UL requirements. All lugs above 4/0 shall be 2 hole lugs with NEMA spacing. The lugs shall be rated for operation through 35 KV. The lugs shall be of closed end construction to exclude moisture migration into the cable conductor.

1.6 INSTALLATION

A. Install electrical cable wire and connectors as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure products serve intended functions.

B. Store cable, wire and connectors in factory installed coverings in a clean, dry indoor space which provides protection against weather.

C. Pull conductors together where more than one is being installed in a raceway.

D. Use pulling compound or lubricant, when necessary; compound must not deteriorate conductor and insulation.

E. Do not use a pulling means, including fish tape, cable or rope which can damage raceway.

F. Install exposed cable, parallel and perpendicular to surface or exposed structural members and follow surface contours, where possible.

G. Color Code: All secondary service, feeder and branch circuit conductors throughout projects as follows:

208Y/120 volts	Phase	480y/277 volts
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	White
Green	Ground	Green

H. Keep conductor splices to a minimum.

I. Install splices and taps for power wiring which has equivalent or better mechanical strength and insulation as conductor.

J. Use splice and tap connectors on power wiring which is compatible with conductor material.

K. Do not install more than three conductors in any one splice.

L. Install poly pull line in all spare/empty conduits.

M. Prior to energization, check cable and wire for continuity of circuitry and for short circuits. Correct malfunction when detected.

N. Subsequent to wire and cable hook ups, energize circuitry and demonstrate functioning in accordance with requirements.

O. Multi conductor cables shall not be spliced but shall run continuous from point of supply to equipment connection.

P. Shielded pair cable shall be grounded at one end only and as close to signal source as possible.

Q. A minimum separation of 12 inches between analog signal leads and a-c power leads should be maintained. For a-c power leads carrying 100 amps or greater, a 24 inch separation should be maintained. Parallel runs should be limited to less than 500 feet. Perpendicular runs may be as close as 6 inches.

1.7 SPECIAL INSTALLATION INSTRUCTIONS

A. Wire or cable splices for control and instrumentation circuits shall not be accepted.

B. Do not install any control or instrumentation cable or wiring in same conduit or J-box with electrical power wiring, unless otherwise noted.

C. NOTE: Electrical Contractor shall be responsible for providing and installing all power, control and instrumentation wiring and cable from all remote devices to the pump station control panel (PCP). This shall include the termination of wires/cables on both ends and installation of wire No. markers.

END SECTION

SECTION 16130 - ELECTRICAL BOXES AND FITTINGS

1. RELATED DOCUMENTS

A. General provisions of contract General and Supplementary Conditions and General Requirements.

B. Requirements of Electrical General Provision Sections govern this Section, where applicable.

C. This Section shall be governed by Alternates insofar as they affect this work.

2. DESCRIPTION OF WORK

A. Provide labor, materials, equipment, and services for proper and complete installation of electrical boxes and fittings.

B. Extent of electrical box and electrical fitting work is indicated by drawings and schedules, and requirements of this section.

3. QUALITY ASSURANCE

A. Comply with National Electrical Code (NFPA 70) as applicable to construction and installation of electrical boxes and fittings.

B. Provide boxes and fittings which have been listed and labeled by Underwriters' Laboratories.

C. Comply with National Electrical Manufacturers Association standards as applicable to nonmetallic fittings for underground installation.

4. MATERIAL

A. Provide boxes, cabinets, and fittings as indicated on Drawings, schedules, and as required for job.

B. Interior Outlet Boxes: Provide galvanized steel interior outlet wiring boxes, of type, shape and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices.

C. Interior Outlet Box Accessories: Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual wiring situations. Choice of accessories is Installer's option.

D. Weatherproof Outlet Boxes: Provide corrosion resistant cast metal weatherproof outlet wiring boxes, of type, shape and size, including depth of box, with threaded conduit ends and cast metal face plate, including face plate gasket and corrosion proof fasteners.

E. Junction and Pull Boxes: Provide galvanized sheet steel junction and pull boxes, with screw on covers; of type, shape and size, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers.

F. Conduit Bodies: Provide galvanized or aluminum cast metal conduit bodies, of type, shape, and size, to suit each respective location and installation, constructed with threaded conduit ends, removable cover, and corrosion resistant screws.

G. Bushings, Knockout Closures and Locknuts: Provide corrosion resistant punched steel box knockout closures, conduit locknuts and malleable iron conduit bushings of type and size to suit each respective use and installation.

H. Acceptable Manufacturers

(1) Appleton, Crouse-Hinds, Hoffman or T&B or equal.

5. INSTALLATION

A. Install electrical boxes and fittings as indicated, or in compliance with NEC requirements, in accordance with manufacturer's written instructions and with recognized industry practices to ensure that boxes and fittings serve intended purposes.

B. Provide weatherproof outlets for interior and exterior locations exposed to weather or moisture exposure.

C. Provide knockout closures to cap unused knockout holes where blanks have been removed.

D. Locate boxes and conduit bodies so as to ensure accessibility of electrical wiring.

E. Avoid using round boxes where conduit must enter box through side of box, which would result in a difficult and insecure connection with a locknut or bushing on rounded surface.

F. Secure boxes rigidly to substrate upon which they are being mounted, or solidly embed boxes in concrete or masonry.

G. Do not use sectional (gangable) boxes.

H. Use threaded hub type outlet boxes (NEMA 4X) with gasketed weatherproof covers and stainless steel hardware where surface mounted at following locations:

(1) Exterior locations

(2) Where exposed to moisture laden atmosphere

(3) Where indicated on drawings

(4) At pump station and valve vault areas.

I. Measure mounting height from finished floor or finished grade to center line of cover plate.

J. NEMA 4 junction and pull boxes shall be stainless steel, unless otherwise noted.

K. Junction boxes for use in wet-wells and other hazardous areas shall be water tight, rust proof, corrosion resistant, and explosion proof with threaded conduit openings (5 ½ full threads - minimum) and provided with rust proof hardware.

L. Explosion proof sealing fittings shall be furnished and installed in accordance with NEC requirements.

M. Outlet or junction boxes for use with exposed aluminum conduit shall be copper free, cast aluminum type, or stainless steel.

N. Saw cut openings for boxes in exposed masonry walls.

END SECTION

SECTION 16135 - ELECTRICAL EQUIPMENT SUPPORTS

1. RELATED DOCUMENTS

A. General provisions of contract General and Supplementary Conditions and General Requirements.

B. Requirements of Electrical General Provision Sections govern this Section, where applicable.

C. This Section shall be governed by Alternates insofar as they affect this work.

2. DESCRIPTION OF WORK

A. Provide labor, materials, equipment, and services for proper and complete installation of electrical equipment supports.

3. QUALITY ASSURANCE

A. Comply with National Electrical Code (NFPA 70) as applicable to construction and installation of electrical equipment supports.

B. Provide fittings which have been listed and labeled by Underwriters' Laboratories.

C. Acceptable Manufacturers: Kindorf, Unistrut, Allied or equal.

4. MATERIALS

A. All exterior and interior mounting brackets and strut shall be aluminum. Fasteners used to mount equipment where exposed to weather or in corrosive environments shall be non-magnetic stainless steel.

5. INSTALLATION

A. All electrical equipment shall be rigidly mounted, and installed using supporting devices as indicated on the Contract Drawings, as required by the work, and described herein.

B. All free standing equipment shall be anchored to its foundation using expansion bolts with stainless steel fasteners of the size and number recommended by the equipment manufacturer.

C. Where required, seismic restraints shall be provided for electrical equipment.

END SECTION

SECTION 16140 - WIRING DEVICES

1. RELATED DOCUMENTS

A. General provisions of Contract, General and Supplementary Conditions and General Requirements.

B. Requirements of Electrical General Provision sections govern this Section, where applicable.

C. This section shall be governed by alternates insofar as they affect this work.

2. DESCRIPTION OF WORK

A. Provide labor, material, equipment and services for proper and complete installation of wiring devices.

3. QUALITY ASSURANCE

A. Comply with National Electrical Code (NFPA No. 70) as applicable to construction and installation of electrical wiring devices.

B. Provide electrical wiring devices which have been tested, listed and labeled by Underwriters' Laboratories.

C. Comply with National Electrical Manufacturers Association standards for wiring devices.

4. SUBMITTALS

A. Submit manufacturer's data on wiring devices and plates.

B. Device manufacturers other than those listed below must have ten day written prior approval.

C. It is the responsibility of the contractor to provide data that devices are equal other than by catalog numbers.

5. MATERIAL

A. Provide factory fabricated wiring devices, in type, color, and electrical rating for service indicated and as described below. Where type and grade are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements, and comply with NEC and NEMA standards for wiring devices.

B. Devices and Plates

(1) All receptacles, switches, and non-metallic device plates shall be gray in color unless otherwise indicated.

C. Device Plates - Standard

(1) All plates shall be of 302 stainless steel (non magnetic) with rounded or beveled edges. All device plate screws shall be stainless steel with countersunk heads. Plates shall be installed vertically and with an alignment tolerance of 1/16 inch. Device plates shall be of the one-piece type, of suitable shape for the devices to be covered. Plates shall have a smooth finish with no crevices to collect dirt. Oversize plates are not acceptable.

(2) All non-weatherproof metal wall plates shall be corrosion resistant 302 super stainless steel unless otherwise noted.

D. Device Plates - Weatherproof

(1) All devices in dusty and or wet locations shall use weatherproof corrosion resistant cover plates of cast aluminum, rustproof, weatherproof, with spring loaded "in use" cover for receptacle and external handle or neoprene cover for switch. Similar to Hubbell 1795 for switches and Hubbell WP8M or WP26MH for receptacles.

E. Switches

(1) All switches shall be 20 ampere for 120/277 volt AC lighting circuits.

(2) All switches shall be specification grade side wired.

(3) Switches shall be of the following mfg.

	HUBBELL	BRYANT
Single Pole	1221	1121
Double Pole	1122	1122
Three Way	C5320	1123
Four Way	1124	1124
Pilot Light	1121 PL	1121 PL

F. Receptacles – Specification Grade

(1) GFCI Receptacles

1. Ground fault shall have solid state sensing circuitry and a circuit interrupter switch. It shall be rated for operation on a 60 Hz, 120V, 20A branch circuit. Device shall have nominal sensitivity to ground leakage current of four to six milliamperes and shall function to interrupt the current supply for any value of ground leakage current above five milliamperes on load side of the device. Device shall have a minimum nominal tripping time of 1/30th of a second.

2. Device shall be of the following mfg.

	HUBBELL	BRYANT
15A 125V 5 15R	GF5252	GF5262
20A 125V 5 20R	GF5352	GF5362

(2) Duplex Receptacles Corrosion Resistant

1. Receptacles shall be 5-20R 20A, 125V, 2 pole, 3 wire as required.

2. Receptacles shall have the following characteristics:

1) "T" type contacts for phase and neutral female connections.

2) Female ground connections shall be riveted to bridge.

3) Bridge shall be of hot dipped steel.

4) Face plate shall be impact resistant nylon.

5) Receptacle body shall be of heat resistant thermoset material.

6) Face plate to bridge connecting rivet shall be spun brass.

7) Automatic self grounding clip.

8) Receptacles shall be of the following mfg.

HUBBELL

20A 125V 5-20R	HBL53CM62 (Marine Grade)

9) Corrosion resistant GFCI receptacles shall be Hubbell GF8300A (Hospital Grade).

6. INSTALLATION

A. Install wiring devices where indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and in accordance with recognized industry practices to ensure that products serve intended function.

B. Delay installation of devices until wiring is completed.

C. Install receptacles and switches only in electrical boxes which are clean; free from excess building materials and debris.

D. Install receptacles with ground pin on top.

E. All devices and plates shall be of the same manufacturer.

F. Do not use sectional plates.

G. Upon installation of wall plates, receptacles and switches, advise Contractor regarding proper and cautious use of convenience outlets. At time of Substantial Completion, replace those items which have been damaged, including those burned and scored by faulty plugs.

H. Test wiring devices to ensure electrical continuity of grounding connections, and after energizing circuitry, to demonstrate compliance with requirements.

I. All outlet boxes shall have a cover plate.

END SECTION

SECTION 16150 - MOTORS

1.1 RELATED DOCUMENTS

A. General provisions of Contract, General and Supplementary Conditions, and General Requirements, apply to this Section.

B. Requirements of Electrical General Provisions sections govern work specified in this Section.

C. This section shall be governed by alternates insofar as they affect this work.

1.2 DESCRIPTION OF WORK

A. Provide labor, materials, equipment and services necessary for proper and complete installation of motors.

B. Motors are to be furnished with driven equipment. All motors shall conform to the following Specifications and any special requirements of the driven equipment. Special requirements of the driven equipment shall take precedence over these Specifications should a discrepancy occur. Starting torque and slip ratings shall conform to the requirements of the driven equipment. [All motors 15 horsepower and larger (230 volt) or 25 horsepower and larger (480 volt) shall be started via solid state reduced voltage starters unless otherwise noted on the Contract Drawings.]

C. Polyphase motors shall be of the squirrel cage induction type and single phase of the capacitor start-induction run type except as otherwise noted.

1.3 QUALITY ASSURANCE

A. Manufacturers offering products complying with requirements include:

General Electric

Westinghouse

U.S. Motors

Gould Century

Baldor

Marathon

Reliance

Magnatek

Siemens

Or Equal

B. Provide motors which have been listed and labeled by Underwriters Laboratories.

C. Comply with National Electrical Code (NFPA No. 70) as applicable to installation and construction of electrical power/distribution transformers.

D. Comply with applicable portions of National Electrical Manufacturers Association Standards ST20 pertaining to power/distribution transformers.

E. Comply with applicable American National Standards Institute (ANSI) standards pertaining to power/distribution transformers.

F. Comply with applicable portions of Institute of Electrical and Electronic Engineers (IEEE) standards pertaining to motors.

1.4 SUBMITTALS

A. Shop drawings shall consist of motor dimensions, name¬plate data from each motor and tests as outlined above. Also included shall be efficiency and power factor at 100, 75, and 50 percent load. Operation, maintenance, and lubrication information (including bearing catalog numbers) shall be submitted with shop drawings for review.

1.5 EQUIPMENT

A. Motors 200 Horsepower and Under for Service Under 600 Volts

(1) Ratings and Electrical Characteristics

a. Time: All motors shall be rated for continuous duty.

b. Temperature: Based on NEMA standards for a maximum ambient temperature of 40 degrees Celsius and an altitude of 3,300 feet or less, according to service factor and insulation class employed.

c. Voltage: All single phase motors shall be rated 120/208/230 volts and all polyphase motors 230/460 volts. All motors shall be capable of normal operation at balanced voltages in the range of ±1 0 percent from rated winding voltage.

d. Frequency: All a-c motors shall be rated for 60 Hz. operation. All motors shall be capable of normal operation at frequencies 5 percent above or below the nominal rating of 60 Hz.

e. Horsepower: Horsepower of the motors shall be as given in the specification division on the driven equipment or as shown on the Contract Drawings. Submersible motors shall be allowed to be furnished even though the horsepower rating may not be in accordance with standard NEMA assignments. In many cases, the horsepower specified is a minimum requirement and certain alternate manufacturers may require larger horsepower motors. The larger motor shall be furnished at no extra cost to the OWNER.

f. Locked Rotor Current: Locked rotor current shall be in accordance with NEMA standards.

g. Efficiency and Power Factor: Efficiency and power factor shall be given consideration during shop drawing review. The ratings at full, 3/4, and 1 /2 load shall be compared to similar motors manufactured by acceptable

suppliers listed in these Specifications. Excessive variation shall be considered grounds for rejection.

h. Speed: Synchronous speed of motors shall correspond to standard NEMA ratings. Actual speed shall be as given in the specification division on the driven equipment. Slip shall not exceed 5 percent at full load.

i. Service Factor: The service factor shall be 1.0 unless requirements of the driven load necessitate a higher service factor.

j. Insulation Class: Insulation class for submersible motors shall be NEMA Class F. Motors to be operated at variable speed shall also be Class F. Class F insulated motors shall operate at a Class B rise at nameplate horsepower loading.

k. Design Level: Motors shall be NEMA design B, except as otherwise noted.

l. Enclosure: Submersible motors shall be air [or oil filled] and of watertight construction.

m. Frame Size: Frame designations shall be in accordance with NEMA standards.

n. Winding Over-temperature Sensors: All submersible motors shall be provided with motor winding thermostats. The devices shall be hermetically sealed, snap-acting thermal switches, actuated by a thermally responsive bi-metallic disk. A minimum of 1 per phase is required; with switches wired into the control circuit of the starter to provide de-energization should overheating threaten.

o. All submersible pump/motor assemblies shall be equipped to detect presence of moisture and alarm at the controller.

p. Motors to be controlled by VFD's shall be inverter duty rated, NEMA MG-1.

(2) Mechanical Characteristics

a. Submersible Motor Construction

1) See Equipment Specifications.

(3) Tests, Nameplates and Shop Drawings

a. Tests

1) Tests shall be required on integral horsepower motors only. A factory certified test report of "electrically duplicate motors previously tested" shall be supplied on all motors under 200 horsepower. The test shall be certified by the factory and shall contain a statement to the effect that complete tests affirm the guaranteed characteristics published in the manufacturer's catalogs or descriptive literature.

2) Tests will be in accordance with IEEE test procedures.

b. Nameplates

1) Each motor shall have a permanently affixed nameplate of brass, stainless steel, or other metal of durability and corrosion resistance. The data contained on the nameplate shall be in accordance with NEMA standards.

(4) Efficiency Requirements

a. Motor full load efficiency requirements shall be met as a minimum for premium efficiency totally enclosed 3 phase integral horsepower motors per the latest NEMA Test Methods for the units horsepower and operating speed to be installed.

b. Where indicated on the Contract Drawings or in the Contract Specifications motors shall be of the energy efficient line offered by the motor manufacturer, having comparable performance characteristics to their standard line as far as torque and horsepower are concerned. Efficiency and power factor however, shall be higher than the manufacturer's standard line of motors and shall be documented in the shop drawings submittal in sufficient detail to allow the ENGINEER complete review of what is offered. Motors shall be referred to simply as "premium efficiency" in Specifications and Contract Drawings.

c. All motors to be installed for connection to V.F. drives shall be inverter duty rated, NEMA MG-1.

1.6 INSTALLATION

A. All electric motors shall be protected against the accumulation of moisture, dust and debris and physical damage during the course of installation of the job.

B. Handle motors carefully to avoid damage to components, enclosures and finishes. Do not install damaged equipment; replace and return damaged units to equipment manufacturer.

C. Store motors in a clean dry place and protect from weather and construction traffic.

D. Install motors in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that motors comply with requirements of National Electrical Code, and applicable portions of ANSI/NEMA standards pertaining to installation of electrical motors and ancillary equipment.

E. All motors shall be manufactured and installed in accordance with applicable NEMA standards and NEC provisions, latest revisions.

END SECTION

SECTION 16170 - SAFETY AND DISCONNECT SWITCHES

1. RELATED DOCUMENTS

A. General provisions of Contract, General and Supplementary Conditions and General Requirements, apply to this section.

B. Requirements of electrical general provision sections govern work specified in this section.

C. This section shall be governed by alternates insofar as they affect this work.

2. DESCRIPTION OF WORK

A. Provide labor, materials, equipment and services necessary for proper and complete installation of safety and disconnect switches.

B. Types of safety and disconnect switches required for project include the following:

Equipment disconnects.

Appliance disconnects.

Motor circuit disconnects.

3. QUALITY ASSURANCE

A. Comply with National Electrical Code (NFPA 70) as applicable to construction and installation of electrical safety and disconnect switches.

B. Provide safety and disconnect switches which have been listed and labeled by Underwriters Laboratories.

C. Comply with National Electrical Manufacturers Association Stds. Pub. No. KS1.

D. Manufacturers of safety and disconnect switches shall be Square "D", Allen-Bradley or Cutler-Hammer.

4. SUBMITTALS

A. Submit manufacturer's data on electrical safety and disconnect switches.

5. EQUIPMENT

A. Provide heavy duty type, sheet steel enclosed safety switches, of type, size and rating indicated; incorporating quick make, quick break type switches, constructed so switch blades are visible in "OFF" position with door open; equipped with operating handle which is an integral part of enclosure base and whose position is easily recognizable and is padlockable in "OFF" position.

B. Mount switches in NEMA 12 enclosures unless otherwise indicated. Boxes exposed to wet or rain conditions shall be NEMA 4 type unless otherwise noted. Switches shall be rated at 240 or 600 minimum volts as required by voltage of circuit on which they are utilized and shall be rated in horsepower. Each shall be capable of interrupting locked rotor current of motor for which it is to be used. Current shall be assumed as ten (10) times full rated load current.

C. Mount switch parts on insulating bases to permit replacement of parts from front of switch. All current carrying parts shall be designed to carry rated load without excessive heating. Switch contacts shall be silver tungsten type or plated to prevent corrosion, pitting and oxidation and to assure suitable conductivity. Fuse clips shall be of positive pressure type and switch operating mechanism shall be designed to retain its effectiveness with continuous use at rated capacity without use of auxiliary springs in current path. Switches shall be capable of withstanding available fault current or let through current before fuse operates without damage or change in rating. Fuse clips shall be designed and coordinated to accommodate class and type of fuse specified or indicated to be used with switch.

6. INSTALLATION

A. Deliver switches individually wrapped in factory fabricated fiber board type containers.

B. Handle switches carefully to avoid damage to material components, enclosures and finish. Do not install damaged switches; remove from project site.

C. Store switches in a clean dry space. Protect switches from dirt, fumes, water and physical damage.

D. Install safety and disconnect switches where indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and in accordance with recognized industry practices.

E. Coordinate safety and disconnect switch installation work with electrical raceway and cable work, as necessary for proper interface.

F. Install disconnect switches used with motor driven appliances larger than 1/8 h.p. and motors and controllers within sight of controller position unless otherwise indicated.

7. SPECIAL INSTALLATION INSTRUCTIONS

A. All disconnect switches noted to have a NEMA 4 enclosure shall be stainless steel.

END SECTION

SECTION 16181 - FUSES

1. RELATED DOCUMENTS

A. General Provisions of Contract, General and Supplementary Conditions and General Requirements, apply to this section.

B. Requirements of electrical general provision sections govern work specified in this section.

C. This section shall be governed by alternates insofar as they affect this work.

2. DESCRIPTION OF WORK

A. Provide all labor, materials, equipment and services necessary for proper and complete installation of fuses.

3. QUALITY ASSURANCE

A. Comply with National Electrical Code (NFPA 70) as applicable to construction and installation of fuses.

B. Fuses shall be listed by Underwriters Laboratories.

4. SUBMITTALS

A. Submit manufacturer's data on fuses.

5. EQUIPMENT

A. Except as otherwise specified herein, provide complete sets of fuses for all switches requiring fuses. Fuses shall be of size indicated on drawings. Provide spare fuses in original boxes of the following quantities: one complete set for each different size, type and class.

B. Install current limiting fuses in lieu of regular fuses where fault current exceeds 10,000 RMS amperes. Fuses rated over 600 amperes shall be NEMA Class L. Unless otherwise specified, fuses for use with switches rated 600 amperes and less shall be UL Class RK 1, and have interrupting rating of 200,000 RMS amperes. Class RK 1 fuses shall be dual element type with minimum time delay of ten seconds at 500 percent of rating.

C. Current limiting high interrupting capacity fuses manufacturer with each unit as required for complete coordination.

D. Provide all project fuses supplied by same manufacturer. Proper selectivity with associated protective equipment shall be substantiated by published catalog data.

E. Switch size and fuse ratings indicated on Drawings and/or specified are based on general approximate values for each motor horsepower delineated. Since characteristics of fuses for motor short circuit protection vary with different manufacturers, coordinate fuse values with switch sizes for each motor.

6. INSTALLATION

A. Install fuses where indicated and required in accordance with manufacturer's written instructions, applicable requirements of N.E.C., and in accordance with recognized industry practice.

END SECTION

SECTION 16200 - MISCELLANEOUS ELECTRICAL EQUIPMENT

1. RELATED DOCUMENTS

A. General provisions of Contract, General and Supplementary conditions and General Requirements, apply to this section.

B. Requirements of Electrical General Provision sections govern this section, where applicable.

C. This section shall be governed by alternates insofar as they apply to this work.

2. DESCRIPTION OF WORK

A. Provide all labor, materials, equipment and services necessary for proper and complete installation of equipment specified.

B. Refer to other Division 16 sections for additional work required in conjunction with electrical equipment, not work of this section.

3. QUALITY ASSURANCE

A. Special Use Markings: Provide equipment, constructed for special use, with UL marks indicating that special usage, i.e., "suitable for use in Class 1, Division 1 Environments".

B. UL Compliance: Comply with applicable UL publications pertaining to miscellaneous equipment. Provide units which have been listed and labeled by Underwriters Laboratories.

C. NEC Compliance: Comply with National Electrical Code (NFPA 70) as applicable to installation of miscellaneous electrical equipment. Comply with applicable NEC Articles pertaining to installation of wiring and equipment in hazardous locations.

4. SUBMITTALS

A. Submit manufacturer's data on **all** miscellaneous electrical equipment items.

B. Submit dimensioned drawings of equipment and enclosures indicating accurately scaled layout of enclosures and required individual devices.

5. EQUIPMENT

A. Bitumastic Coatings

1. Coatings for use on conduits and between metal and concrete contact points shall be of self priming type.

2. Coatings shall be black, high build type single component coal tar mastic capable of maximum 30 mil dry film thickness.

3. Coatings shall be applied in two (2) coats to achieve average of 18 mil dry film thickness over surface to be protected.

4. Coatings shall be Carboline Bitumastic 50 or equal.

B. Corrosion Control Tape

1. **Corrosion control tape shall be applied to all rigid aluminum conduit where in contact with concrete (passing thru slabs, etc.) and where installed below concrete or in contact with earth.**

2. Corrosion control tape shall be Polyken No. 826 yellow in color, 12 mil thickness, 2" or 4" wide as required. Use Polyken No. 1027 primer prior to tape installation per manufacturer requirements.

C. Exothermic Ground Connections

1. Exothermic welding systems shall be approved by Underwriters Laboratories to ANSI UL 467 "Grounding and Bonding Equipment."

2. Exothermic welding shall be used for making electrical connections of copper to copper, copper to steel or copper to cast iron for grounding and cathodic applications.

3. Exterior connections shall be suitable for exposure to the elements of direct burial in earth or concrete without degradation over the lifetime of the grounding system.

4. Interior connections in occupied building shall be made using a low smoke producing process.

5. Products for exothermic connections shall be Cadweld, Thermoweld, Permaweld or equal.

6. INSTALLATION

A. Handle miscellaneous equipment carefully to prevent breakage, denting and scoring finish.

B. Store miscellaneous electrical equipment indoors and protect from weather. When necessary to store outdoors, elevate well above grade and enclose with durable, waterproof wrapping.

C. Install miscellaneous electrical equipment, in accordance with manufacturer's written instructions, applicable requirements of NECA and in accordance with recognized industry practices to ensure that products comply with requirements and serves intended purposes.

D. Coordinate installation of miscellaneous electrical equipment with cable and raceway installation work and work of other trades.

E. Anchor equipment firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secure.

END SECTION

SECTION 16450 - ELECTRICAL GROUNDING

1. RELATED DOCUMENTS

A. General provisions of Contract, General and Supplementary Conditions and General Requirements, apply to this section.

B. Electrical general provision sections govern this section, where applicable.

C. This section shall be governed by Alternates insofar as they apply to this work.

2. DESCRIPTION OF WORK

A. Provide labor, material, equipment and services for proper and complete electrical grounding system.

B. Grounding of electrical installations comprises both system and equipment grounding, and includes, but is not necessarily limited to, metal raceways, transformer frames, switchgear enclosures, metal enclosures of electrical devices, and circuit conductors.

C. Requirements of this section apply to electrical grounding work specified elsewhere in these specifications.

D. Electrical cable, wire, connectors, clamps, and raceway work are specified in applicable Division 16 basic material sections.

E. Method

(1) Supplement grounded neutral of secondary distribution system by and equipment grounding systems to properly safeguard equipment and personnel. Design equipment grounding system so all metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, portable equipment, and other conductive items in close proximity with electrical circuits operate continuously at ground potential and provide a low impedance path for possible ground fault currents.

(2) The AC secondary system ground shall be connected using exothermic welds to at least three ground rods minimum 3/4 inch by 10 feet. Where required to meet requirements of herein specified tests, install extra rods at no additional cost to Owner. Locate rods a minimum of 10 feet from each other or any other electrode and loop interconnect with each other by a minimum No. 6 AWG bare copper conductor brazed to each rod below grade. Do not splice grounding electrode conductor.

(3) In addition, provide in conduit a minimum 3/0 or as required green insulated copper ground conductor to main metallic water service entrance and connect to same by means of adequate ground clamps. Where a dielectric main water fitting is installed, connect this ground conductor to street side of dielectric water fitting. Do not install a jumper around this fitting. Bond to ground conductor at each end. Provide with ground clamps a 3/0 jumper around water meter.

(4) Connect system neutral ground and equipment ground system to common ground bus as indicated on Drawings, or if not indicated, as required by NEC.

(5) Ground secondary services at supply side of secondary disconnecting means and at related transformers in accordance with NEC. Provide each service disconnect enclosure with a neutral disconnecting means and an insulated neutral stud which interconnects with insulated neutral and uninsulated equipment ground buses to establish system common ground point. Locate neutral

disconnecting link or links so that low voltage neutral bar with all interior secondary neutrals can be isolated from common ground bus and service entrance conductors.

(6) Size required equipment grounding conductors and straps in compliance with NEC. Provide equipment grounding conductors with green insulation equivalent to insulation on associated phase conductors. Braze related feeder and branch circuit grounding conductors to grounding bar or connect with approved pressure connectors. A feeder serving several panelboards shall have a continuous grounding conductor which shall be connected to each related cabinet bar. Aluminum, straps or bars may be substituted for proposed copper items if this is consistent with materials proposed for low voltage distribution system. Aluminum materials shall be comparable in current carrying capacity, temperature, rise, and mechanical strength, and installation shall include all necessary precautions regarding electrical connections with dissimilar metals.

(7) Provide low voltage distribution systems with a separate green insulated equipment grounding conductor for each single or three phase feeder and each branch circuit. Install required grounding conductor in common conduit with related phase and/or neutral conductors. Where there are parallel feeders installed in more than one raceway, each raceway shall have a green insulated equipment ground conductor. Single phase branch circuits required for 120 and 277 volt lighting, receptacles, and motors shall consist of phase, neutral and grounding conductors installed in common metallic conduit. Provide flexible metallic conduit equipment connections utilized in conjunction with the above single phase branch circuits with suitable green insulated grounding conductors connected to approved grounding terminals at each end of flexible conduit. Provide single phase branch circuits required for special equipment and all branch circuits installed in nonmetallic or flexible conduits with a separate grounding conductor.

(8) Determine number and size of pressure connectors to be provided on all equipment grounding bars required in panelboards and other electrical equipment for termination of equipment grounding conductors. In addition to active circuits, provide pressure connectors for all three phase spares and spaces.

(9) Provide a green colored equipment ground conductor and connected as described below. Provide each ground conductor with spade tongue terminals or solderless pressure connectors to suit conditions.

a. From green ground terminal of all receptacles to green 10 32 "washer in head" outlet box machine screw. Note: Receptacles with special cast boxes and factory designed and approved ground path will not require a separate ground jumper.

b. From green 10 32 "washer in head" machine screw in ceiling outlet box or junction box through flexible metallic conduit to ground terminal in fixture.

c. From green 10 32 "washer in head" machine screw in ceiling outlet box or junction box through flexible metallic conduit to green 10 32 "washer in head" machine screw in switch outlet box in movable partitions.

d. From green 10 32 "washer in head" machine screw in junction box or disconnect switch through flexible metallic conduit to ground terminal in connection box mounted on single phase fractional horsepower motor.

e. From equipment ground bus in motor control center through conduit and flexible metallic conduit to ground terminal in connection box mounted on three phase motor. Note: where motor has separate starter and disconnect device, ground conductor shall originate at ground bar in panelboard supplying these motors and be bonded to each starter and disconnect device enclosure also.

f. From equipment ground bar to equipment grounding bar on a busway, install and connect by an approved method a ground conductor.

g. From a computer area power panel ground bar, provide each branch circuit with a green insulated equipment ground conductor. Minimum size of this conductor shall be per NEC but no ground conductor circuit shall exceed 3 ohms resistance to building ground system.

(10) Nonmetallic conduits or ducts shall contain a green insulated grounding conductor unless otherwise specified.

a. Equipment grounding conductors are not required for telephone ducts.

(11) Where electric devices such as electric air cleaners or heaters are installed in air ducts, provide a green insulated equipment ground conductor. Bond conductor to each unit, air duct, and to ground in panelboard.

(12) Where electric immersion type water heater or surface anti frost heating cables are installed, provide a green insulated equipment ground conductor. Bond this conductor to water piping at unit and to ground bar in panelboard.

(13) Subject completed equipment grounding system to a megger test at each service disconnect enclosure ground bar to insure that ground resistance, without chemical treatment or other artificial means, does not exceed twenty five (25) ohms. Certified test reports of ground resistance shall be submitted to Engineer for approval. Necessary modifications for compliance with the twenty five (25) ohm value shall be performed without additional expense to Owner.

(14) Where steel conduit(s) terminate without mechanical connection to a metallic housing of electrical equipment by means of locknut and bushings or adapters such as switchboards, switchgear, motor control centers, the following procedure shall be followed: Provide each conduit with a ground bushing and each bushing connecting with a bare copper conductor to ground bus in electrical equipment. Ground conductor shall be in accordance with article on Grounding of NEC. Bond electrically non continuous metallic conduits containing ground wiring only to ground wire at both conduit entrance and exit in a manner similar to that described above.

3. QUALITY ASSURANCE

A. Comply with NFPA No. 70, National Electrical Code, as applicable to materials and installation of electrical grounding systems and associated equipment and wiring.

B. Comply with UL standards and IEEE Greenbook pertaining to electrical grounding and bonding.

C. Manufacturers offering products complying with requirements include: Cadweld, ITT Blackburn, ITT Weaver, Copperweld Bimetallics Group, Cathodic Engineering Equipment Co., or equal.

4. SUBMITTALS

A. Submit manufacturer's information on exothermic type connection system. Submit written results of grounding system megger test.

5. EQUIPMENT

A. Except as otherwise indicated, provide for each electrical grounding indicated, a complete assembly of materials including but not necessarily limited to cable, wire, connectors, terminals (solderless lugs), grounding rods/electrodes and plate electrodes, bonding jumper braid, and other items and accessories needed for a complete installation. Where more than one type meets indicated requirements, selections is Installer's option. Where material or component is not otherwise indicated, provide products complying with NEC, and established industry standards.

B. Unless otherwise indicated, provide electrical grounding conductors for grounding connections matching power supply wiring materials and sized according to NEC.

C. Provide electrical connectors, terminals and clamps as recommended by connector, terminal and clamp manufacturer for intended applications.

D. Steel ground rods with copper welded exterior, 3/4" dia. x 10'.

E. Acceptable Manufacturers:

(1) Grounding equipment shall be Cadweld, ITT Blackburn, ITT Weaver, Copperweld Bimetallics Group, Cathodic Engineering Equipment Co., or equal.

6. INSTALLATION

A. Testing

(1) The CONTRACTOR shall be required to provide all labor, tools, instruments, and materials as necessary to perform testing of the grounding electrode system. Results shall be submitted in writing to the ENGINEER. The testing shall be done to determine the effectiveness of the selected grounding scheme and to see that it conforms with resistance specified (2.5 ohms maximum).

(2) The testing should be done using a fall-of-potential method test at the point of grounding electrode conductor connection to main power distribution equipment and at each separately derived system or MCC. The test shall be performed no sooner than 48 hours after a rainfall event.

(3) The written report should contain the following information:

a. Type of ground scheme used, i.e., building steel, driven rod, mat, etc.

b. Type of instrument used.

1) Mfr.

2) Model number

3) Confirm fall-of-potential test

4) *Serial number

5) *Where instrument was obtained

* These 2 items are required so that the same instrument may be utilized should reproduction of the test be necessary due to unsatisfactory readings/instrument miscalibration.

c. Ground resistance readings obtained at various test distances.

d. Ground resistance/distance curve.

e. Value of Grounding Electrode Resistance at knee of curve.

f. Sketch showing setup of instrumentation and location electrode and test probes.

g. Proposed method to achieve the specified resistance, should an unacceptable reading be obtained.

h. Ground resistance readings obtained (if applicable) after modification incorporated.

B. Ground Enhancement Material

(1) Where indicated on the Drawings or as deemed necessary by the CONTRACTOR to achieve design grounding electrode system resistance, a ground enhancement material shall be utilized, in accordance with manufacturer's recommendations.

(2) The ground enhancement material must be permanent and maintenance free (no recharging with salts or chemicals which may be corrosive) and maintain its earth resistance for the life of the system. It must set up firmly and not dissolve or decompose, or otherwise pollute the soil or local water table. The material shall be capable of being applied dry or in a slurry form, and shall reduce resistance by at least 40 percent.

(3) Basic components of this material shall be carbon, hydraulic cements, and hydrous aluminum silicates. Minimum 4-inch diameter holes shall be used with ground rod installations, with depth 6" shorter than length of rod, completely filled with the material. Trenches for grounding electrode conductor shall also utilize this material the full length from electrode to building, in accordance with manufacturer installation recommendations, except trench depth shall allow buried conductor to be at least 2'-6" deep.

(4) Ground enhancement material shall be GEM by Erico Products, Powerfill by Cathodic Engineering Equipment Company, or equal.

(5) Should ground rods be impractical for use due to rocky conditions, then grounding electrode plates may be used after acceptance by the ENGINEER or a case by case basis.

(6) Install electrical grounding systems where indicated, in accordance with manufacturer's instructions and NEC as necessary to interface installation of electrical grounding system with other work.

C. Special Installation Instructions

(1) Contractor shall coordinate with General Contractor and connect main AC system ground to exposed rebar stub at main service disconnect per 2014 N.E.C. requirements.

(2) All connections to ground rods shall be made using exothermic (Cadweld) type connections.

END SECTION

SECTION 16800 - SURGE PROTECTIVE DEVICES

1. RELATED DOCUMENTS

A. General Provisions of Contract, General and Supplementary Conditions and General Requirements, apply to this section.

B. Requirements of electrical general provision sections govern this section, where applicable.

C. This section shall be governed by alternates insofar as they apply to this section.

2. DESCRIPTION OF WORK

A. This Section includes Surge Protection Devices for low-voltage power, control and communication equipment.

B. Provide labor, material, equipment and services necessary for proper and complete installation of secondary surge (lightning) arresters and surge protective devices.

C. In addition to this section, the Contractor shall refer to other specification sections and drawings to ascertain the extent of work included.

3. QUALITY ASSURANCE

A. Comply with National Electrical Code Article 285 as applicable to construction and installation of surge arresters.

B. Provide surge arresters which have been listed and labeled by Underwriters Laboratories.

(1) UL1449 3rd Edition: Surge Protective Devices (SPD)

(2) UL1283 5th Edition: Electromagnetic Interference Filters

C. Comply with applicable portions of ANSI/IEEE:

(1) C62.41.1: 2002 IEEE Guide on the Surge Environment in Low-Voltage (1000V and less) AC Power Circuits

(2) C62.41.2: 2002 IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000V and Less) AC Power Circuits

(3) C62.45: 2002 IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits

(4) C62.62: 2000 IEEE Standard Test Specifications for Surge Protective Devices for Low Voltage (1000V and Less) AC Power Circuits

(5) C62.72: 2007 IEEE Guide for the Application of Surge Protective Devices for Low Voltage (1000V and Less) AC Power Circuits

D. Surge protective devices selected for project shall comply with short circuit current ratings per N.E.C. 285.6.

E. Surge protective devices selected for project shall comply with NFPA 780 – Standard for the Installation of Lightning Protection Systems.

F. Source Limitations: All secondary service suppression devices and accessories shall be from a single manufacturer.

4. SUBMITTALS

A. Submit manufacturer's data on secondary lightning arresters.

B. Submit manufacturer's data on surge protective devices.

5. PRODUCTS

A. The types of surge protective devices required for project shall include the following as noted within plans and specifications:

(1) Surge protective devices (modular-replaceable module solid state type).

(2) Surge protective devices (non-modular encapsulated non-replaceable component- solid state type).

(3) Telephone, data, signal and instrumentation surge protective devices.

B. Surge Protective Devices (SPDs)

(1) Description

(a) This section describes the materials and installation requirements for transient voltage surge suppressors (TVSS) for the protection of all AC electrical circuits from the effects of lightning induced currents, substation switching surges and internally generated surges resulting from inductive and/or capacitive load switching.

(2) Modular Surge Protection (Type 1)

(a) Configured as shown on the riser diagram and/or panel schedules.

(b) The SPD surge current ratings shall be based on the electrical system ampacity listed in the table below.

Electrical System Ampacity @ SPD Install Point	Surge Protection (kA)	
	Per Mode	Per Phase
2500 – 6000A	300	600
1200 – 2000A	250	500
600 – 1000A	200	400
225 – 400A	150	300
125 – 225A	100	200

(c) The SPD shall be rated for voltage, phase and wye or Delta configuration as indicated on Drawings or noted in specifications.

(d) Modes of Protection: The SPD system shall provide surge protection in all possible modes (L-N, L-G, L-L, and N-G) for the circuit or service to be protected. Each replaceable module must provide the uncompromising ability to deliver full surge current rating per mode.

(e) SPD modules shall be configured to isolate individual suppression component failures without causing total loss of surge protection in that mode.

(f) Opening of supplementary protective devices, internal or external, is not permissible during UL1449 3rd Edition Nominal Discharge testing.

(g) Optional Connection Methods: [Fused Disconnect, 60A, #6AWG] [Surge Rated Disconnect, 100A, #2AWG] [Distribution Block, 100A, #2AWG] [Terminal Block, 60A #6AWG].

(h) Each individual module shall feature an LED indicating the individual module has all surge protection devices active. If any module is taken off-line, the LED will turn off and/or a "fail" LED will illuminate, providing individual module status.

(i) Monitoring: Units shall have Status Indication Lights, Surge Counter with Audible Alarm and Form "C" Contacts.

(j) The modular SPD shall be provided in a NEMA 4 enclosure for exterior use and NEMA 12 enclosure for interior use unless otherwise noted.

(k) The SPD shall provide EMI/RFI electrical noise attenuation of 36 to 44dB in the range of 50kHz to 100MHz as defined by MIL-STD-220A test procedures.

(l) Voltage Protection Ratings: The UL1449 3rd Edition Voltage Protection Ratings "VPR" (6kV, 3000 Amps, 8/20µs waveform) must not exceed the UL assigned values listed below.

	208/120V	480/277V
Line to Neutral	900V	1200V
Line to Ground	800V	1200V
Neutral to Ground	700V	1200V
Line to Line	1200V	2000V

(m) The SPD shall have a minimum UL 1449 3rd Edition Nominal Discharge Current Rating (In) of 10,000 Amps. When used in conjunction with a UL 96A certified Lightning Protection System the (In) rating shall be 20,000 Amps.

(n) Approved Manufacturers: The following SPD manufacturers and respective models are acceptable, subject to conformance with indicated requirements:

Current Technologies TSr Product Series

THOR SYSTEMS SL2 Product Series

Liebert Intercepter II Series

(3) NON-MODULAR SURGE PROTECTION (Type 2)

(a) Configured as shown on the riser diagram and/or panel schedules.

(b) The SPD surge current ratings shall be based on the electrical system ampacity listed in the table below.

Electrical System Ampacity @ SPD Install Point	Surge Protection (kA)	
	Per Mode	Per Phase
400 – 800A	150	300
125 – 225A	100	200
15-100A	50	100

(c) The SPD shall be rated for voltage, phase and wye or Delta configuration as indicated on Drawings or noted in specifications.

(d) Modes of Protection: The SPD system shall provide surge protection in all possible modes (L-N, L-G, L-L, and N-G) for the circuit or service to be protected. Each replaceable module must provide the uncompromising ability to deliver full surge current rating per mode.

(e) All non-modular units shall be factory wired for each phase conductor and for Neutral and Ground conductors.

(f) Continuous LED indication of the system integrity (including N-G mode for a Wye system) utilizing LEDs. Monitoring: Units shall have Solid State Status Indication Lights, Surge Counter with Audible Alarm and Form "C" Contacts.

(g) The non-modular SPD shall be provided in a NEMA 4 enclosure for exterior locations or NEMA 12 enclosure for interior locations unless otherwise noted.

(h) The SPD shall provide EMI/RFI electrical noise attenuation of 32 to 37dB in the range of 50kHz to 100MHz as defined by MIL-STD-220A test procedures.

(i) Voltage Protection Ratings: The let-through voltage test results used to obtain the UL1449 3rd Edition Voltage Performance Ratings "VPR" (6kV, 3000 Amps, 8/20μs waveform) must not exceed the UL assigned values listed below.

	208/120V	480/277V
Line to Neutral	700V	1200V
Line to Ground	700V	1200V
Neutral to Ground	800V	1200V
Line to Line	1000V	2000V

(j) The SPD shall have a minimum UL 1449 3rd Edition Nominal Discharge Current Rating (In) of 10,000 Amps. When used in conjunction with a UL 96A certified Lightning Protection System the (In) rating shall be 20,000 Amps.

(k) Approved Manufacturers: The following NON-MODULAR SPD manufacturers and respective models are acceptable, subject to conformance with indicated requirements:

Current Technologies	TSn Product Series
THOR SYSTEMS	TG Product Series
Liebert	Accuvar All Product Series

(4) Transient Voltage Surge Suppressors - Telephone, Data, Signal and Instrumentation.

(a) TVSS shall be listed in accordance with UL 497A where applicable.

(b) TVSS shall be of compact in-line design and have low shunt capacitance for minimum signal loss.

(c) TVSS shall utilize high speed avalanche diodes for protection.

(d) TVSS units shall meet or exceed the following criteria:

1) Response time < 10ns

2) Maximum shunt capacitance < 40pf except coaxial. Devices which shall be < 30AR.

3) Coaxial cable devices shall have -0.5db insertion loss and no series resistance.

4) Telephone/Data units shall exceed Category 5.

5) Standard clamp voltages/peak pulse currents shall meet or exceed the following as applicable to respective system requirements:

Ethernet 10-base T	7.5V/750A
Telephone Dial-up	240V/250A
CSU/DSU	60V/200A
T-1	60V/200A
DDS	60V/200A
Cable TV	7.5V/750A
Satellite TV	18V/340A
4-20MA Instrumentation (Analog)	30V/370A

(e) TVSS shall have a warranty for a period of five years.

(f) Manufacturers

1) Surge protectors shall be as manufactured by Current Technologies, TSC, DDC, MTC and CCC Series or equal. EDCO Series SS65 (4-20ma instrumentation) or equal.

(5) Transient Voltage Surge Suppressors - 120VAC Hardwired Equipment

(a) TVSS shall be listed in accordance with UL 1449 Third Edition and UL 1283.

(b) TVSS shall provide surge current diversion paths for all modes of protection; L-N, L-G, N-G.

(c) TVSS shall have operational status indicators and each MOV shall be fused.

(d) Unit shall be housed in NEMA 4 enclosure, have terminal screw connections and each MOV shall be fused.

(e) TVSS shall meet or exceed the following criteria:

1) Maximum surge current capability (single pulse rated) PER PHASE (2 x per mode) shall be:

a) Hardwired equipment (40) kA per phase or as noted on drawings.

(f) Manufacturers

Surge protectors shall be as manufactured by EDCO, HSP Series or equivalent.

6. INSTALLATION

A. Deliver each piece of equipment in durable shipping cartons. Maintain cartons through shipping, storage and handling as required to prevent damage and eliminate dirt and moisture. Store cartons inside and protect from weather.

B. Install system and materials in accordance with manufacturer's instructions and roughing in drawings, and details on drawings. Install electrical work and use electrical products complying with requirements of applicable Division 16 sections of these specifications.

C. Term "wiring" is defined to include providing of wire, conduit and miscellaneous materials as required for mounting and connecting devices.

D. Install a complete wiring system as required for system(s) surge protection.

E. Number Code or Color Code conductors, appropriately and permanently for identification and servicing of systems.

F. Contractor shall install surge protective devices and lightning arresters.

G. Surge Protective Devices shall be provided in quantities such that all modes of protection of the secondary service is protected. This protection shall be provided at the main service panel.

H. Surge Protective Devices shall be installed such that both line and ground lead lengths are as short as possible. Splicing of additional conductor to increase lead length as provided by manufacturer will not be accepted.

I. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner or others except when permitted and then only after arranging to provide temporary utility services according to requirements indicated. Notify and coordinate with the engineer when an interrupt is required and prior to interrupting.

J. Coordinate location of field-mounted surge protective devices to allow adequate clearances for maintenance.

K. All devices must be installed on the load side of the facility after the first overcurrent protection or disconnect unless otherwise noted.

L. Products shall be installed external to service, distribution, and branch panel equipment. All SPDs must have the same or greater AIC, Interrupting or Fault rating of the equipment the SPD is protecting.

M. Continuity measurements shall be made between the Neutral and Ground connections to verify the Neutral-to-Ground bond.

7. WARRANTY

A. All Surge Protective Devices (SPDs), associated hardware, and supporting components shall be warranted to be free from defects in materials and workmanship, under normal use and in accordance with the instructions provided, for a period of five (5) years.

B. Any component or subassembly contained within the surge protection system that shows evidence of failure or incorrect operation during the five (5) year warranty period, shall be replaced by the manufacturer.

8. SPECIAL INSTALLATION INSTRUCTIONS

A. Contractor shall furnish and install (1) Type "1" SPD on new service fed from utility company transformer.

END SECTION

SECTION 16941 - CONTROL AND INSTRUMENTATION CABLE AND WIRE

1. RELATED DOCUMENTS

A. General Provisions of Contract, General and Supplementary Conditions and General Requirements apply to work specified in this section.

B. Requirements of Electrical General Provision Sections govern this Section, where applicable.

C. This section shall be governed by Alternates insofar as they affect this work.

2. DESCRIPTION OF WORK

A. Provide labor, materials, equipment and services necessary for proper and complete installation of control and instrumentation cable and wire.

B. Requirements of this section apply to cable and wire work specified elsewhere in these specifications.

C. Unless specified otherwise in this Section or indicated on Drawings, control and instrumentation device/equipment power wiring is specified under Section 16120.

3. QUALITY ASSURANCE

A. Comply with National Electrical Code (NFPA 70) as applicable to construction and installation of control cable and wire.

B. Provide cable and wire which has been listed and labeled by Underwriters Laboratories.

C. Comply with National Electrical Manufacturers Association/Insulated Power Cable Engineers Association Standards publications pertaining to materials, construction and testing wire cable, where applicable.

D. Manufacturers offering products complying with requirements include:

(1) Wire:
Southwire Company
Triangle PWC, Inc.
Or equal

(2) Cable:
Belden
Or equal

4. SUBMITTALS

A. Submit manufacturers' product data on all 4-20MA signal cables and power cables.

5. MATERIALS

A. Provide factory-fabricated cable and wire of sizes, ratings, materials and types indicated. Where not indicated, provide proper selection as determined by main control and instrumentation panel supplier to comply with project's installation requirements and NEC standards.

B. Use (1) 16 ga. twisted/shielded pair cable for 4-20ma signal circuits from transmitters etc. Cable shall be Belden No. 8719, or General Cable type VNTC with 100% shield coverage and stranded/tinned 18 ga. drain wire.

C. Use No. 12 stranded conductor for control circuit wiring connected to lighting switches and snap switches.

D. Valves, valve controllers, start-stop selector switches etc. Use minimum 75 degrees C rated insulation unless specified otherwise, indicated on Drawings, or required by NEC. Use 600 volt insulation rating unless specified or indicated otherwise.

6. INSTALLATION

A. Install cable and wire as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure products serve intended functions.

B. Store cable, wire and connectors in factory-installed coverings in a clean, dry indoor space which provides protection against weather.

C. Pull conductors together where more than one is being installed in a raceway.

D. Use pulling compound or lubricant, when necessary; compound must not deteriorate conductor and insulation.

E. Do not use a pulling means, including fish tape, cable or rope which can damage raceway.

F. Install exposed cable, parallel and perpendicular to surface or exposed structural members and follow surface contours, where possible.

G. Wire or cable splices for control and instrumentation circuits shall not be accepted.

H. Install poly pull line in all spare control and instrumentation circuit conduits.

I. Prior to energization, check cable and wire for continuity of circuitry and for short circuits. Correct malfunction when detected.

J. Do not install any control or instrumentation cable or wiring in same conduit or J-box with electrical power wiring.

K. **NOTE:** Electrical Contractor shall be responsible for providing and installing all control and instrumentation wiring and cable from all remote devices to the main control panel (MCP). This shall include the termination of wires/cables on both ends and installation of wire No. markers.

7. SPECIAL INSTALLATION INSTRUCTIONS

A. Wire or cable splices for control and instrumentation circuits shall not be accepted.

B. Do not install any control or instrumentation cable or wiring in same conduit or J-box with electrical power wiring, unless otherwise noted.

C. All 4-20MA signal cables shall be run complete without splice in minimum 3/4" conduit. These cables shall not be run in same conduit or through exterior pull boxes which contain power wiring.

END SECTION