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# SANITARY SEWER PUMP STATION REHABILITATION LIBERTY CENTER, OHIO

## INDEX OF SHEETS

SHEET #	DRAWING DESCRIPTION
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C103	PROPOSED WEST MAPLE STREET PUMP STATION "C" IMPROVEMENTS DETAIL SHEET
C104	EXISTING WEST MAPLE STREET PUMP STATION "B" DEMOLITION PLAN
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C106	PROPOSED DAMASCUS STREET PUMP STATION "A" IMPROVEMENTS DETAIL SHEET
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E102	EAST MAPLE ST. PUMP STATION "C" SINGLE LINE AND DETAILS

## LEGENDS

### EXISTING LEGEND

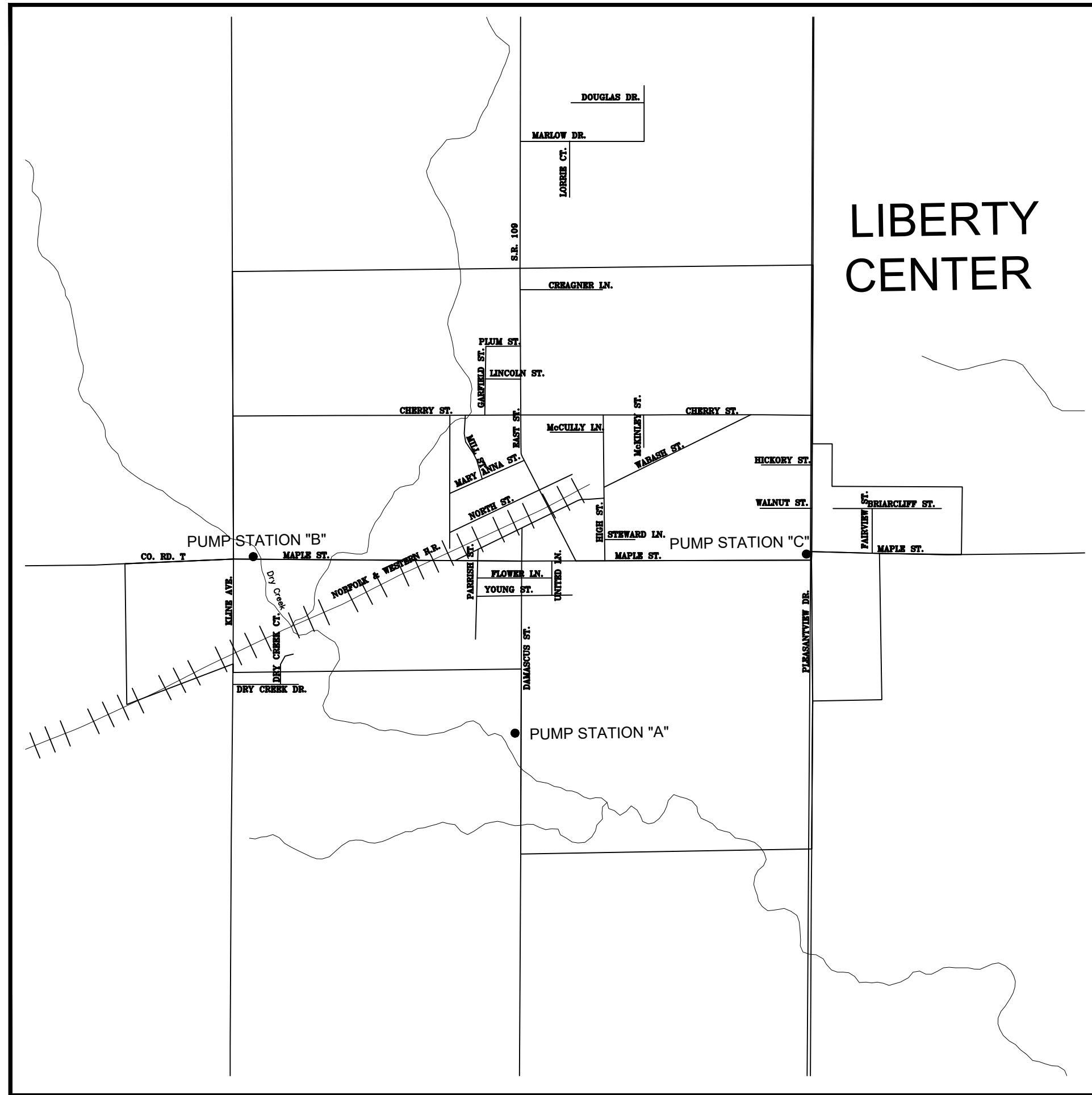
— 625 —	EXISTING MAJOR CONTOUR
— 624 —	EXISTING MINOR CONTOUR
✕ 73.85	EXISTING SPOT ELEVATION
- R/W -	RIGHT-OF-WAY
- - - - -	EDGE OF PAVEMENT
— ST — ST —	EXISTING STORM SEWER
— SAN —	EXISTING SANITARY SEWER
— WAT —	EXISTING WATERLINE
— OE — OE —	EXISTING OVERHEAD ELECTRIC
— — — — —	EXISTING TELECOMMUNICATIONS
x — x — x — x	EXISTING FENCE LINE
⊗	EXISTING CATCH BASIN
⊙	EXISTING SANITARY MANHOLE
⊙	EXISTING SANITARY CLEANOUT
⊙	EXISTING DOWN SPOUT
⊙	EXISTING FIRE HYDRANT
⊙	EXISTING WATER VALVE
⊙	EXISTING POWER POLE
⊙	EXISTING ELECTRICAL TRANSFORMER
⊙	EXISTING ELECTRIC MANHOLE
⊙	EXISTING ELECTRIC METER
—	EXISTING GUY WIRE
○	EXISTING POST
⊙	SOIL BORING
●	P.K.S.
●	NAIL SET

### PROPOSED LEGEND

— ST — ST —	PROPOSED STORM SEWER
— WAT —	PROPOSED WATERLINE
▭	PROPOSED HALF-HEIGHT HEADWALL
■	PROPOSED CATCH BASIN
⬮	PROPOSED FIRE HYDRANT
▨	PROPOSED ASPHALT PAVEMENT
▩	PROPOSED CONCRETE PAVEMENT
— 625 —	PROPOSED MAJOR CONTOUR
— 624 —	PROPOSED MINOR CONTOUR
— 0.5% —	PROPOSED SLOPE
✕ 74.00	PROPOSED SPOT ELEVATION
✕ 74.00	PROPOSED SPOT ELEVATION AT FACE OF CURB ADD 0.50' FOR TOP OF CURB ELEVATION
→	DRAINAGE FLOW ARROW

### EROSION & SEDIMENT CONTROL LEGEND

— SF — SF —	PROPOSED SILT FENCE
⊙	PROPOSED STABILIZED CONSTRUCTION ENTRANCE
⊙	PROPOSED INLET PROTECTION
⊙	PROPOSED PERMANENT STABILIZATION
— — — — —	SOIL TYPE BOUNDARY



## LOCATION MAP

SCALE: 1 inch = 1000 feet

## UTILITY LIST

TELEPHONE  
CENTURY LINK  
812 DOLAN ST.  
DEFIANCE, OHIO 43512  
(419) 782-9876

ELECTRIC  
TOLEDO EDISON  
SEND PLANS TO: DAN RAIRIGH  
MAIL STOP HLOC 2330  
6099 ANGOLA ROAD  
HOLLAND, OH 43528  
(419) 249-5900

SITE CONTACT: JOHN WIRICK  
(419) 249-4170

STORM, SANITARY AND WATER  
VILLAGE OF LIBERTY CENTER  
110 EAST STREET  
LIBERTY CENTER, OHIO 43532  
BRAD GODWIN  
(419) 966-2106

ELECTRIC  
TRICOUNTY RURAL ELECTRIC  
8945 COUNTY ROAD L K2  
MALINTA, OH 43535  
(419) 256-7900

ANR PIPELINE  
700 LOUISIANA STREET  
HOUSTON, TX 77002  
1-800-827-5267  
1-888-427-2875 (EMERGENCY)  
SEND PLANS TO: US\_CROSSINGS@TRANSCANADA.COM

GAS  
OHIO GAS COMPANY  
715 E. WILSON STREET  
PO BOX 528  
BRYAN, OHIO 43506  
KRIS HANDSHOE, GAS DISTRIBUTION ENGINEER  
(419) 630-2233 EXT. 233  
EMAIL: KRIS\_HANDSHOE@OHIOGAS.COM

## SPECIFICATIONS

ALL MATERIAL AND CONSTRUCTION MUST MEET THE REQUIREMENTS OF THE VILLAGE OF LIBERTY CENTER:

### STORM SEWER

THE STANDARDS AND SPECIFICATIONS OF THE VILLAGE OF LIBERTY CENTER AND THE OHIO ENVIRONMENTAL PROTECTION AGENCY

### WATERLINES

THE STANDARDS AND SPECIFICATIONS OF THE VILLAGE OF LIBERTY CENTER AND THE OHIO ENVIRONMENTAL PROTECTION AGENCY

### SANITARY SEWER

THE STANDARDS AND SPECIFICATIONS OF THE VILLAGE OF LIBERTY CENTER AND THE OHIO ENVIRONMENTAL PROTECTION AGENCY

### PAVEMENT

THE STANDARDS AND SPECIFICATIONS OF THE OHIO DEPARTMENT OF TRANSPORTATION

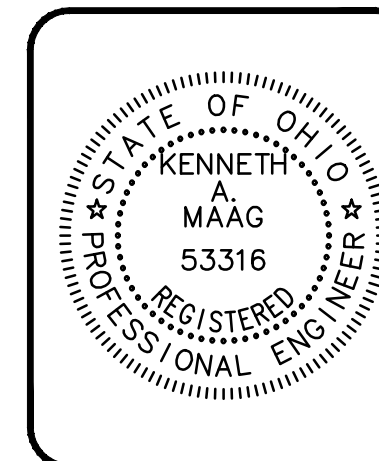
## BENCHMARK

THE VERTICAL DATUM IS BASED ON NAVD88 AS OBSERVED FROM CONTINUALLY OPERATED BASE STATION MANAGED BY OHIO DEPARTMENT OF TRANSPORTATION.

THE COORDINATES ARE REFERENCED TO OHIO STATE PLANE GRID COORDINATES OH-N NAD83 (2011).

SITE BENCHMARK #1  
MAG NAIL IN CURB @ NW CORNER INTERSECTION OF E. MAPLE ST. & PLEASANTVIEW DR.  
N=650764.74 E=1557483.79 ELEV:680.03

SITE BENCHMARK #2  
MAG NAIL SET IN WEST END OF HEADWALL NORTH SIDE OF W. MAPLE ST.  
N=650831.89 E=1552420.56 ELEV:666.77



NO.	DATE	DESCRIPTION
REVISIONS		



**POGGEMEYER DESIGN GROUP**  
A KLEINFELDER COMPANY  
101 CLINTON STREET, SUITE 1300  
(419) 782-3067  
DEFIANCE, OHIO 43512

**SANITARY SEWER  
PUMP STATION REHABILITATION  
LIBERTY CENTER, OHIO**

**COVER  
SHEET**

DRAWN BY: MEK  
CHECKED BY: KAM  
DATE: 2/23/21

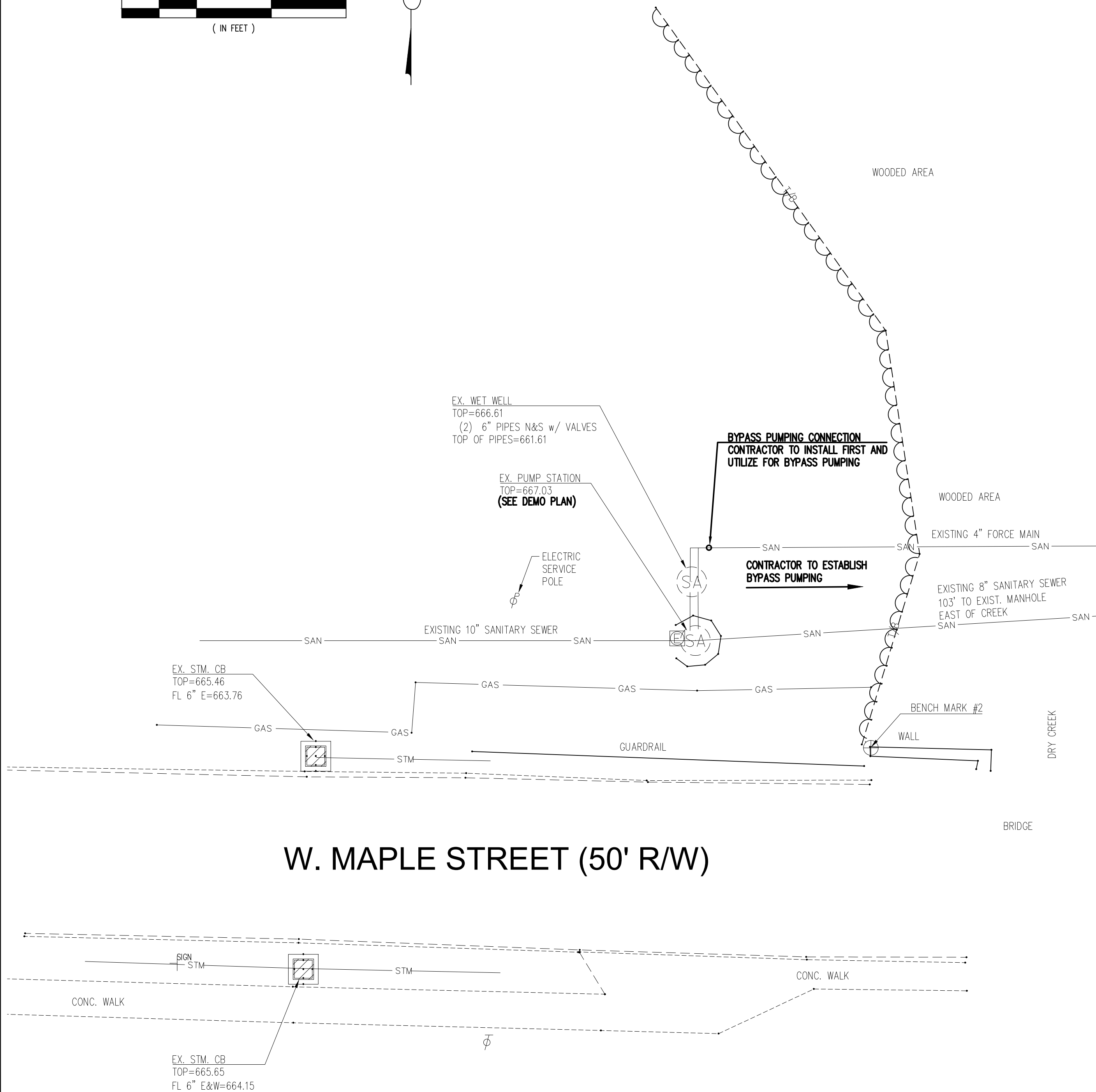
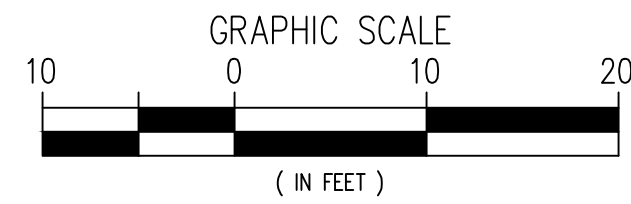
**C100**  
OF

JOB NUMBER  
144000-000027

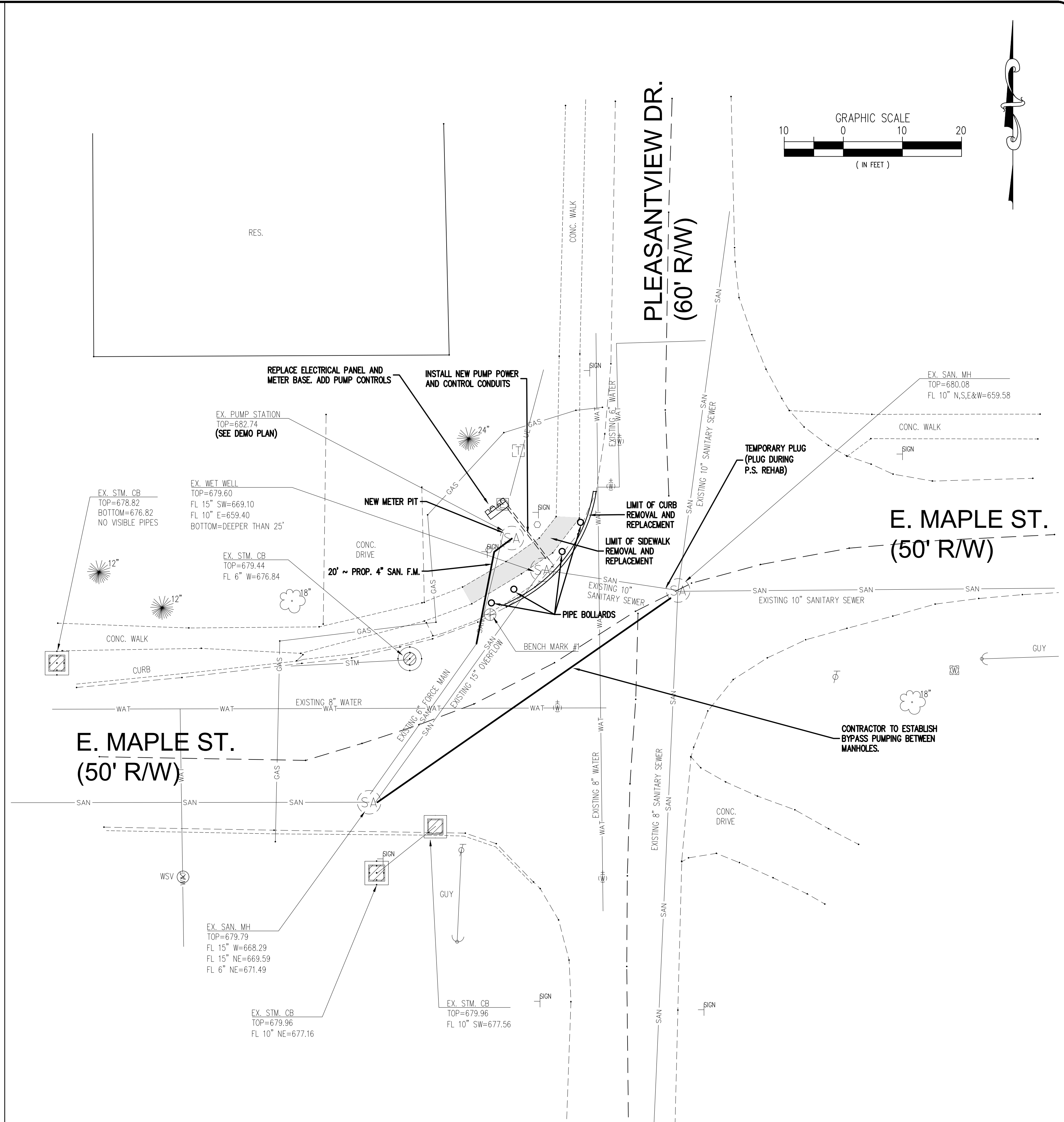


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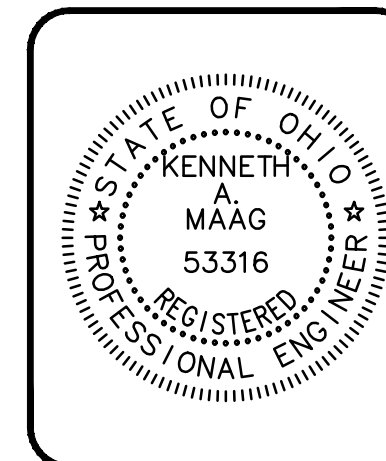
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## W. MAPLE STREET PUMP STATION "B"



## E. MAPLE STREET PUMP STATION "C"



NO.	DATE	DESCRIPTION
REVISIONS		



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A KLEINFELDER COMPANY  
101 CLINTON STREET, SUITE 1300  
DEFAANCE, OHIO 43512  
(419) 782-3067

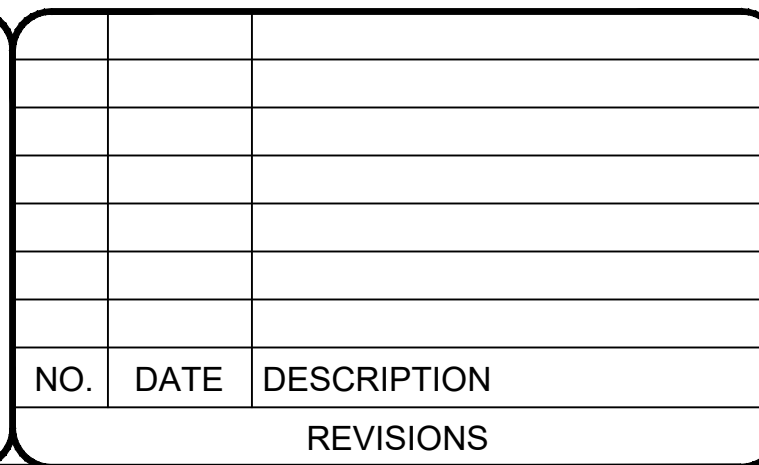
**SANITARY SEWER  
PUMP STATION REHABILITATION  
LIBERTY CENTER, OHIO**

**PROPOSED MAPLE ST.  
PUMP STATION  
IMPROVEMENTS**

DRAWN BY MEK	CHECKED BY KAM
DATE 2/23/21	
C101 OF	
JOB NUMBER 144000-000027	



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PROPOSED WEST MAPLE ST.  
PUMP STATION 'B'  
IMPROVEMENTS

DESIGNED BY  
**MEK**
CHECKED BY  
**KAM**

DATE  
2/23/21

C102

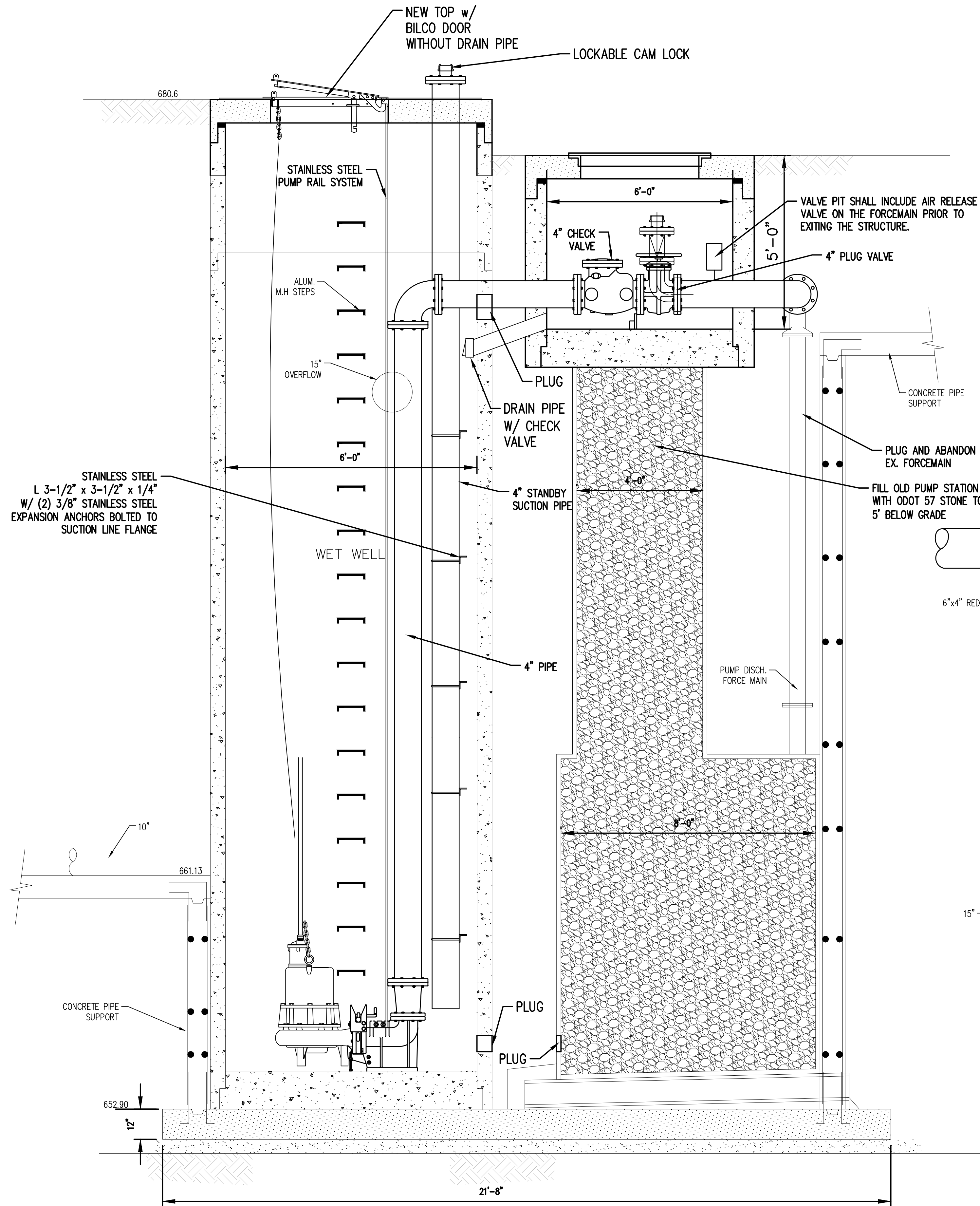
OF

JOB NUMBER  
14400N-000027



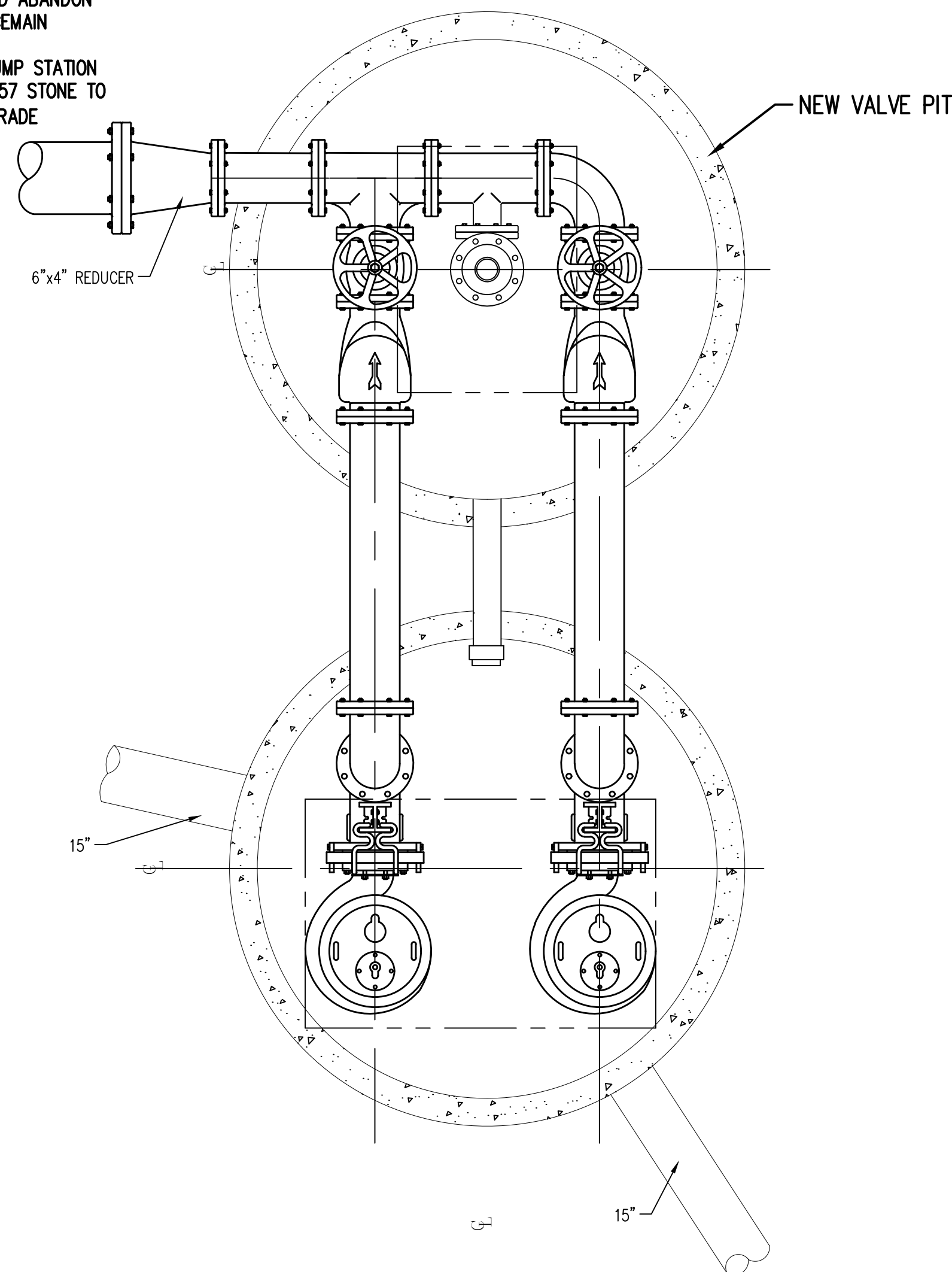
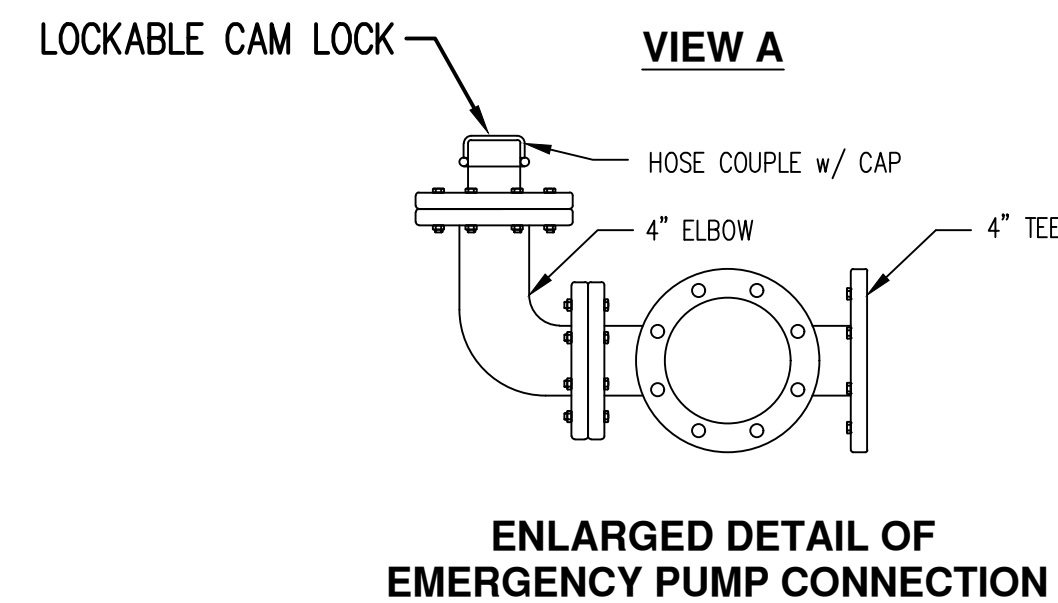
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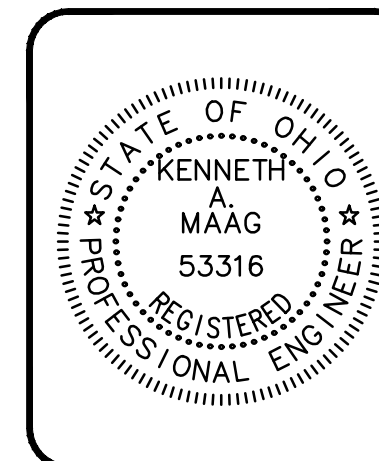


ELEVATION VIEW

EAST MAPLE STREET PUMP STATION "C" DETAIL  
NOT TO SCALE



PLAN VIEW



NO.	DATE	DESCRIPTION
REVISIONS		

**POGEMEYER DESIGN GROUP**  
A KLEINFELDER COMPANY  
101 CLINTON STREET SUITE 1300  
DEFIANCE, OHIO 43512  
(419) 782-3067

**PROPOSED EAST MAPLE ST.  
PUMP STATION "C"  
IMPROVEMENTS**

DESIGNED BY	CHECKED BY
MEK	KAM
DATE	
2/23/21	

**C103**  
OF

JOB NUMBER
144000-000027



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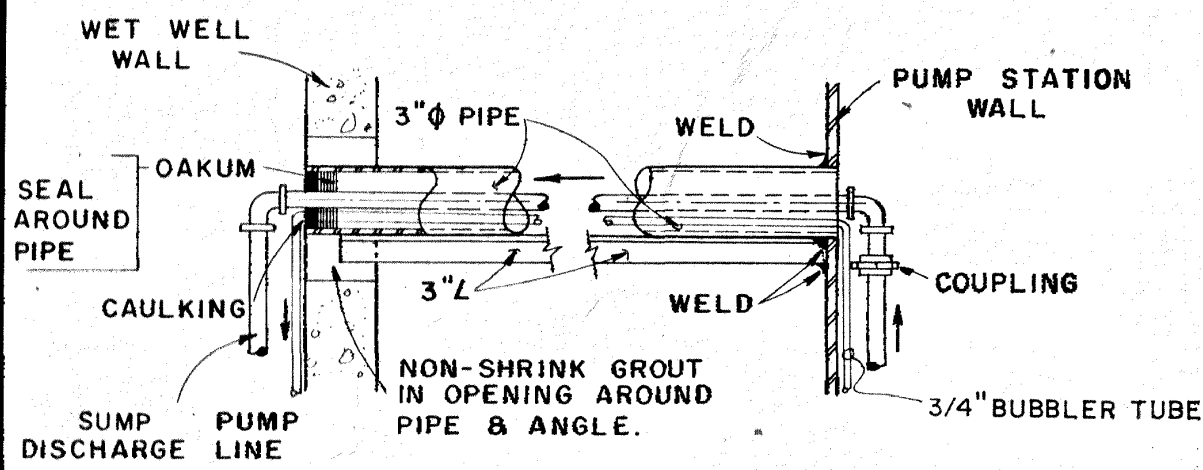




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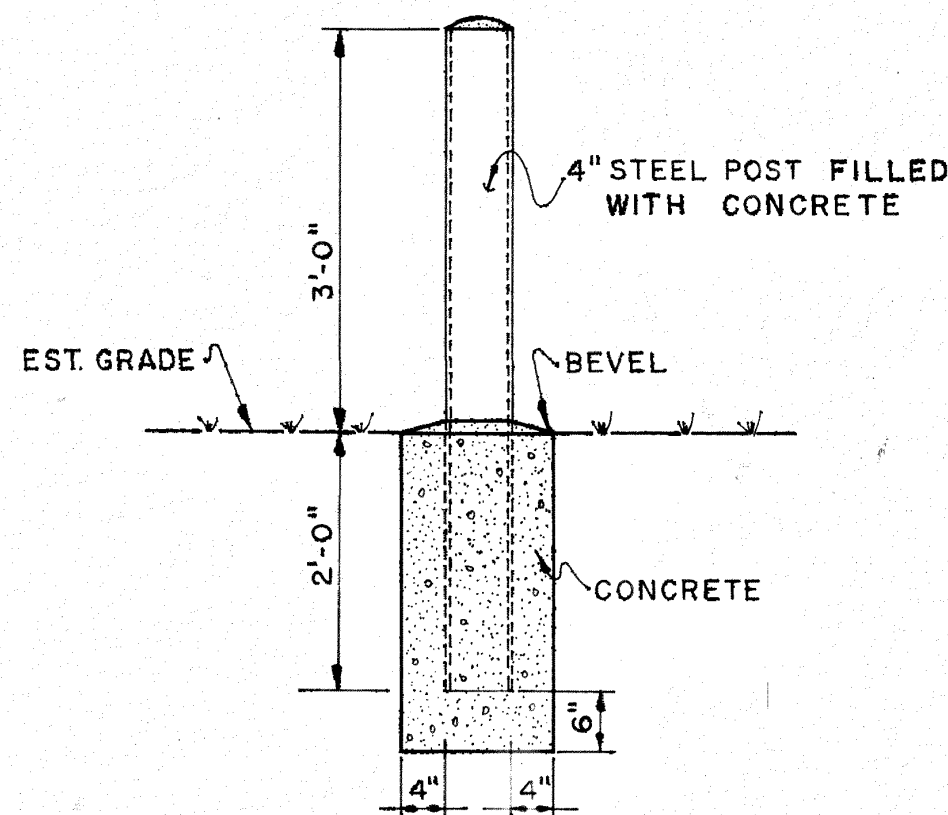
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PUMPING STATION NO.	LOCATION	ELEVATIONS			DIMENSIONS				PIPE SIZES		DIMENSIONS						SEWAGE PUMPS	VALVES			STATION			ELECTRICAL			
		A	B	C	D	E	F	G	suction duct H	discharge cast iron I	K	L	M	N	O	P	RATED CAPACITY	SUCTION	DISCH.	CHECK	MIN. P. THICKNESS FLOOR WALL TUBE	1 SERVICE CONDUITS	2 MAIN DISCONNECT SWITCH	REMARKS			
C	MAPLE ST. & COUNTY RD. 7	680.6	652.90	654.65	6.48	6'-0"	4'-0"	8'-0"	8"	6"	8"	8'-0"	8'-0"	1'-0"	2'-8"	12'-0"	200 GPM @ 20' TDH.	8"	6"	6"	3/8" 3/8" 1/4"	1-1 1/2" C W/2 NO 10 (TELEPHONE) 1-1 1/4" C W/3 NO 6 1-3/4" C W/3 NO 12	1-60A / 3P -NEMA 3R W/6 40 A DUAL ELEMENT CURRENT LIMITING FUSES	3 STATUS & ALARM LIGHTS			
																							4 SECONDARY-240VOLT 3Ø DELTA MIN. 13KVA				

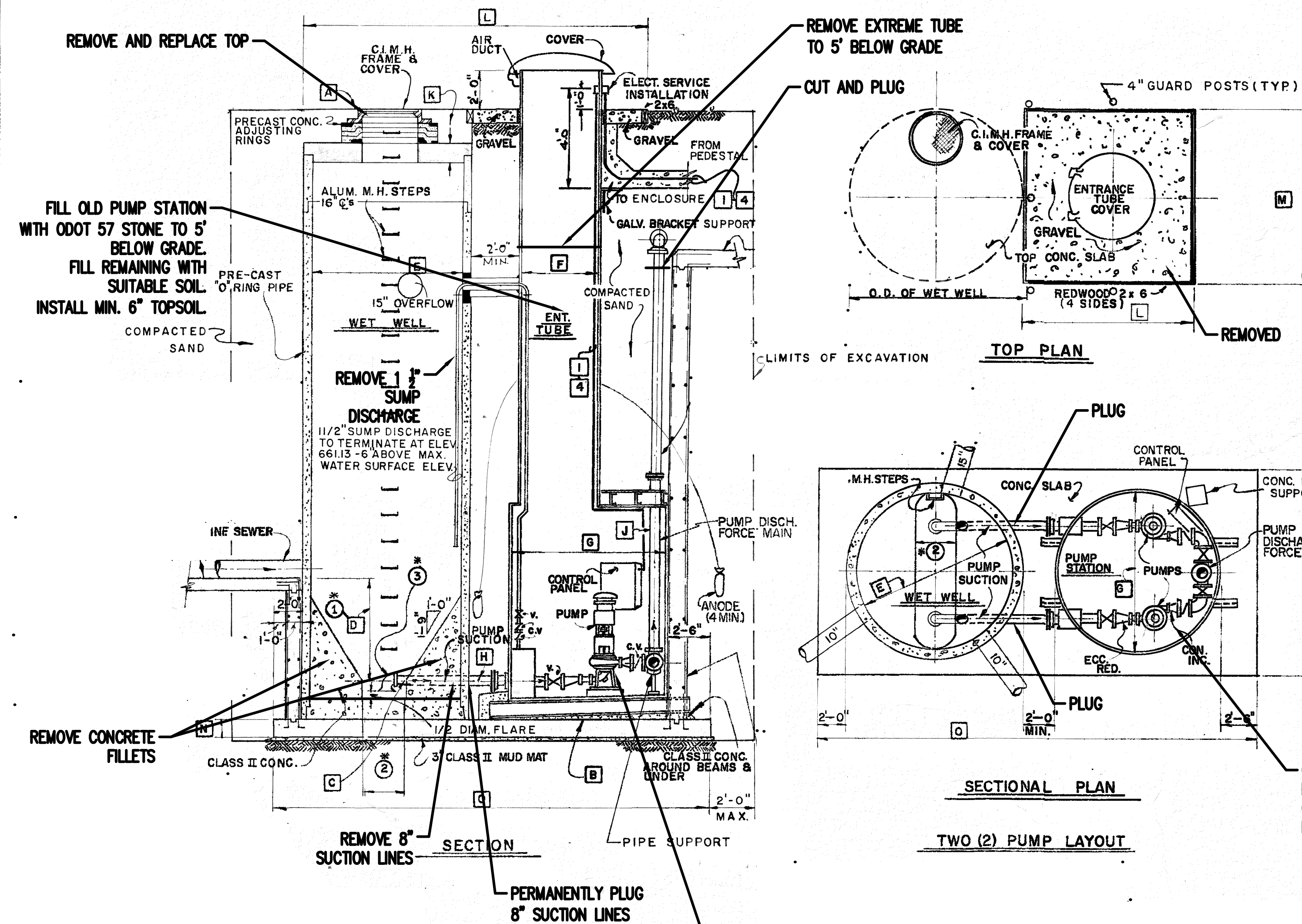


NOTE  
SUMP PUMP DISCHARGE & BUBBLER TUBE PIPING INTO WETWELL TO BE 4'-0" BELOW GRADE.

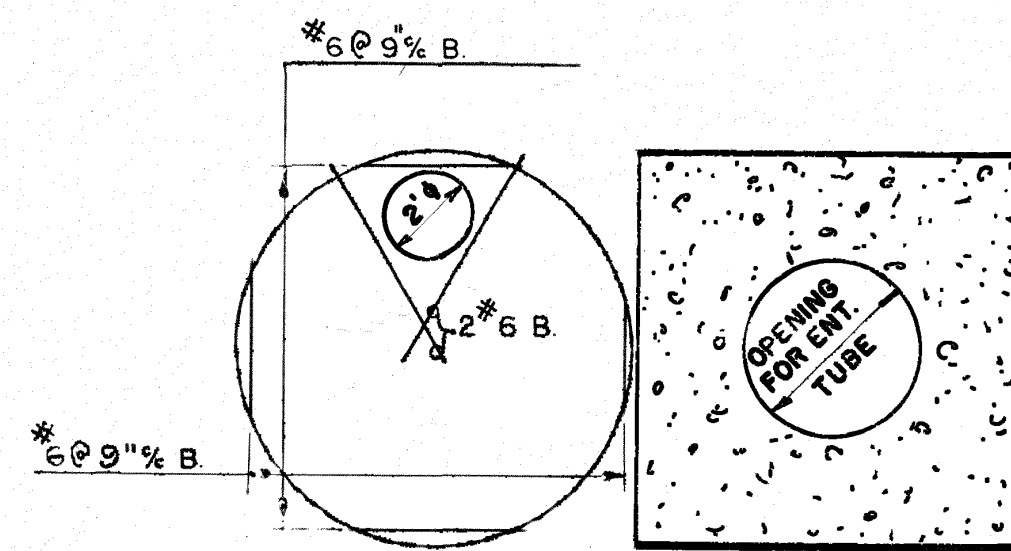
SUMP PUMP & BUBBLER TUBE PIPE SUPPORT BETWEEN WET WELL & PUMP STATION



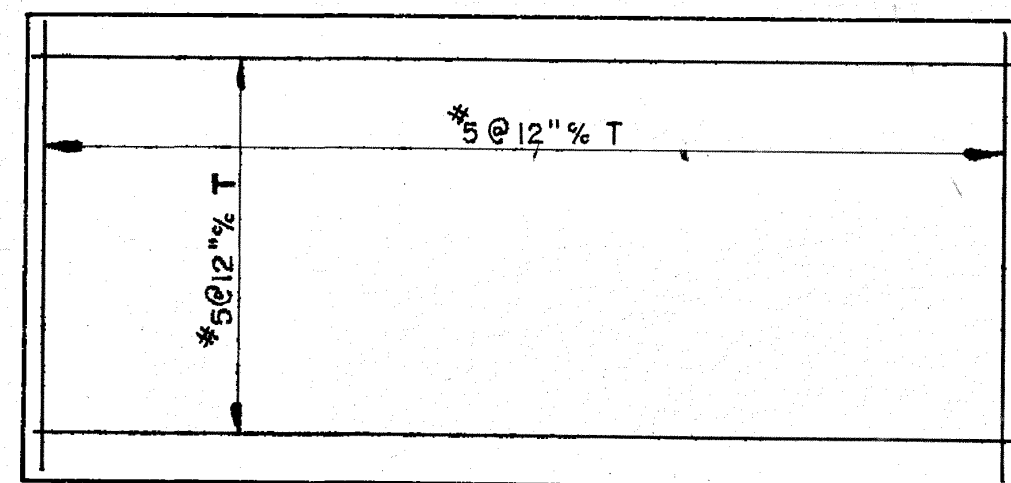
GUARD POST DETAIL



CONTRACTOR TO REMOVE ALL PUMPS, PIPING, ELECTRICAL COMPONENTS, PIPE SUPPORTS ETC. FROM EX. PUMP STATION AND DISPOSE.

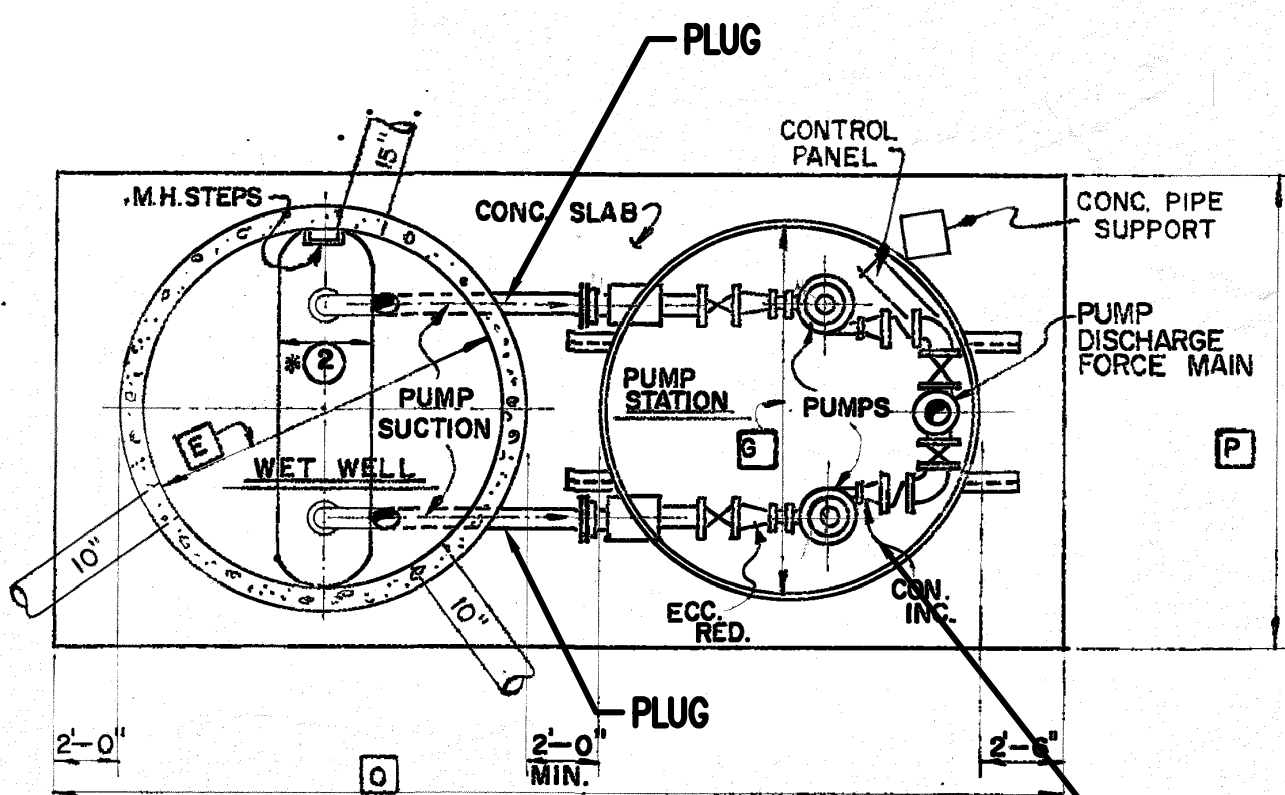


TOP SLAB



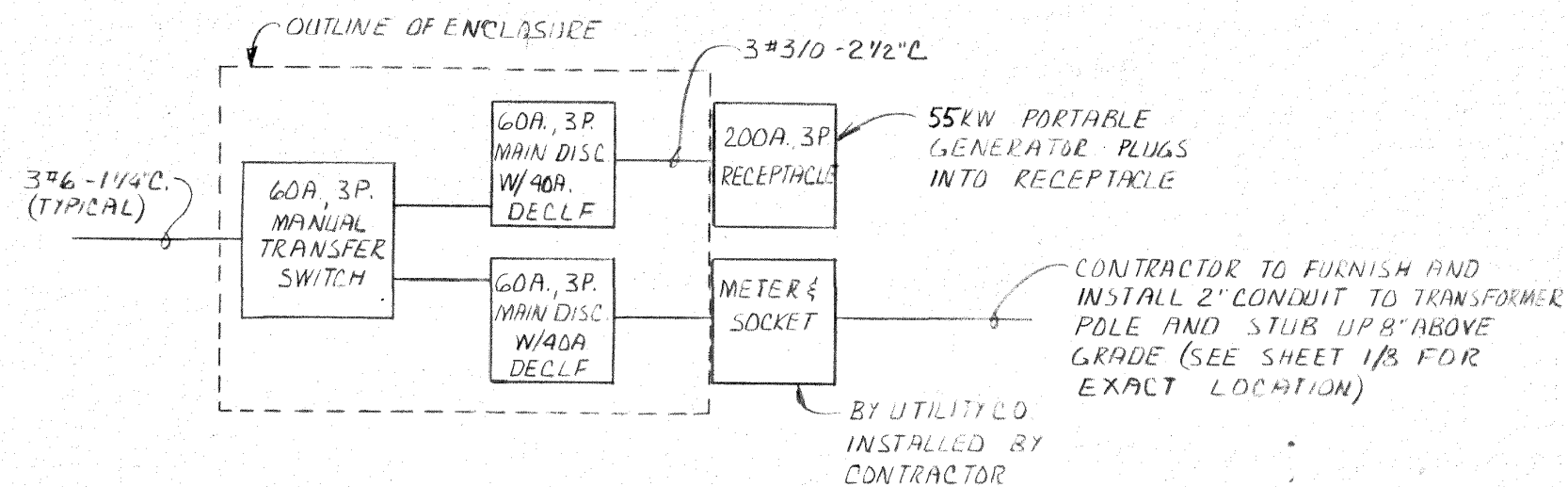
BOTTOM SLAB

PLAN OF CONCRETE SLAB REINFORCING

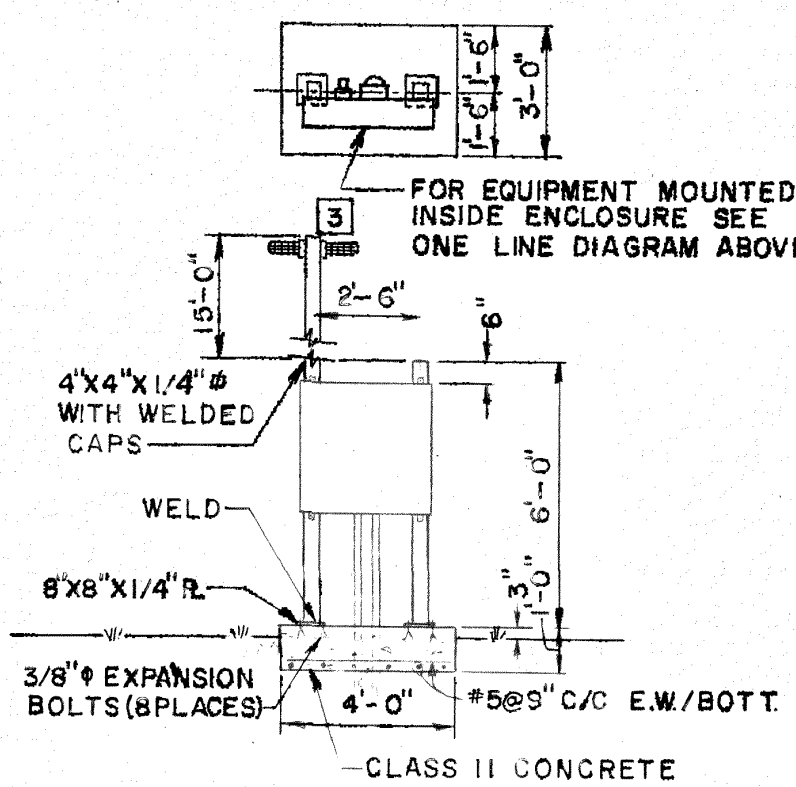


SECTIONAL PLAN

TWO (2) PUMP LAYOUT



ONE LINE DIAGRAM



PEDESTAL DETAIL

CONTRACTOR TO REMOVE ELECTRICAL PANELS



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101 CLINTON STREET SUITE 1300  
DEFAANCE, OHIO 43512  
(419) 782-3067

**SANITARY SEWER  
PUMP STATION REHABILITATION  
LIBERTY CENTER, OHIO**

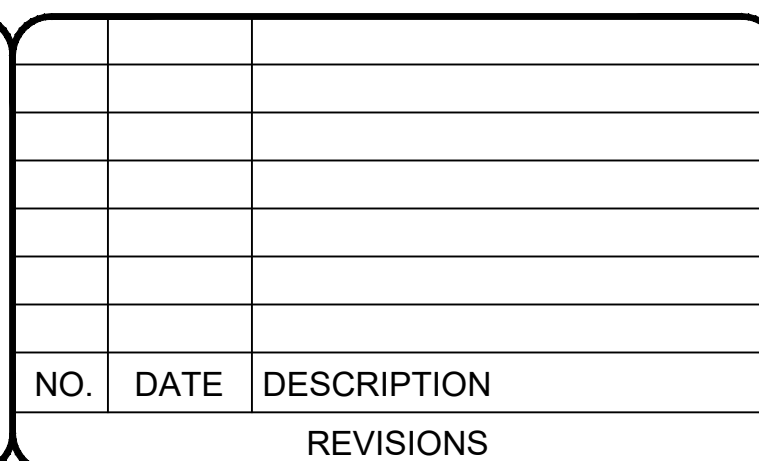
**EXISTING EAST MAPLE ST.  
PUMP STATION 'C'  
DEMOLITION PLAN**

DESIGNED BY: MEK  
CHECKED BY: KAM  
DATE: 2/23/21

**C105**  
OF

JOB NUMBER  
144000-000027





JOB NUMBER  
144000-000027



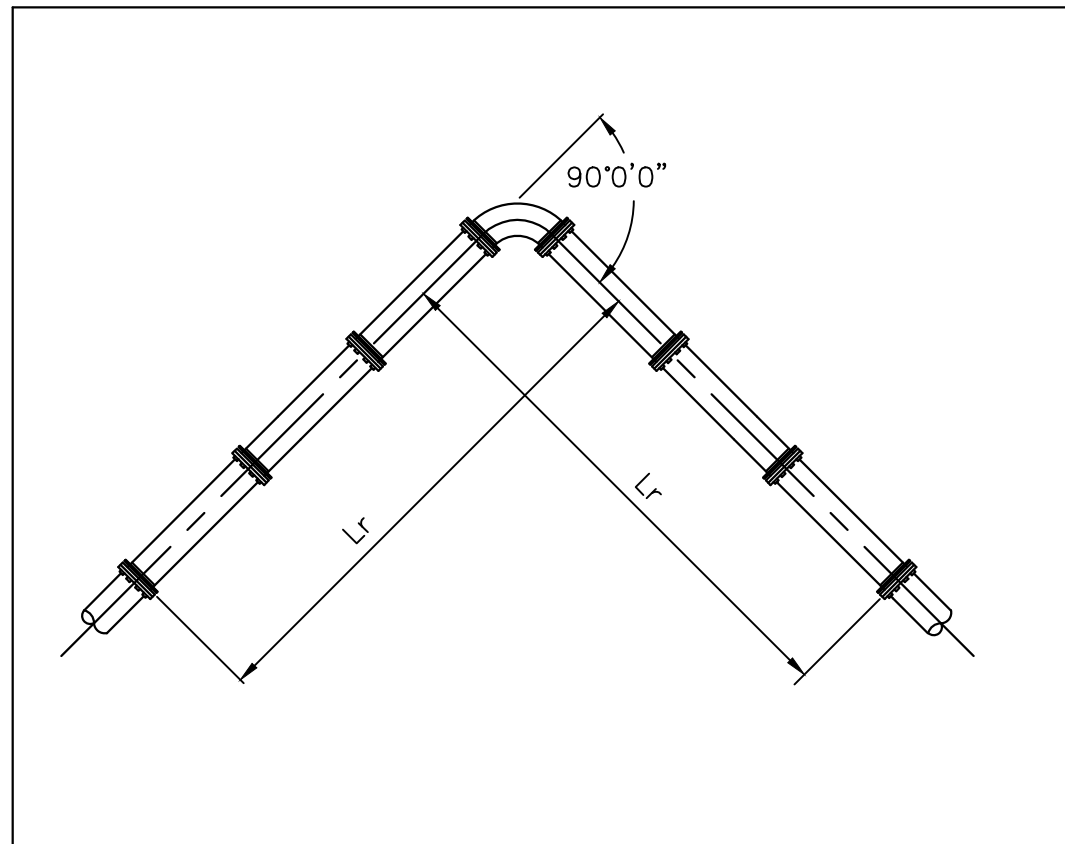


FIGURE 1. HORIZONTAL BEND

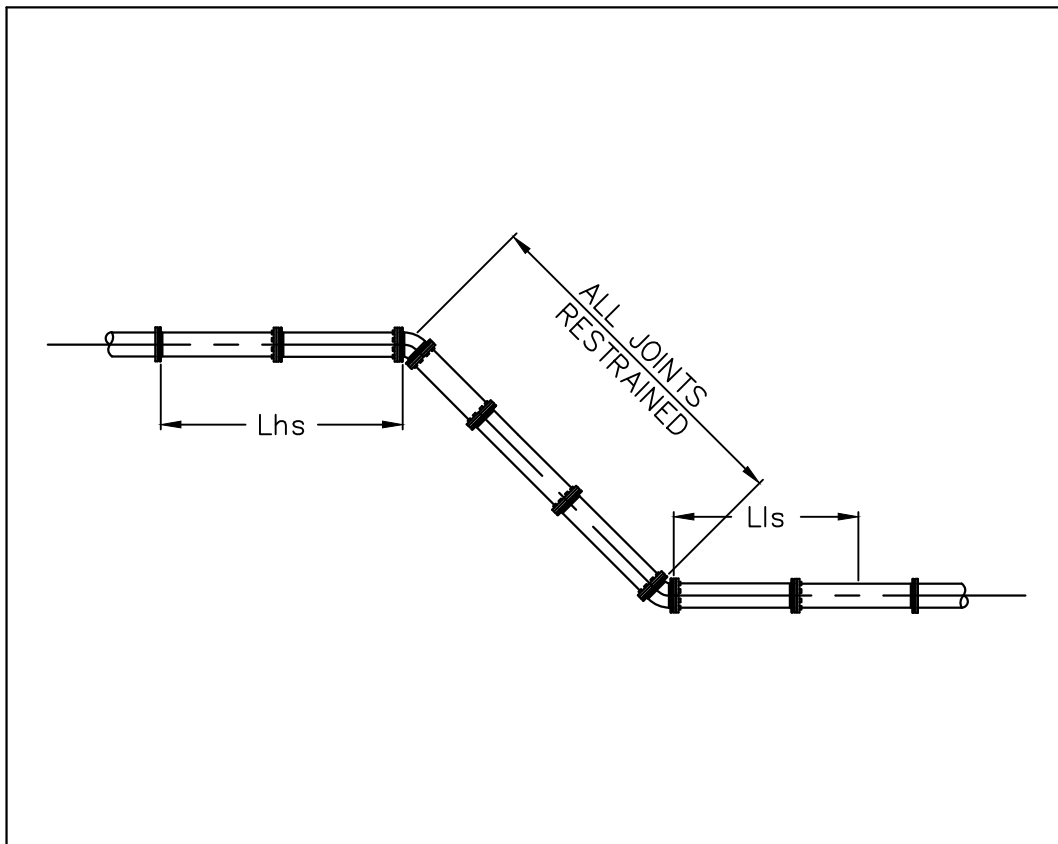


FIGURE 2. VERTICAL DOWN BEND AND OFFSET BEND

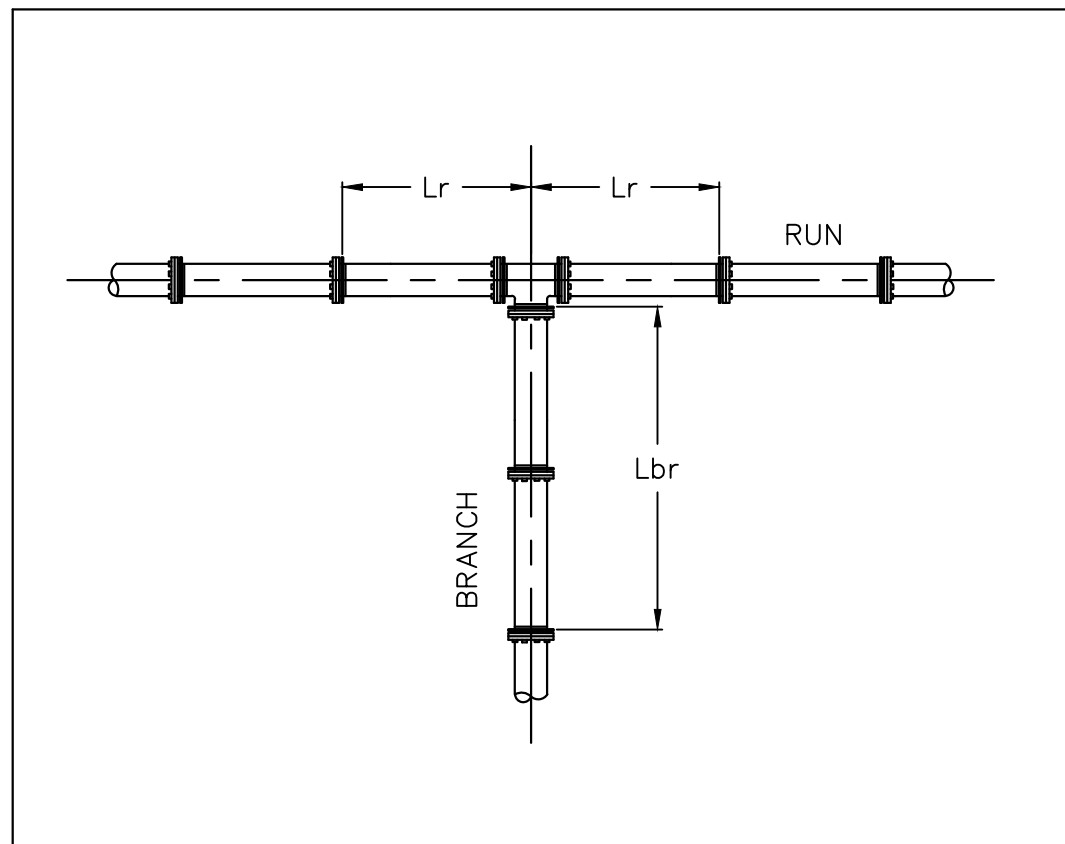


FIGURE 3. TEE

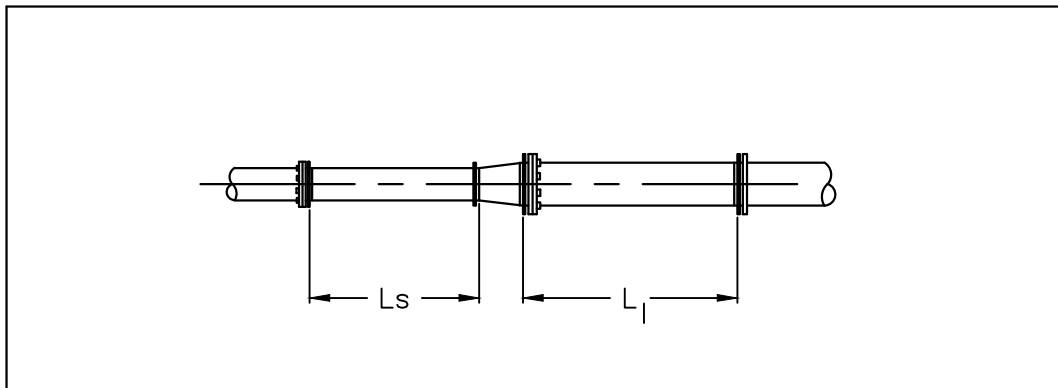


FIGURE 4. REDUCER

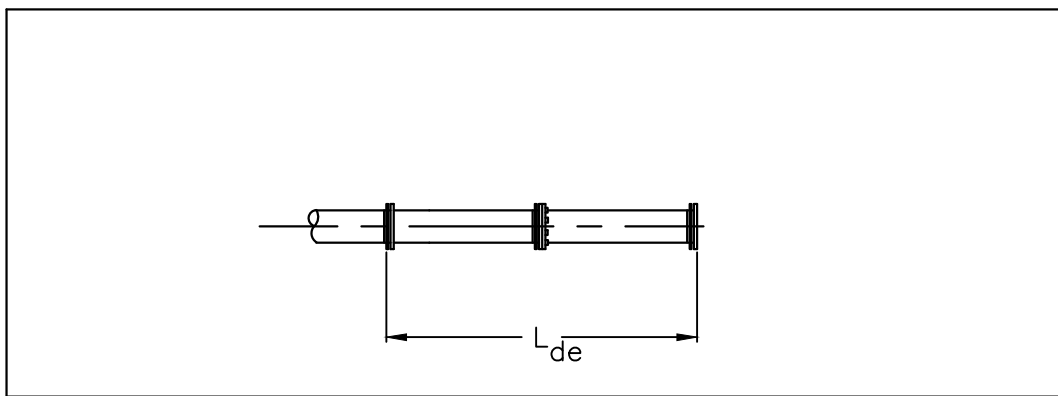


FIGURE 5. DEAD END

MINIMUM LENGTH OF PIPE RESTRAINED (FEET)								
SIZE	HORIZONTAL BENDS			VERTICAL BENDS				DEAD END Lde
	90°	45°	22.5°	45°		22.5°		
	Lr	Lr	Lr	Lhs	Lls	Lhs	Lls	
6"	20	8	4	18	6	9	3	44
8"	26	11	5	24	8	11	4	58
10"	32	13	6	29	10	14	5	69
12"	37	16	7	34	12	16	6	82
14"	43	18	9	39	13	19	6	94
16"	48	20	10	44	15	21	7	106
20"	59	24	12	53	19	26	9	129
24"	69	29	14	62	22	30	11	151

PVC PIPE

SIZE	HORIZONTAL BENDS						VERTICAL BENDS			DEAD END	
	90°		45°		22.5°		45°		22.5°		
	Lr	Lr	Lr	Lhs	Lls	Lhs	Lls	Lde			
6"	21	9	4	12	6	6	3	28			
8"	27	11	5	15	8	7	4	37			
10"	33	14	7	18	10	9	5	44			
12"	39	16	8	22	12	10	6	52			
14"	44	18	9	25	13	12	6	60			
16"	50	21	10	28	15	13	7	68			
20"	61	25	12	34	18	16	9	82			
24"	72	29	14	40	22	19	10	96			

DUCTILE IRON

SIZE	HORIZONTAL BENDS						VERTICAL BENDS			DEAD END
	90°	45°	22.5°	45°		22.5°				
	Lr	Lr	Lr	Lhs	Lls	Lhs	Lls	Lde		
6"	36	15	7	28	11	14	5	68		
8"	48	20	10	37	15	18	7	89		
10"	57	24	11	44	18	21	9	107		
12"	68	28	13	52	21	25	10	126		
14"	78	32	15	60	24	29	12	144		
16"	88	36	17	67	27	32	13	163		
20"	107	44	21	82	33	39	16	198		
24"	125	52	25	96	39	46	19	232		

DUCTILE IRON W/ POLYETHYLENE WRAP

MECHANICAL RESTRAINTS

150 PSI  
GROUND COVER = 4'

BRANCH SIZE	RUN SIZE							
	6"	8"	10"	12"	14"	16"	20"	24"
6"	*	*	*	*	*	*	*	*
8"	8	*	*	*	*	*	*	*
10"	30	18	5	*	*	*	*	*
12"	49	39	28	18	7	*	*	*
14"	66	57	1	39	30	20	1	*
16"	81	74	66	58	50	42	25	8
20"	110	104	97	91	85	78	65	51
24"	135	130	125	120	115	109	98	87

TEES  
PVC PIPE

MINIMUM LENGTH OF PIPE RESTRAINED (FEET) (Lbr)

BRANCH SIZE	RUN SIZE							
	6"	8"	10"	12"	14"	16"	20"	24"
6"	9	3	*	*	*	*	*	*
8"	22	18	13	8	3	*	*	*
10"	33	29	25	21	17	13	5	*
12"	42	39	36	33	30	26	20	13
14"	51	49	46	43	41	38	32	26
16"	60	58	56	53	51	48	43	38
20"	76	75	73	71	69	67	63	59
24"	91	90	88	87	85	84	80	77

TEES  
DUCTILE IRON PIPE

MINIMUM LENGTH OF PIPE RESTRAINED (FEET) (Lbr)

BRANCH SIZE	RUN SIZE							
	6"	8"	10"	12"	14"	16"	20"	24"
6"	21	7	*	*	*	*	*	*
8"	53	42	31	19	7	*	*	*
10"	79	70	60	51	42	32	12	*
12"	102	95	87	80	72	64	47	30
14"	124	118	111	105	98	91	77	63
16"	145	140	134	128	122	116	104	92
20"	184	180	175	171	166	161	152	142
24"	220	217	213	209	205	202	194	186

TEES  
DUCTILE IRON PIPE W/ POLYETHYLENE WRAP

MINIMUM LENGTH OF PIPE RESTRAINED (FEET) (Lbr)

REDUCTION SIZE	LARGE SIZE							
	6"	8"	10"	12"	14"	16"	20"	24"
6"	32	24	43	60	75	89	116	140
8"	29	23	65	107	156	271	412	570
10"	29	24	62	101	156	271	412	570
12"	28	24	61	101	156	271	412	570
14"	28	24	61	101	156	271	412	570
16"	28	24	61	101	156	271	412	570
20"	28	24	61	101	156	271	412	570
24"	28	24	61	101	156	271	412	570

REDUCERS  
PVC PIPE

MINIMUM LENGTH OF PIPE RESTRAINED (L<sub>1</sub>) (FEET)

REDUCTION SIZE	LARGE SIZE							
	6"	8"	10"	12"	14"	16"	20"	24"
6"	20	16	27	38	48	57	74	89
8"	19	15	26	37	47	56	73	88
10"	18	14	25	36	46	55	72	87
12"	18	14	25	36	46	55	72	87
14"	18	14	25	36	46	55	72	87
16"	18	14	25	36	46	55	72	87
20"	18	14	25	36	46	55	72	87
24"	18	14	25	36	46	55	72	87

REDUCERS  
DUCTILE IRON PIPE

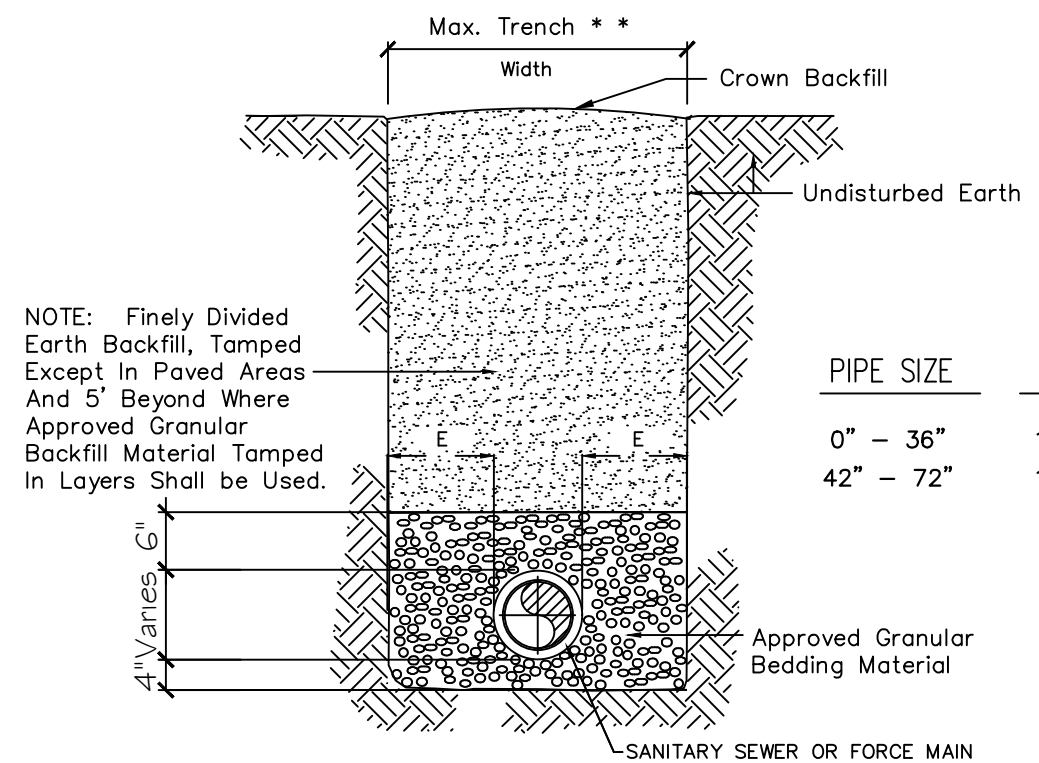
MINIMUM LENGTH OF PIPE RESTRAINED (L<sub>1</sub>) (FEET)

REDUCTION SIZE	LARGE SIZE							
	6"	8"	10"	12"	14"	16"	20"	24"
6"	49	108	181	266	365	599	883	1215
8"	37	66	92	115	137	178	215	253
10"	36	67	94	119	163	203	243	283
12"	44	96	156	239	356	529	772	1089
14"	37	68	97	124	166	212	256	306
16"	42	93	137	212	356	529	772	1089
20"	37	68	97	124	166	212	256	306
24"	37	68	97	124	166	212	256	306

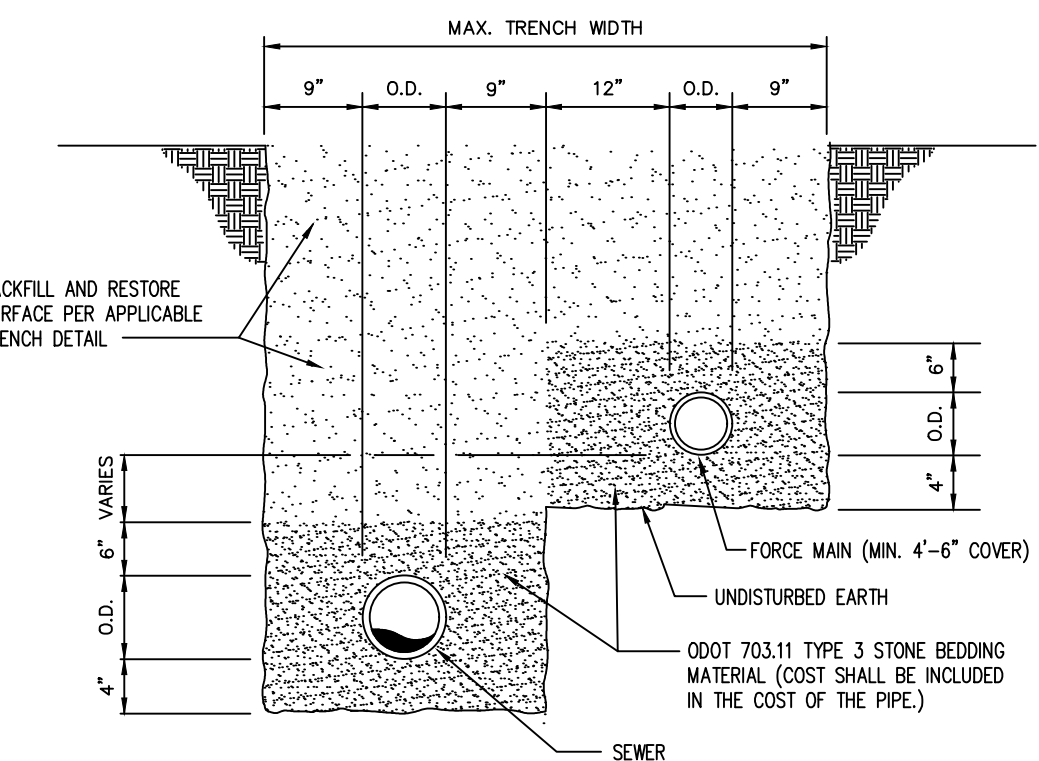
REDUCERS  
DUCTILE IRON W/ POLYETHYLENE WRAP

MINIMUM LENGTH OF PIPE RESTRAINED (L<sub>1</sub>) (FEET)

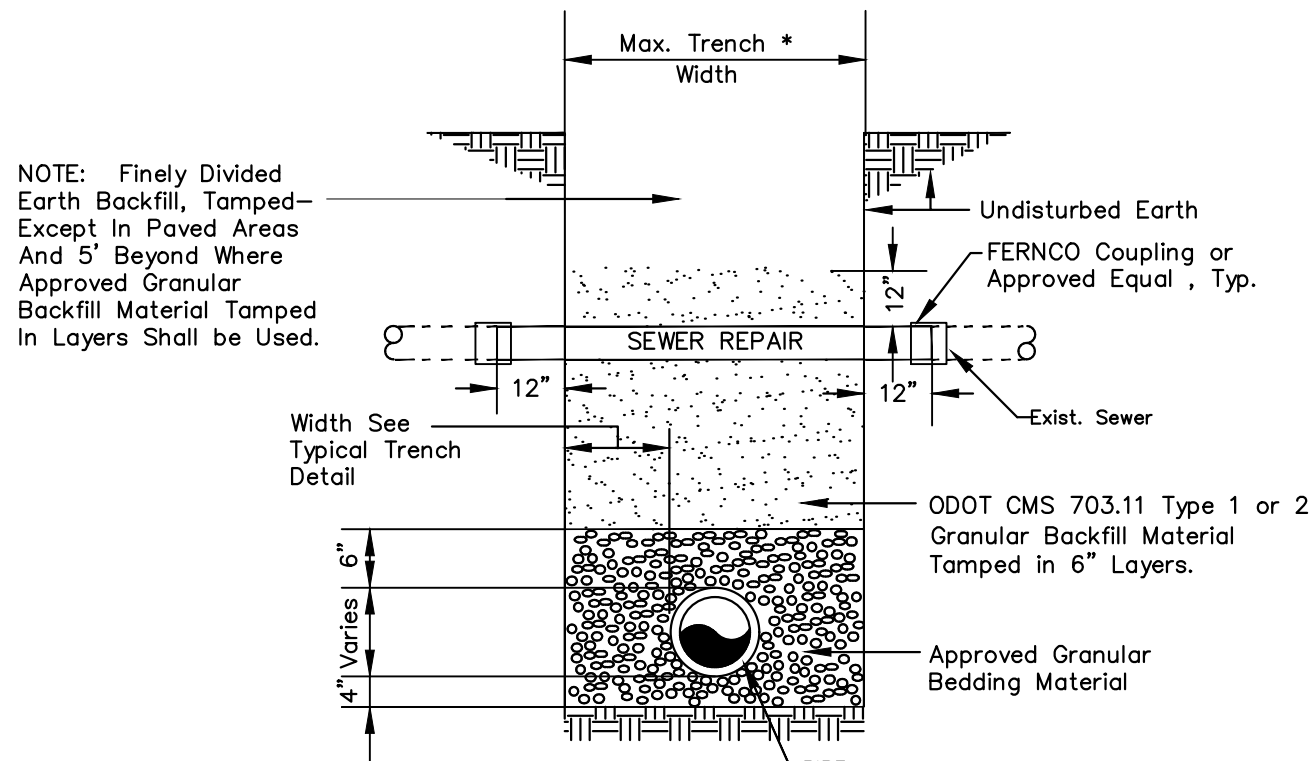
L<sub>s</sub> : IF A SPECIFIED LENGTH OF PIPE, L<sub>s</sub> (FEET), ON THE SMALL SIDE OF THE REDUCER IS FREE OF BENDS, VALVES, TEES OR OTHER FITTINGS, RESTRAINTS ARE NOT NECESSARY FOR THE REDUCER; OTHERWISE THE LARGER SIDE OF THE REDUCER SHALL BE RESTRAINED THE MINIMUM LENGTH (L<sub>1</sub>) (FEET).



PIPE TRENCH DETAIL  
N.T.S.



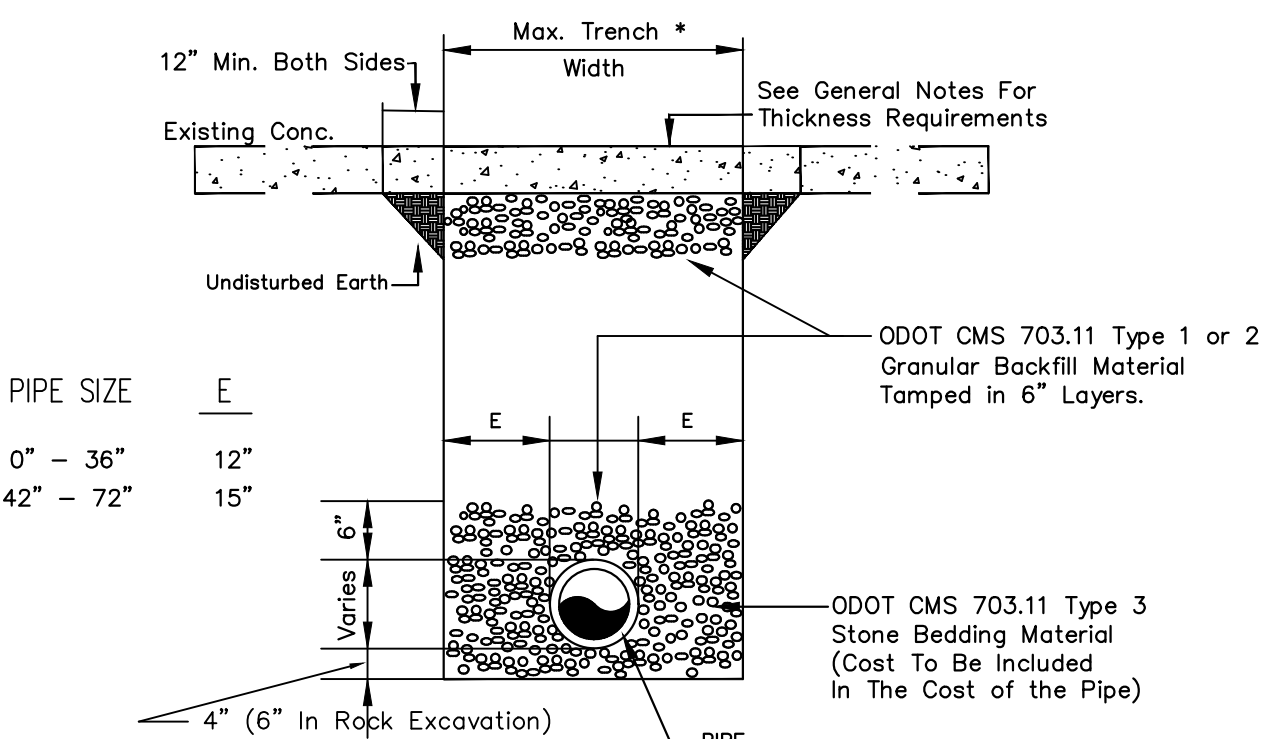
SEWER AND FORCE MAIN IN COMMON TRENCH  
Not to Scale



\* Pay Limits Only, Maximum Trench Width Shall Be The Same As The Trench Width At The Top Of The Pipe. The Sewer Repair Pay Length is the Maximum Trench Width Plus 2 FT.

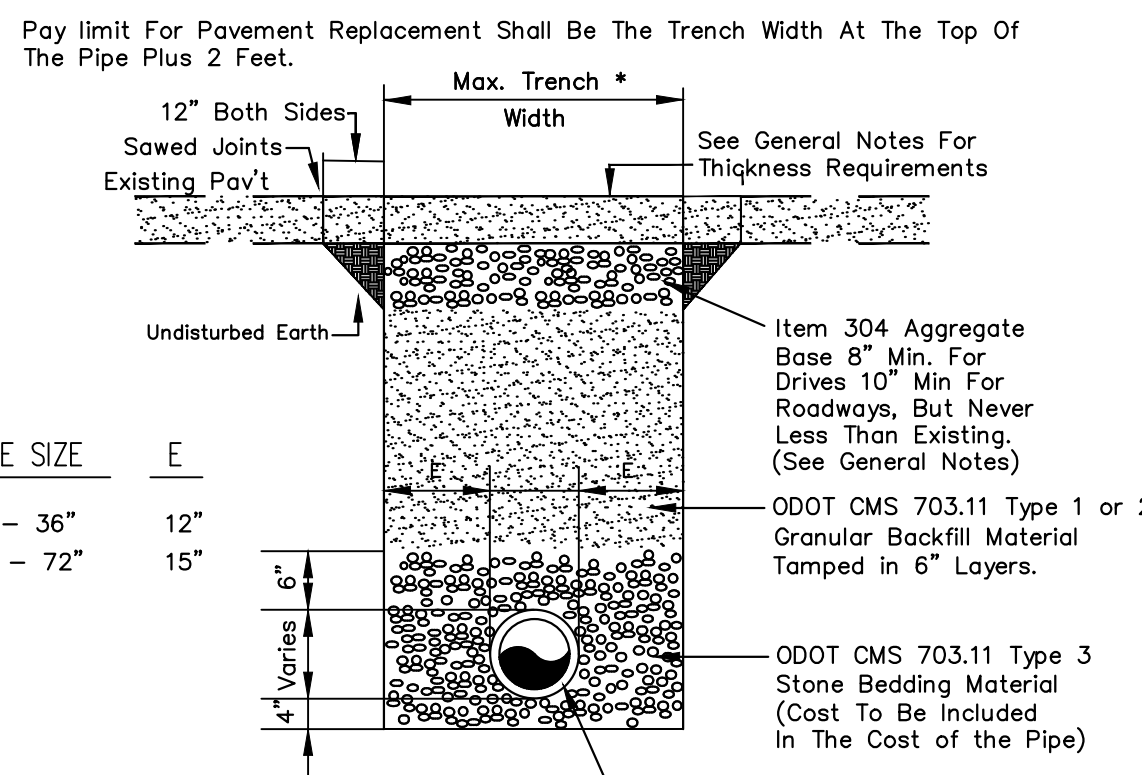
SEWER REPAIR OVER SANITARY SEWER

Pay limit For Pavement Replacement Shall Be The Trench Width At The Top Of The Pipe Plus 2 Feet.



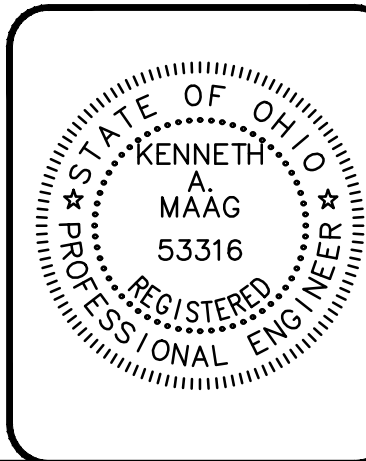
\* For Pay Limits Only, Maximum Trench Width Shall Be The Same As The Trench Width At The Top Of The Pipe.

GRAVITY SANITARY SEWER  
TRENCH DETAIL IN CONCRETE PAVEMENT



\* For Pay Limits Only, Maximum Trench Width Shall Be The Same As The Trench Width At The Top Of The Pipe.

GRAVITY SANITARY SEWER  
TRENCH DETAIL IN ASPHALT PAVEMENT



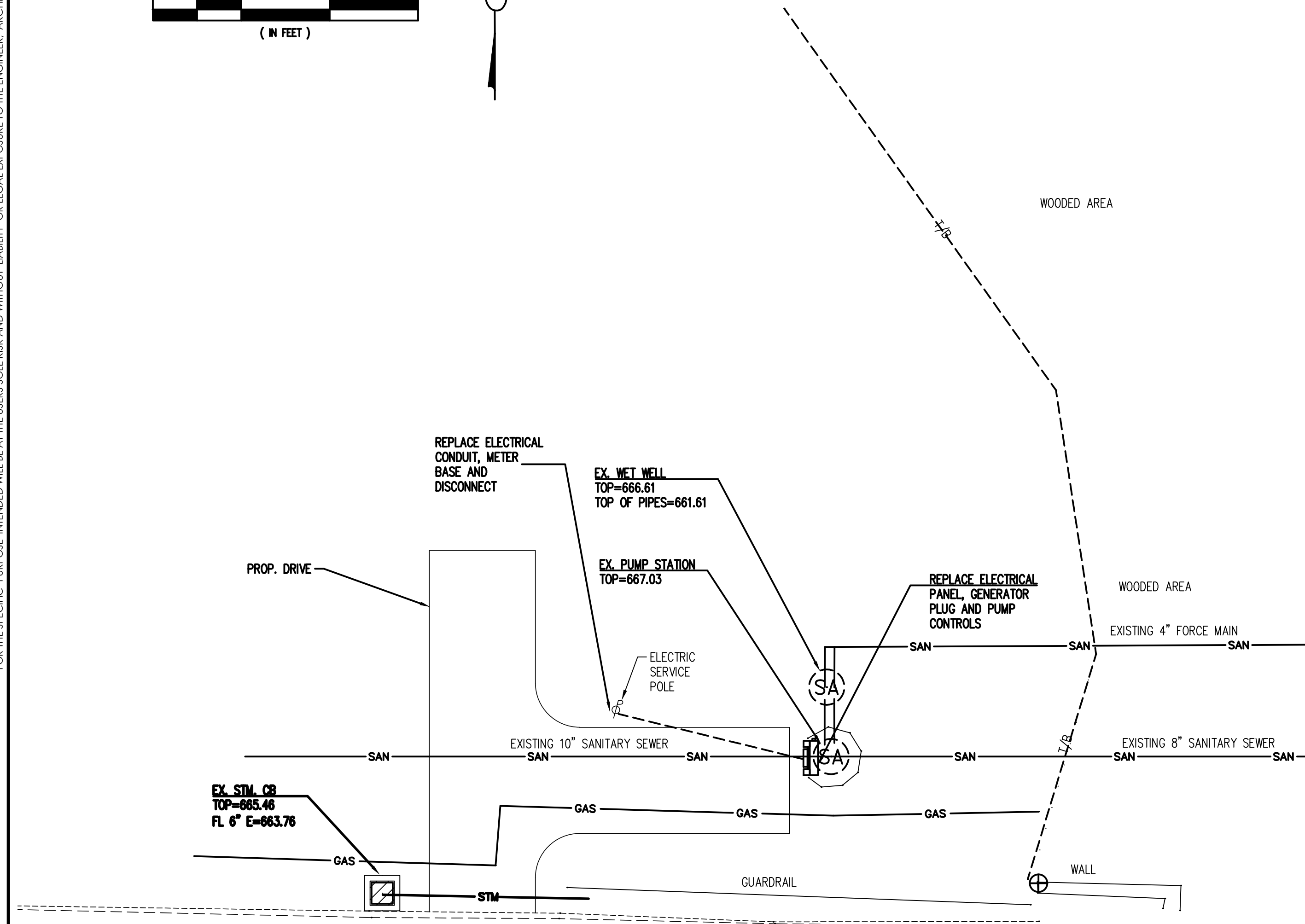
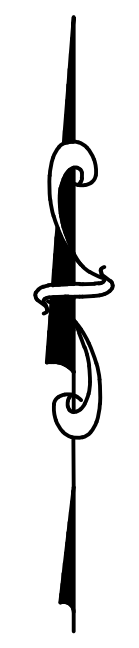
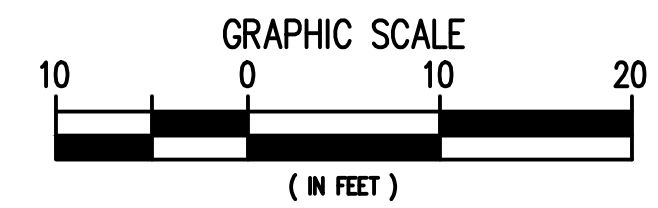
NO.	DATE	DESCRIPTION
REVISIONS		

DRAWN BY MEK	CHECKED BY KAM
DATE 2/23/21	
C107 OF	
JOB NUMBER 144000-000027	

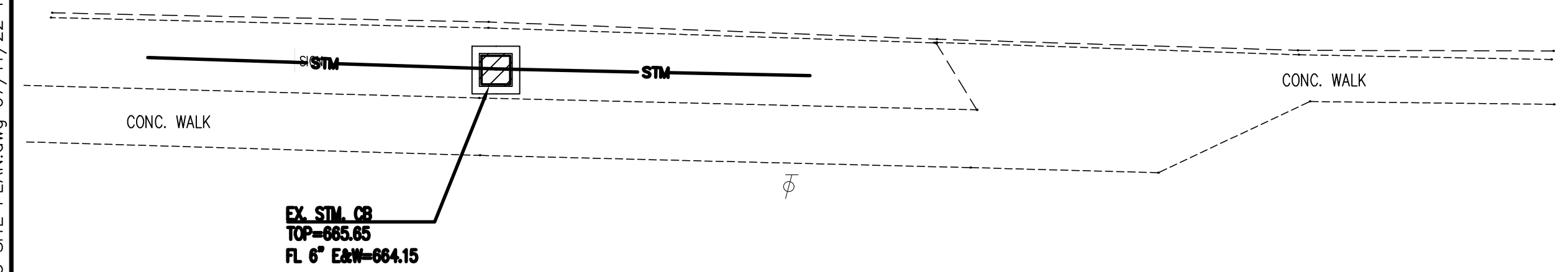


FILE No. I:\144000\00027\14400000027-E100 ELECTRIC SITE PLAN.dwg 07/11/22 14:40-BTidd

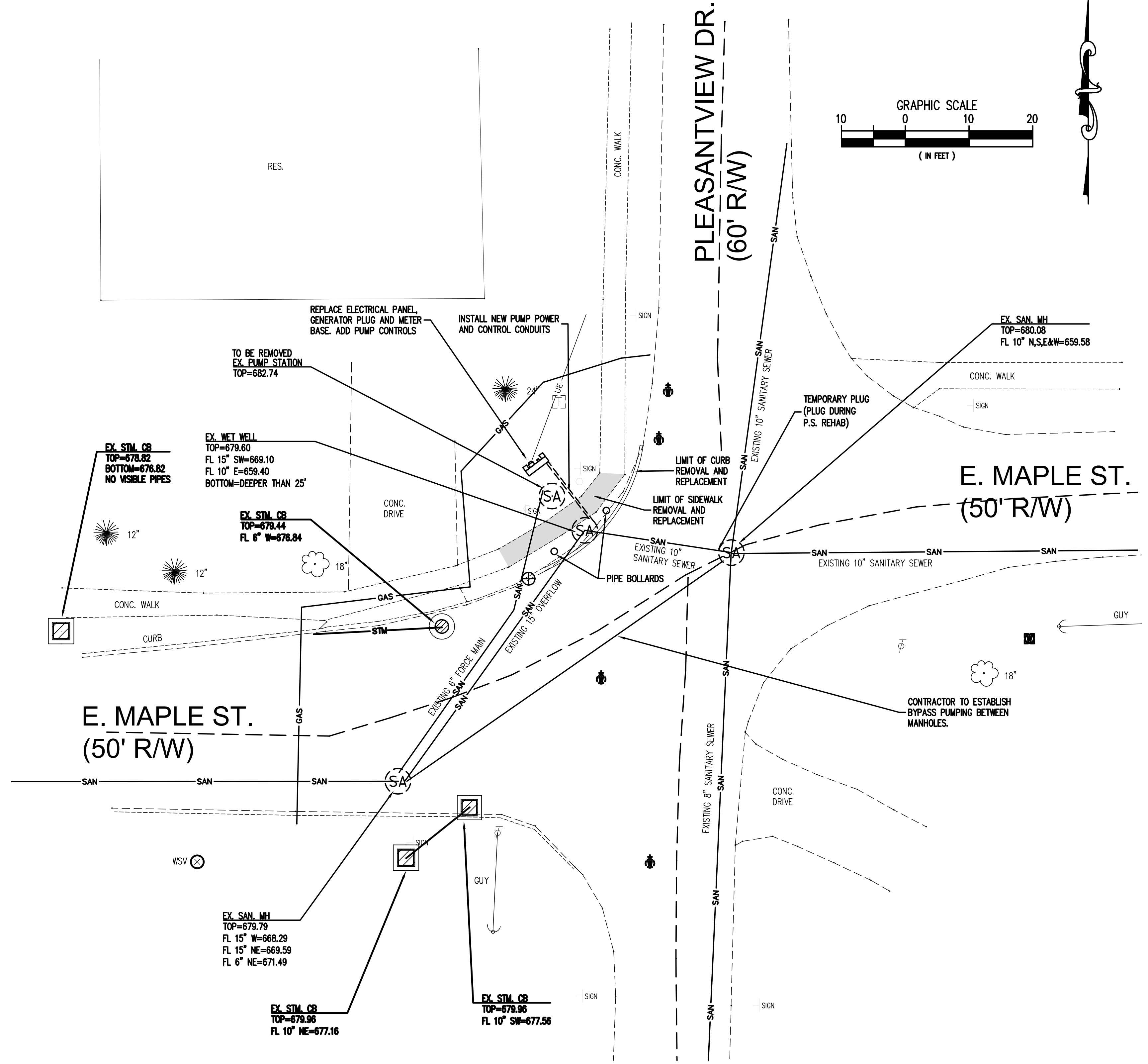
ANY INFORMATION OR DATA ON THIS DRAWING IS NOT INTENDED TO BE SUITABLE FOR REUSE BY ANY PERSON, FIRM OR CORPORATION OR ANY OTHERS ON EXTENSIONS OF THE PROJECT. THE USER OF THIS DRAWING SHALL BE RESPONSIBLE FOR THE ACCURACY OF THE INFORMATION AND DATA FOR THE PROJECT. THE USER OF THIS DRAWING SHALL BE RESPONSIBLE FOR THE ACCURACY OF THE INFORMATION AND DATA FOR THE PROJECT.



W. MAPLE STREET (50' R/W)

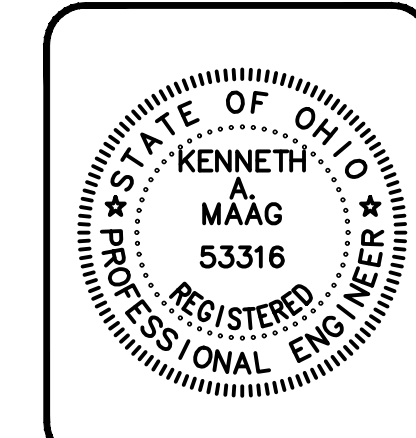
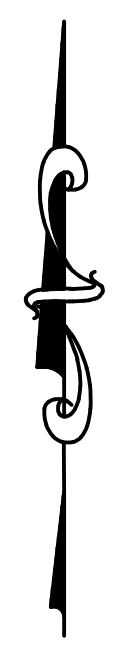
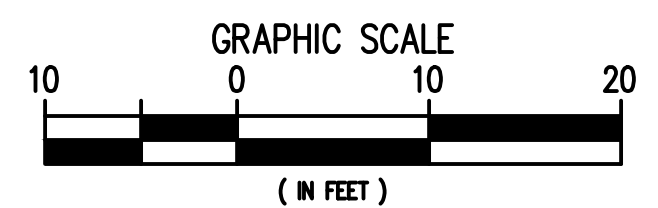


## W. MAPLE STREET PUMP STATION "B"



E. MAPLE ST.  
(50' R/W)

## E. MAPLE STREET PUMP STATION "C"



NO.	DATE	DESCRIPTION
2	7/11/2022	ISSUED FOR BIDS
1	8/9/2021	ISSUED FOR REVIEW

REVISIONS

**POGGEMEYER DESIGN GROUP**  
A KLEINFELDER COMPANY  
101 CLINTON STREET, SUITE 1300  
DEFIANCE, OHIO 43512  
(419) 782-3067

**SANITARY SEWER  
PUMP STATION REHABILITATION  
LIBERTY CENTER, OHIO**

**PROPOSED MAPLE ST.  
PUMP STATION  
ELECTRICAL SITE PLAN**

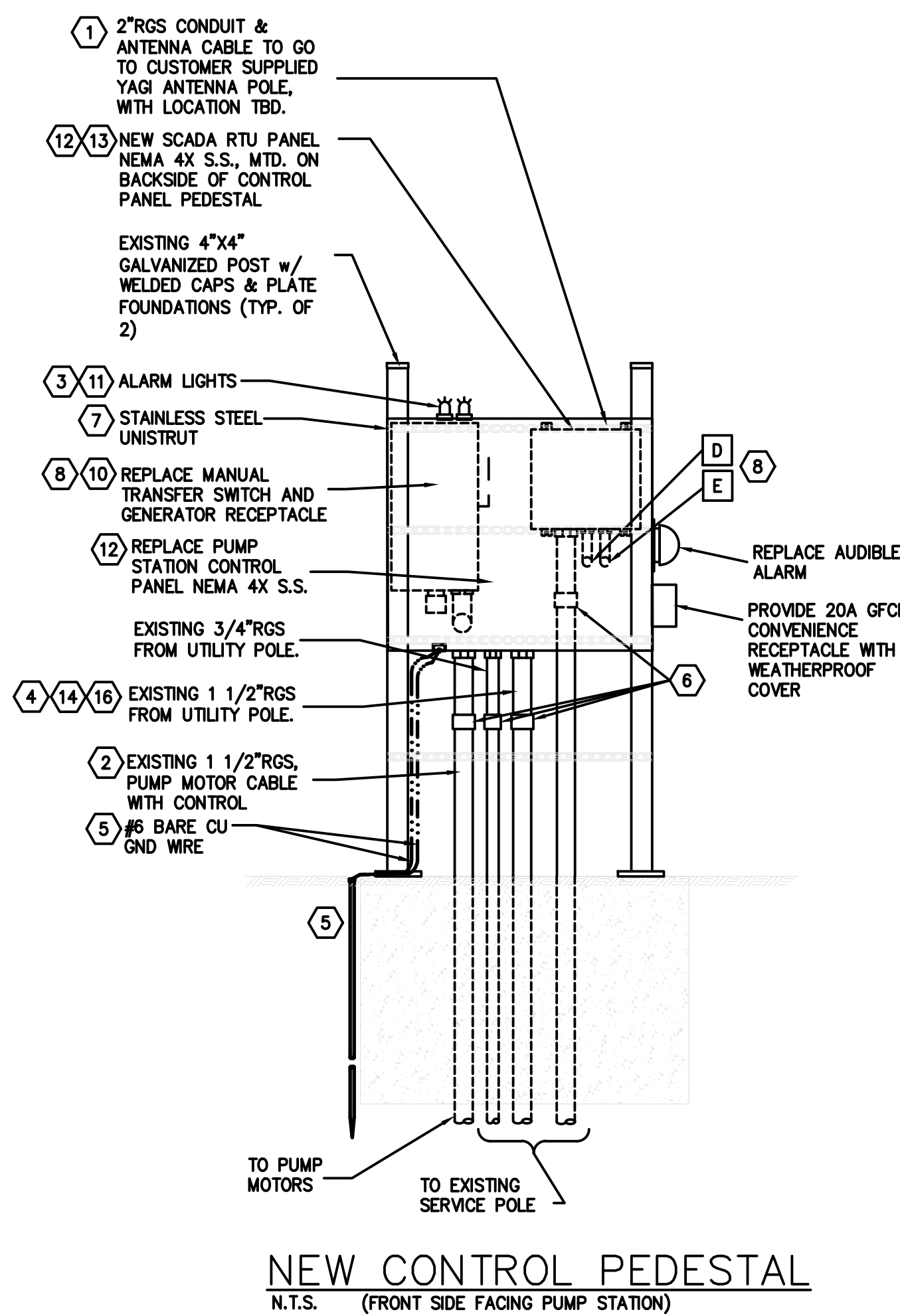
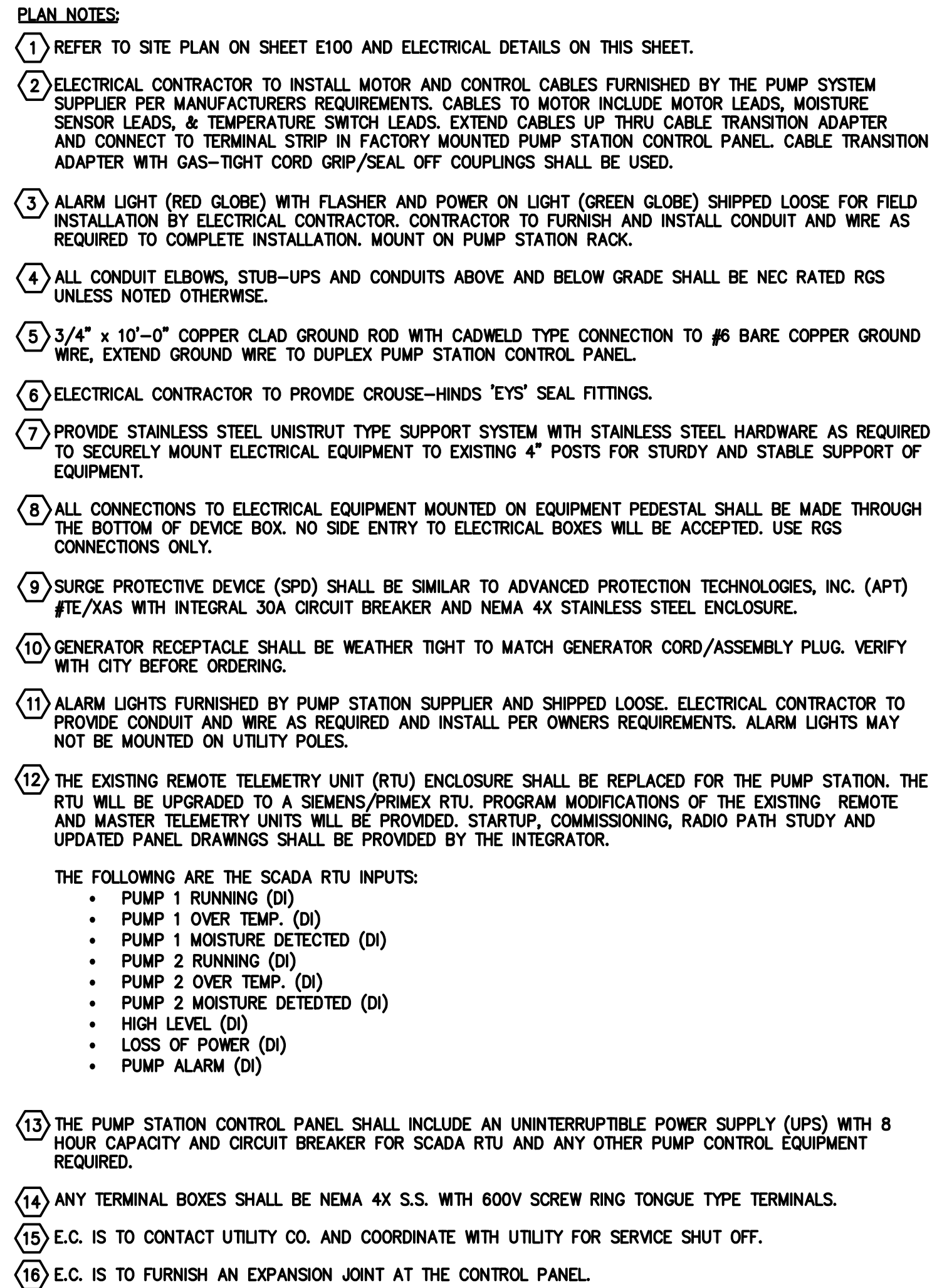
DRAWN BY	CHECKED BY
BWT	KAM
DATE	7/21/21

**E100**  
OF

JOB NUMBER  
144000-000027



FILE No. I:\144000\000027\144000000027-F101 PS B Single Line & Details.dwg 07/11/22 14:42-BTidd



**NOTE:**  
1. REFER TO SINGLE-LINE FOR WIRE FILL AND CONDUIT SIZES.

2	7/11/2022	ISSUED FOR BIDS
1	8/9/2021	ISSUED FOR REVIEW
NO.	DATE	DESCRIPTION
REVISIONS		

**POGEMEYER DESIGN GROUP**  
A KLEINFELDER COMPANY  
1 CLINTON STREET, SUITE 1300  
DEFANCE, OHIO 43512-1067  
(419) 782-3067

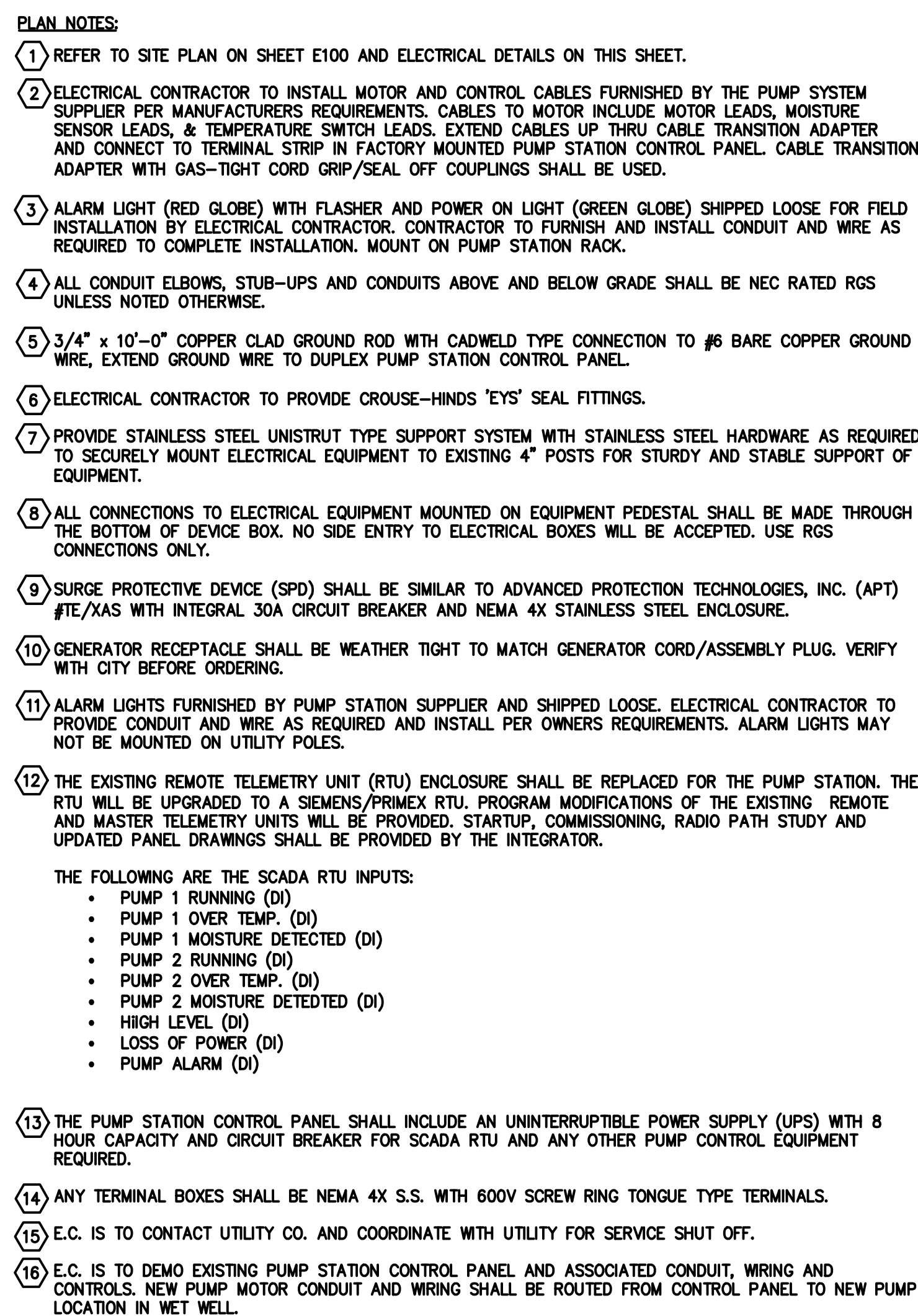
DEFIANCE, OHIO 43512


[419] 782-3067

101 CLINTON STREET, SUITE 1300



FILE No. I:\144000\000027\144000000027-F102 PS C. Single Line & Details.dwg 07/11/22 14:43--BTidd



			
	2	7/11/2022	ISSUED FOR BIDS
	1	8/9/2021	ISSUED FOR REVIEW
	NO.	DATE	DESCRIPTION
REVISIONS			

DRAWN BY	CHECKED BY
BWT	KAM
DATE	
7/29/21	

E102

—OF—

JOB NUMBER



## **SECTION V**



## OHIO PUBLIC WORKS COMMISSION

### ADVISORY

**DOMESTIC STEEL USE REQUIREMENTS:** Sections 153.011 and 153.99 of the Ohio Revised Code have been amended to provide enforcement of, and civil penalties for the violation of, statutory requirements that domestic steel be used in all public improvements supported in whole or in part by state capital funds.

This includes all projects receiving funding from the State Capital Improvements Program and the Local Transportation Improvements Program.

Additionally, the following notice must be included in boldface type and capital letters in all bid notifications and specifications of Commission funded projects.

**"DOMESTIC STEEL USE REQUIREMENTS AS SPECIFIED IN SECTION 153.011 OF THE REVISED CODE APPLY TO THIS PROJECT. COPIES OF SECTION 153.011 OF THE REVISED CODE CAN BE OBTAINED FROM ANY OF THE OFFICES OF THE DEPARTMENT OF ADMINISTRATIVE SERVICES."**

These requirements are contained in Senate Bill No. 11, and are effective immediately for any project "for which bidding commences on or after the date of this act".

The full text of this bill is available on the Commissions web site at:

[<www.pwc.state.oh.us>](http://www.pwc.state.oh.us)

Questions regarding your responsibilities should be directed to your legal counsel.

Released: March 29, 2001

Status: Ongoing



## GENERAL REQUIREMENTS

### 1.1 GENERAL

All work shall be performed in accordance with the current edition of the State of Ohio, Department of Transportation, Construction and Material Specifications and supplements thereto, except the measurement and payment sections thereof, in effect 14 calendar days prior to the receiving of bids for this project, and the current American Water Works Association Standards and Specifications, the current Ohio Environmental Protection Agency Standards and Specifications and supplemented by the construction standards and specifications contained herein. All work performed within the scope of this project is subject to the approval of the Owner.

### 1.2 MINOR DETAILS

Minor details not specifically mentioned in these specifications or not shown on the plans, but necessary to secure a workmanlike job and proper operation shall be provided by the Contractor without extra cost.

### 1.3 REGULATIONS

During the conduct of the performance on and in connection with this project, the Contractor and Subcontractors shall comply with the Occupational Health and Safety Act, and all other applicable Federal and State laws and Local ordinances. Said compliance shall also include, but not be limited to, observance of all applicable safety and health regulations issued by any Federal, State or Local governing body as such regulations are now in existence and as may be hereinafter amended.

### 1.4 PERMITS

The Village of Liberty Center will obtain the necessary permits for the sewer installed from the OEPA. The Village of Liberty Center has also obtained all of the required right-of-way easements.

The Contractor shall comply with the requirements and provisions of all approvals, licenses, and permits. Fines and related costs resulting from the Contractors failure to comply with the requirements and provisions of all approvals, licenses and permits shall be the obligation of the Contractor.

### 1.5 BEGINNING CONSTRUCTION

The Owner shall be notified forty-eight (48) hours prior to beginning the actual construction. All location and grade stakes shall be set by the Contractor.

### 1.6 PRECONSTRUCTION CONFERENCE

- A. OWNER will schedule a conference after Notice of Award.
- B. Attendance Required: OWNER, ENGINEER, Special Consultants, Utilities, CONTRACTOR, CONTRACTORS Superintendent, and major Subcontractors.



- C. ENGINEER will record minutes and distribute copies within 2 days after meeting to participants and those affected by decisions made.

#### 1.7 CONSTRUCTION PROGRESS SCHEDULE

- A. Submit four copies of preliminary progress schedule at preconstruction conference.
- B. Revise and resubmit as required.
- C. Submit revised schedule with each Application for Payment, identifying changes since previous version.
- D. Submit a computer generated horizontal bar chart with separate lines for each portion of work or operation, identifying first work day of each week.
- E. By the last working day of each week, provide ENGINEER with a written schedule of planned construction activities for the following week.

#### 1.8 PROGRESS MEETING

- A. Contractor to schedule and administer meetings throughout progress of the work at maximum monthly intervals or as otherwise deemed necessary by OWNER or ENGINEER.
- B. Contractor to make arrangements for meetings, prepare agenda with copies for participants, preside at meetings, give 72 hours prior notice.
- C. Attendance Required: Contractors job superintendent and office representative managing job, major Subcontractors and Suppliers, OWNER, ENGINEER, as appropriate to agenda topics for each meeting.
- D. Contractor to record minutes and distribute copies within 2 days after meeting to participants and those affected by decisions made.

#### 1.9 SUBMITTAL PROCEDURES

- A. As a minimum, Submittals are required for items covered by these specifications. Submittals for additional items shall be submitted when deemed necessary by ENGINEER. Submittals for samples or referenced Ohio Department of Transportation (ODOT) materials shall be in accordance with ODOT 700, Minimum Requirements for Sampling Materials.
- B. Submit the number of copies with CONTRACTOR requires, up to a maximum of six, plus two copies which will be retained by ENGINEER (maximum total of eight copies) **electronic submittals are acceptable.**
- C. Apply CONTRACTORs stamp, signed or initialed certifying that review, approval, verification of materials and equipment required, field dimensions, adjacent construction



work, and coordination of information is in accordance with the requirements of the Work and Contract Documents.

- D. **Provide space for ENGINEER review stamps.**
- E. When revised for resubmission, identify all changes made since previous submission.

#### 1.10 ITEMS NOTED AS SPECIAL OR AS DIRECTED

Items noted as special or as directed in the general summary are to be paid for only when ordered by the Engineer during construction. Quantities shown are for bidding purposes only.

#### 1.11 LIMITS AND CONDITIONS FOR PAYMENT

The limits and conditions for payment of each unit price and lump sum item designated hereafter is defined in such specified item description and per the bid schedule.

#### 1.12 APPLICATIONS FOR PAYMENT

- A. Submit five (5) copies of each application on an OWDA Contractors Estimate form (1 page) and the Unit Price (1 page)
- B. Payment Period: Monthly.
- C. Include with each application, as appropriate, an Affidavit of Contractor or an Affidavit for Final Payment certifying under oath:
  - 1. The names and addresses of all Subcontractors furnishing labor, material, or services and of all persons furnishing material included in such estimate.
  - 2. That all bills for materials and labor included in preceding estimates have been paid in full (or if not paid in full, a list of unpaid bills giving amounts paid to each Supplier or Subcontractor, together with the reason for non-payment).
  - 3. That all bills for materials and labor included in such estimate have been or will be paid from the proceeds thereof.
- D. For payment for materials and equipment stored at the Site, furnish supporting documentation.
- E. No payment for materials and equipment stored at an Aoff-site@ location, will be approved.



### 1.13 INTERPRETATION OF ESTIMATED QUANTITIES

The estimate of quantities of work to be done and materials to be furnished under this contract as given in the proposal is to serve as a basis for comparison of proposals and the award of the contract. The Owner does not expressly or by implication agree that the actual quantities involved will correspond therewith; nor shall the bidder plead misunderstanding or deception because of such estimate of quantities, or at the character, location or other conditions pertaining to the work.

Payment will be based on the actual quantities of work performed in accordance with the contract at the contract unit prices specified. No allowance will be made for any change in anticipated profits due to an increase or decrease in the original estimate of quantities. The Owner retains the authority to non-perform any portion of this project or to add material and/or labor to the project at the unit prices submitted in the proposal.

### 1.14 ADDITIONAL WORK

If additional work is required due to unforeseen circumstances or at the direction of the Owner and/or Engineer, the Contractor shall submit, to the Engineer for review, costs for material and labor to perform the work. If the Owner and/or Engineer disagrees with the cost to perform the work, the Owner reserves the right to direct the Contractor to perform the work under force account. The Contractor shall be paid for such force account work as stated in Section 109.05 (C) of the ODOT Construction and Materials Manual (latest edition).

### 1.15 CHANGE PROCEDURES

- A. ENGINEER will advise of minor changes in the work not involving an adjustment to contract price or contract time as authorized by paragraph 9.05 of the General Conditions.
- B. OWNER may issue a request for a change which includes a detailed description of the proposed change with supplementary or revised Drawings and Specifications. CONTRACTOR will prepare and submit within 30 days, a statement describing the effect on the contract price and contract time with full documentation.
- C. CONTRACTOR may propose changes by submitting a request for change to ENGINEER, describing the proposed change and its full effect on the Work. Include a statement describing the reason for the change, and the effect on the Contract Price and Contract Time with full documentation.
- D. Work Change Directive: ENGINEER may issue a Work Change Directive signed by OWNER, instructing CONTRACTOR to proceed with a change in the Work, and designate method of determining any change in Contract Price or Contract Time. Promptly execute the change.
- E. Change Order: ENGINEER will issue change orders for signatures of parties as provided in the conditions of the Contract.



1.16 CONSTRUCTION STAKING

All location and grade stakes shall be set by the **Contractor**.

1.17 CONSTRUCTION LIMITS

The Contractor must at all times conduct his operations within the public right-of-way, easements, or work agreement as shown in the plans.

1.18 REPAIR OF DISTURBED AREAS

All areas disturbed by construction shall be repaired in accordance with the current Edition of the Ohio Department of Transportation Construction and Material Specification - Item 659 - Seeding and Mulching. No extra payment shall be made for this work and the cost of repair shall be included in the contract unit prices as stated in the proposal.

1.19 PAVEMENT REMOVAL

Pavement removal shall be in accordance with Item 202 of the ODOT Construction and Material Specification Handbook (Current Edition). All edges of existing pavement to be removed shall be saw-cut.

1.20 UNDERGROUND UTILITIES

The location of the underground utilities shown on the plans are as obtained from the owners of the utility and are not guaranteed or represented as being accurate by the Owner or the Engineer or to be in the position indicated on the drawings. Likewise, there is no guarantee or representation that all existing lines and facilities are shown on the drawings. **It is the Contractors responsibility to obtain detailed information on the location of existing utility lines from the various utility companies prior to starting construction.**

1.21 UTILITIES NOTIFICATION

At least two (2) working days prior to commencing construction operations in an area which may involve underground utility facilities, the Contractor shall notify the Project Engineer, the registered utility protection service (1-800-362-2764), and the owners of each underground utility facility shown in the plans.

The owner of the underground utility facility shall, within forty-eight (48) hours, excluding Saturdays, Sundays, and legal holidays after notice is received, stake, mark or otherwise designate the location of the underground utility facilities in the construction area in such a manner as to indicate their course together with the approximate depth at which they were installed. The marking or locating shall be coordinated to stay approximately two (2) days ahead of the planned construction. The following is a known list of utility companies involved in the project.



<b><u>GAS</u></b> OHIO GAS COMPANY KRIS HANDSHOE, DISTRIBUTION ENGINEER 715 E. WILSON STREET P.O. BOX 28 BRYAN, OHIO 43506 KRIS_HANDSHOE@OHIOGAS.COM (419) 630-2233 EXT. 233	<b><u>WATER, STORM AND SANITARY</u></b> VILLAGE OF LIBERTY CENTER BRAD GODWIN 110 EAST STREET LIBERTY CENER, OH 43532 (419) 966-2106
<b><u>TELEPHONE</u></b> CENTURY LINK 812 DOLAN STREET DEFIANCE, OH 43512	<b><u>ELECTRIC</u></b> TRICOUNTY RURAL ELECTRIC 8945 COUNTY ROAD L K2 MALINTA, OH 43535 (419) 256-7900
<b><u>ELECTRIC</u></b> TOLEDO EDISON PLANS TO : DAN RAIRIGH MAIL STOP HLOC 2330 6099 ANGOLA ROAD HOLLAND, OH 43528 (419) 249-5900 SITE CONTACT: JOHN WIRICK (419) 249-4170	<b><u>PIPE LINE</u></b> ANR PIPELINE 700 LOUISIANA STREET HOUSTON, TX 7002 1-800-827-5267 1-888-427-2875 (EMERGENCY)

#### 1.22 LIMITATION OF SUBSURFACE INFORMATION

Certain information regarding the reputed presence, size, character and location of existing underground structures, pipes and conduits has been shown on the drawings. There is no certainty of the accuracy of this information and the location of underground structures shown may be inaccurate and other obstructions that those shown may be encountered. The Contractor, having submitted a bid for the work, distinctly agrees that neither the Owner nor the Engineer is responsible for the correctness or sufficiency of the information considered a part of the Contract; that he shall have no claim for delay or extra compensation or damage against the Owner or Engineer on account of incorrectness given, or on account of the insufficiency or absence of the information regarding obstructions either revealed or not revealed on the drawings and that he shall have no claim for relief from any obligation or responsibility under the contract, in case of the location, size or character of any pipe or other underground structure is not as indicated on the drawings or in case any pipe or other underground structure is encountered that is not shown on the drawings.

#### 1.23 TREES, BUSHES AND SHRUBS

Trees and bushes, which are too near the construction to avoid destruction, despite extreme care on the part of the Contractor, shall be removed and disposed of by the Contractor to the satisfaction of the Engineer. The Engineer's permission shall be obtained prior to the removal of any tree or bush. Per ODOT Item 201 and per the bid schedule.

Other trees, tree limbs and bushes that are so located that equipment of the Contractor will damage same during construction, shall be carefully trimmed, and shaped by workmen skilled in tree trimming. All limbs and branches shall be flushed out. All exposed surfaces in excess of one inch diameter shall be immediately painted with an approved pruning compound. Trees and bushes, other than those whose removal as approved by the Engineer, which are destroyed or damaged to the extent that their continued life is impaired, shall be replaced by the Contractor at his expense and to the satisfaction of the Owner. No payment will be made for tree trimming. The cost of said trimming shall be included in the cost of the construction item requiring the trimming.

Prior to Final Acceptance of the work, the Contractor shall employ a competent arborist to inspect all trees and shrubs along the line of the work and to properly trim, prune, repair and protect any that have been damaged and to designate those which have been so damaged as to require replacement.

#### 1.24 MAINTAINING TRAFFIC

This item includes the furnishing, erection and maintenance of all temporary signs, lights, barricades, watchmen, etc. for the protection of vehicular and pedestrian traffic. It also includes basic procedures by which vehicular and pedestrian traffic shall be controlled during the construction project.

The placement, sequence of erection, materials, size, shape, color, etc. for traffic control devices; the use of flagmen, etc., shall conform to the latest revisions of the Ohio Manual of Uniform Traffic Control Devices for Streets and Highways, and ODOT Item 614 Detail and Requirements. All such signage and/or use of other traffic control is subject to the approval of the Owner/Engineer and the Defiance City Engineer.



**Closure of roadways may occur only upon approval of the Owner.** The Contractor shall be responsible for coordinating all detours with the pertinent local County and State officials. The Contractor shall be responsible for the erection maintenance and removal of all detour signs.

In regards to traffic maintenance during the night, weekends, or holidays, both lanes of the highway must be cleared and be of such condition as to maintain two-way traffic without hazard. This will require cleaning the State highway pavement nightly of construction materials (dirt, stone, etc.) by use of a power broom. The pavement cleaning shall meet the satisfaction of the Engineer and the Ohio Department of Transportation. The Contractor shall not pile, store, or locate construction materials on the State highway pavement unless approved by the Engineer. Excavation must be closed or covered nightly as to preclude a potential traffic hazard vehicular or pedestrian).

**All cost of work to maintain traffic shall be considered incidental to the cost of the project and no separate pay item is provided.**

#### 1.25 PAVEMENT MARKING

Any existing pavement markings destroyed or removed during the execution of any work under these contracts shall be replaced in accordance with ODOT 640.

#### 1.26 HAUL ROUTES

Construction related traffic on other streets shall be kept at a minimum. Haul routes on other roads or section of roads which do not have sewers adjacent shall be strictly prohibited.

Damage to roadways caused by construction traffic shall be repaired in accordance with these specifications at the Owner/Engineers direction. These repairs shall be at the Contractors expense and shall include, but not be limited to, full depth repair, partial depth repair and/or resurfacing. The Contractor is expected to take all precautions necessary to prevent damage to roadways by construction traffic.

All other roadways, alleys, drives, etc. which are damaged by the Contractor or his subcontractor and which do not have sewer either within the pavements or adjacent shall have these damages repaired at the Contractors expense and at the direction of the Engineer. This includes, but is not limited to, full depth repair, partial depth repair and/or resurfacing. However, the Contractor is expected to take all precautions and care in preventing damage.

Contractor shall obtain approval from OWNER for the use of local streets and roads as haul routes.

- A. Haul routes will be reviewed by representatives of OWNER and CONTRACTOR prior to construction to determine the condition of the streets and road and after the Project is completed in order to determine the amount of restoration required of CONTRACTOR.
- B. Haul routes will be established on the conditions that all hauling will comply with established legal load limits and that all State and local traffic laws will be obeyed. Maximum legal truck capacity shall be posted on or listed in trucks.

- C. Traffic Control and Detour Plans: Work necessitating major traffic disruptions is scheduled to be performed on light traffic and truck traffic routes resulting in road closures. CONTRACTOR is responsible for preparing a traffic control plan, establishing detour routes during road closures, and implementing required traffic control measures. Review and approval of truck traffic detour plan will be by ODOT District #1 office in Lima, and by OWNER for the light traffic detour plan. Work shall not begin until these plans are approved and required traffic control measures are in place.

#### 1.27 REMOVAL OF EXCAVATED MATERIAL AND STORAGE OF MATERIALS

All excess excavated material which has been stockpiled at the work site, and which will not be used for backfill or other fill purposes, must be removed from the project area within forty-eight (48) hours. In all cases, stockpiles of all excavated material and all construction material shall be of limited size and shall be neatly maintained or removed from the project site so as not to block existing drainage or be hazardous to pedestrian or vehicular traffic in any way, or interfere with the construction operations of other Contractors. The limitation relative to the stockpiling of all excavated material and all construction material shall be controlled by the Owner and the Engineer. In the event the Contractor fails to remove the excess excavated material, as required above, or fails to satisfactorily modify his operations relative to the stockpiling of excavated or construction materials upon order of the Owner or Engineer, all work except clean-up operations will be stopped, and remain stopped, until the directions of the Owner or the Engineer has been complied with.

- A. The removal and disposal of surplus excavated material shall be the responsibility of CONTRACTOR. Provide OWNER with any surplus material OWNER desires. In doing so, CONTRACTOR shall not be required to haul such material for a greater distance than would be required to otherwise dispose of the material.
- B. Disposal of materials shall be performed in an environmentally sound manner, and in accordance with Laws and Regulations.
- C. Do not dispose of excess material in a wetland, floodplain, surface water, or other environmentally sensitive area.
- D. Install and maintain erosion control measures at disposal site(s) until disposal is complete and the site(s) have been stabilized.

#### 1.28 WORK SEQUENCE

- A. CONTRACTOR shall determine the location and depth of existing waterlines, sanitary service laterals and sewer (storm and/or sanitary) main lines as indicated on the plans prior to beginning construction. The findings shall be reported to the ENGINEER and OWNER to determine if adjustments will be needed to the proposed utilities.
- B. Work shall be performed on one pump station at a time.



1.29 SUBSTANTIAL COMPLETION

- A. For the purpose of this contract, substantial completion for all systems shall be defined as the point where the entire system as shown and/or described in the Construction Documents and Drawings are complete, including ALL testing and disinfection, and ready to be placed in service.
- B. Time Restrictions for Performing Work:
  - 1. Weekdays from 7 a.m. to 5 p.m.
    - a. If normal working time for a particular activity is outside the hours of between 7 a.m. and 5 pm. (i.e., during night), secure OWNERS prior approval.

1.30 VIDEO RECORD OF EXISTING CONDITIONS

**The Contractor shall include in his bid the cost of providing a video record of existing conditions in the entire project area to the Owner prior to the beginning of any of the work under this contract.**

For the purpose of these specifications, the following applies:

A. Qualifications

- 1. The Contractor must use the services of a professional video recording company actively engaged in color audio-video tape records for various municipalities. The Contractor must submit at least three (3) letters of reference pertinent to the performance and satisfactory completion of color audio-video projects for various municipalities.
- 2. The Engineer may make such investigation as he deems necessary to determine the ability of the video company to perform the work and the Contractor shall furnish to the Engineer such information and data for this purpose as the Engineer may request. The Engineer reserves the right to reject any video company if the evidence submitted by such Contractor or the investigation of such video company fails to satisfy the Engineer that such video company is properly qualified to carry out the obligations of the contractor and to complete the work contemplated therein.

B. Equipment

- 1. All equipment, accessories, and material to perform this service shall be furnished by the Contractor, except the plans of the proposed area to be televised, which are furnished by the Engineer.
- 2. When conventional wheeled vehicles are used, the distance from the camera lens to the ground shall not be less than twelve feet (12') to insure proper perspective.
  - a. In some instances, audio-video tape coverage will be required in areas not accessible by conventional wheeled vehicles. Such coverage shall be obtained by walking or special conveyance approved by the project Engineer.

C. Electronic Equipment

1. Format to be MPEG 2 DVD, recorded @ XP speed, containing one video and two audio tracks.
2. Video output from camera(s) used must be capable of producing a minimum of 300 lines of horizontal resolution at center, with minimum light lag. The camera(s) must be able to produce optimum color imagery with a minimum of 7 foot candles of illumination. It shall be capable of providing a video signal-to-noise ratio of at least 49 Db. The camera(s) must be able to produce an acceptable quality color picture of images at varying distances and angles acceptable to the Owner/Engineer.

D. Location Information

1. Audio - Each tape shall begin with the current date, project name and municipality and be followed by the general location, i.e. name of street, viewing side and direction of progress.
2. Video - The engineering stationing numbers must be continuous, be accurate, correspond to the project stationing and include the standard engineering symbols (for example 14 + 84). This transparent information must appear in the lower half of the viewing screen.
3. Video - Below the engineering stationing, periodic transparent alpha numeric information will appear. This information will consist of the name of the project, name of the area covered, direction of travel, viewing side, etc.
4. Digital - To preclude the possibility of tampering or editing in any manner, all video recordings must by electronic means, display continuously and simultaneously generated transparent digital information to include the date and time of recording, as well as the corresponding engineering stationing numbers. The date information will contain the month, day, and year (i.e. 10/5/72) and be placed directly below the time information. The time information shall consist of hours, minutes, and seconds separated by colons (i.e. 10:36:18. This transparent information will appear on the extreme upper left hand third of the screen.

E. Multi-Camera Requirements

1. The audio-video tape shall consist of 1 video and 2 audio tracks, all of which must be recorded simultaneously. All tracks shall consist of original live recordings and thus shall not be copies of other audio or video recordings. Audio track 1 shall contain the narrative commentary of the electrographer, recorded simultaneously with his fixed elevation video record of the zone of influence of construction. Audio track 2 shall contain narrative commentary of the ground level remote technician whose function shall be to provide a complete circumspection of any features not adequately visible to the electrographer and to describe in detail the extent of any damage encountered. In order to maintain the viewer orientation, transition from fixed camera overview to remote camera picture shall be means of an electronic dissolve.



F. Lighting Requirements

1. In order to produce detail and perspective, a minimum of twenty-five thousand watts of 3,400 Kelvin temperature lighting will be required to fill in the shadow area caused by trees, utility poles, road signs and other such objects, or other if approved by the Engineer.

G. Tape Coverage

1. Taped coverage shall include all surface features located within the zone of influence of construction supported by appropriate audio description. Both sides of the street or right-of-way shall be recorded in project area. Audio description shall be made simultaneously with video coverage. Such coverage shall include, but not be limited to, all existing driveways, sidewalks, curbs, ditches, roadways, landscaping, trees, culverts, headwalls, and retaining walls or buildings located within such zone of influence.
2. House and buildings shall be identified visually by house number, when visible, in such a manner that structures of the proposed system, i.e., manholes on a sewer system and gate walls and hydrants on a water system, can be located by reference.
3. The rate of speed in the general direction of travel of the conveyance used during taping shall not exceed 48 feet per minute. Panning rates and zoom-in, zoom-out rates shall be controlled sufficiently such that during playback will produce clarity of the object viewed.
4. All taping shall be done during times of good visibility. No taping shall be done during periods of visible precipitation or when more than 10% of the ground area is covered with snow, unless otherwise authorized by the Engineer.
5. The Engineer shall have the authority to designate what areas may be omitted or added for audio-video coverage.

H. Identification

1. All tapes shall be properly identified by tape number, location and project name and municipality in a manner acceptable to the Engineer.
2. A record of the contents of each tape shall be supplied by a run sheet identifying each segment in the tape by location, i.e. roll number, street or road viewing, tape counter number, viewing side, point starting from, traveling direction and ending destination point.
3. The Contractor shall provide one (1) set of original complete tapes and cases of the work to the Owner as part of this item.

I. Contractor's Responsibilities

1. The Contractor shall be able to televise and tape areas with paved roads, along County owned easements through parks, lawns, and open fields. When video taping on private property, the Contractor shall give the Engineer sufficient prior notice of such entry so that property owners may be advised of and their permission obtained for the work.
2. The Engineer and/or Owner shall have the authority to reject all or any portion of the video tape recording not conforming to specifications.
3. Any taped coverage not acceptable to the Engineer shall be refilmed at no additional charge. The Contractor shall reschedule unacceptable coverage within five (5) days after being notified.

1.31 AS-BUILT RECORD DRAWINGS

It shall be the responsibility of the Contractor to keep record of the actual construction as-built details. ALL changes to the original bid drawings shall be kept up to date and made readily available to any site visitor representing the OWNER or ENGINEER. The as-built drawings shall be provided to the ENGINEER at the completion of the project. Final payment will not be approved until such time that the as-built record drawings are delivered and determined to be accurate and acceptable. The cost of keeping and delivering the as-built record drawings shall be considered incidental to the project.

The sanitary sewer service connections shall be kept documented using the Service Connection Location Reference on the detail sheets of the plans. This information shall be included within the as-built record drawings.

1.32 DOMESTIC MATERIAL REQUIREMENTS

"Steel products" means products rolled, formed, shaped, drawn, extruded, forged, cast, fabricated or otherwise similarly processed, or processed by a combination of two or more of such operations, and used for load-bearing structural purposes, from steel made in the United States by the open hearth, basic oxygen, electric furnace, Bessemer or other steel marking process.

This does not include pipe, valves and/or fittings.

**END OF SECTION**



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## 2. SANITARY SEWERS

### 2.1 GENERAL

This section includes the furnishing of all labor, materials, equipment, and services necessary for the completion of the construction of the gravity sewer in accordance with the Contract Documents. All referenced specifications are to be the most current edition.

### 2.2 MATERIALS

Where transition to higher strength pipe is required due to depth limitation, the higher strength pipe shall be used for the entire distance between manholes.

All material specifications noted below are to be the current edition.

#### PIPE AND FITTINGS:

##### A. PVC/PVCO Pressure Pipe: (Force Main)

1. PVC Pipe: AWWA C900-07, DR 18, pressure class 235 for 4 inches through 12 inches diameter.
2. PVCO Pipe: AWWA C909, pressure class 150 for 4 inch through 24 inch diameter.
3. Integral wall-thickened bell end type incorporating elastomeric gasket.
4. Furnished in nominal 20 foot laying lengths.
5. Joints: Push-on
6. Fittings: AWWA C900, one-piece molded, gasketed.

##### B. PVC Pipe and Fittings: (Gravity)

1. ASTM D3034 for 15 inch diameter and smaller.
2. ASTM F679 with wall thickness T-1 only, ASTM F794 open profile (OP), ASTM F0949, or ASTM F1803 closed profile (CP) for 18 inch and larger.
3. Minimum pipe stiffness of 46 psi at 5 percent deflection when tested in accordance with ASTM D2412.
4. ASTM D3212 elastomeric gasket joint (integral bell), push-on type with bell designed to retain the gasket to prevent pull-out during making of the joint.



5. PVC sewer fittings shall conform to the requirements of ASTM D-3034-89 specification. Wall thickness of fittings shall be SDR 35. Gaskets for elastomeric joints shall be molded with a minimum cross sectional area of 0.20 square inches and conform to ASTM F-477 specification.
6. 18 to 30 inch size: ASTM F794, PS-46 (ODOT SS-942), with ASTM D3212 elastomeric gasket joints.  
**Testing:** ASTM D-1784 and meet this specification for leakage and deflection tests.

C. Polypropylene Pipe (Gravity)

1. ASTM F2736 for pipe sizes 12" through 30" with a minimum pipe stiffness of 46 psi when tested in accordance with ASTM D2412.
2. Joints shall be watertight in accordance with the requirements of ASTM D3212 and shall have two gaskets meeting the requirements of ASTM F477. Gaskets shall be installed by the manufacturer and be covered with a removable protective wrap to ensure they are free of debris. A joint lubricant shall be supplied by the manufacturer and used on the gasket and bell during assembly. Pipe shall have a reinforced bell with a polymer composite band installed by the manufacturer.
3. Fittings shall conform to ASTM F2736 and shall meet the watertight joint performance requirements of ASTM D3212. Bell & spigot connections shall utilize a spun-on, welded or integral bell and spigot with gaskets meeting ASTM F477.
4. Appropriate fittings shall be utilized where connecting polypropylene pipe to PVC pipe.

D. FITTINGS

All plugs, fittings, and other appurtenances called for or otherwise specified in the plans or specifications shall be provided in the location as shown or otherwise noted on the plans. The fittings covered by these specifications include tees, bends, wyes, vee, stoppers, etc. necessary for connections or as otherwise required in connection with the work.

Payment for gravity sanitary sewer pipe will be made at the unit price bid. Payment for all installation costs, bedding, rock removal, granular backfill, plugs, blocking, bends, and any other item not included in the bid form shall be included in the price of the pipe.

2.3 TRENCHES

Sewers shall be laid in open trench, except when crossing State highway pavements or in such other instances as noted on the detail plans. **Open trenching shall be started at the lowest**

**point and shall have the spigot ends pointing in the direction of flow.** Whenever the maximum allowable trench width below the level of the top of the pipe is exceeded for any reason, the Engineer reserves the right to direct the Contractor to utilize pipe of greater strength than would normally be utilized, to modify the type of backfill utilized, or to embed the pipe in concrete, or by a combination of these procedures, all at the expense of the Contractor. Maximum trench width is shown in detail on the plans.

Trenches shall be excavated to a depth of four inches below the outside bottom of the pipe barrel and bell when the pipe is laid on its final grade.

Topsoil shall be stripped to a depth of one (1) foot and stockpiled within work areas with existing agricultural uses. Upon completion of the backfilling operation or during the final clean-up operations, the stockpiled topsoil shall be returned to its original location. Cost of returning the topsoil shall be included in the cost of the pipe installed.

Trenches in rock shall be excavated to a depth of six inches below the outside bottom of the pipe barrel (and bell) when the pipe is laid on its final grade, with the exception that an extra one-half inch shall be added for every foot that the depth of cover over the pipe invert exceeds sixteen feet. **Trenches shall be kept sufficiently free from water during pipe laying and jointing to prevent damage to the joints.**

#### 2.4 SHORING AND BRACING

**Where necessary to prevent caving of the trench and other excavations during progress of the work and whenever and wherever it is necessary either to provide safe working conditions or to avoid the danger of damage to existing structures or structures being built, the Contractor shall support the sides of the excavation by adequate and suitable sheeting, shoring and bracing in accordance with OSHA regulations, 29 CFR, Part 1926, Subpart P - Excavations, Trenching, and Shoring. Costs are to be included in the price of pipe.**

This is to include protection where soil conditions necessitate unusually wide trenches causing damage to street pavement, trees, structures, poles and other private and public property.

Sheeting and bracing that is not ordered to be left in place and which does not extend below the centerline of the pipe may be removed at the discretion and responsibility of the Contractor without endangering structures after the trench backfill has been placed and compacted to a level at least two feet above the top of the pipe. Following removal of sheeting and bracing, the space left due to such removal shall be filled immediately and the backfill recompacted.

Where it is necessary to drive sheeting below the centerline of the pipe, it shall be driven on down below the bottom of the pipe. The sheeting below two feet above the top of the pipe shall be left in place. **The Contractor shall remove or leave sheeting in place at his own expense.** Sheeting and bracing shall not be removed until after the trench backfill has been placed and compacted to a level at least two feet above the top of the pipe.



Where sheeting is pulled after backfilling has been completed or partially completed, the sheeting shall be pulled in increments not to exceed three to four feet in order to avoid the danger of breaking the pipe due to the weight of the backfill.

All sheeting and bracing shall be of sound lumber suitable for the purpose intended and shall be so arranged as to support the trench walls and any existing structures and utilities. Sheeting left in place shall be cut off not less than 18 inches below the surface of the ground. **No sheeting, shoring, or bracing will be paid for by the Owner unless it is left in place on written order of the Engineer.**

## 2.5 PROTECTION OF EXISTING UTILITIES

**Existing utilities and obstructions along the route of the sewers shall be located and their elevations determined at least 400 feet in advance of pipe laying by the Contractor.**

All utilities when encountered shall be adequately supported, shored up or otherwise protected whenever exposed in the excavation at the direction of the Engineer.

While the plans indicate the location of existing utilities, in accordance with the best information presently available, neither the Owner nor the Engineer assumes any responsibility for the accuracy of their location or that all utilities are shown.

### A. Gravity Sanitary Sewer

**Sewers shall be laid at least 10 feet horizontally from any existing or proposed water main. The distance shall be measured edge to edge.**

**Sewers crossing water mains shall be laid to provide a minimum vertical distance of 18 inches between the outside of the water main and the outside of the sewer.** This shall be the case where the water main is either above or below the sewer. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints. Where a water main crosses under a sewer, adequate structural support shall be provided for the sewer to prevent damage to the water main.

When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer shall be designed and constructed equal to water pipe, and shall be pressure tested to assure watertightness prior to backfilling.

### B. Uncover and determine the elevation, size and materials of existing underground utilities along the route of construction, as shown on drawings or marked at the time of construction by the Utility Owner, at least 400 feet in advance of pipe installation.

Adequately support, shore up, or otherwise protect underground utilities whenever exposed in the trench. Extend supports a minimum of 12 inches into undisturbed earth each side of trench. Band or tie utility to bridging for its full length. Where

bridging cannot be supported by a firm foundation, provide vertical support, including any lateral bracing necessary to provide firm support.

## 2.6 PIPE BEDDING

Pipe bedding shall conform to the trench detail(s) on the plans, which shall be ODOT 57/67 - 703.11 Type 3 structural backfill for pipe bedding.

If the material found at an elevation four inches below the elevation of the outside bottom of the pipe barrel is not suitable to provide adequate foundation for the pipe, a further depth shall be excavated and filled with granular bedding material as directed by the Engineer.

**Unauthorized excavated material below an elevation four inches below the outside bottom of the pipe barrel shall be filled with the specified bedding material, at the expense of the Contractor.**

The bedding material shall be shaped to conform to the bottom quadrant of the pipe barrel, and after the pipe is laid, the bedding material shall be shovel-placed and shovel-tamped to fill completely at spaces under and adjacent to the pipe, up to and six inches over the top of the pipe barrel. The Engineer reserves the privilege of regulating the exact grading of the bedding material, depending upon the water characteristics of the trench.

## 2.7 PIPE LAYING

The laying of pipe in finished trenches shall commence from the lowest point, with the spigot ends pointing in the direction of flow. **All pipe shall be laid with ends abutting and true to line and grade. They shall be carefully centered so that when laid they will form a sewer with a uniform invert.** The pipes shall be laid with their full lengths true to line and grade with the aid of batterboards, grade pole, and grade string and shall rest on the bedding material provided. Pipe and special fittings shall be protected during handling against impact shocks and free fall. Pipe shall be kept clean at all times and no pipe shall be used in the work that does not conform to the appropriate ASTM Specifications.

The use of a laser beam is recommended for all pipe installations to set and maintain the proper line and gradient required. Standard installation procedures shall be followed when using a laser beam subject to the approval of the Engineer.

The Contractor shall constantly check line and grade of the batterboards or laser beam and the pipe; and, in the event they do not meet specified limits described hereinafter, the work shall be immediately stopped, the Engineer notified, and the cause remedied before proceeding with the work.

**Curvature in the horizontal and/or vertical alignment of the sewer between manholes is not permitted.**

Variance from established line and grade shall not be greater than one thirty-second (1/32) of an inch per inch of pipe diameter and not to exceed one-half (½) inch, provided that any such

variation does not result in a level or reverse sloping invert; provided also, that variation in the invert elevation between adjoining ends of pipe, due to non-concentricity of joining surface and of pipe, interior surfaces, does not exceed one sixty-fourth (1/64) of an inch per inch of pipe diameter, or one-half (½) inch maximum.

Immediately notify OWNER or ENGINEER of any misalignment of the pipe when laid in accordance with established cuts or elevations.

## 2.8 DRAINAGE IN TRENCHES

Trenches shall be kept sufficiently free from water during pipe laying and jointing to prevent damage to joints. Should water be encountered, the Contractor shall furnish and operate suitable pumping equipment of capacity adequate to dewater the trench, dispose of such water, and to maintain drainage conditions, as approved by the Engineer. During laying and joint making operations, the water level in the working area shall be maintained at an elevation at least two inches below the bottom of the bell of the pipe until such time, in the opinion of the Engineer, water damage to the completed joints will not occur.

## 2.9 BACKFILLING (Refer to Details on Plans)

Backfill shall include the material placed above a plane six (6) inches above the top of the pipe. Backfill shall be free from large rocks, rubbish, large lumps or other harmful debris. The backfill shall be tamped in six (6) inch layers.

Trenches under or within five (5) feet of the edge of paved streets, pavement berms, alleys, sidewalks, driveways and parking areas shall be backfilled to subgrade with granular material meeting ODOT Item 703.11 Type 2 structural backfill. When the pipe is underneath or below the pavement or any other item listed above, the trench shall be backfilled completely with granular materials specified. **The granular material shall be compacted in layers by mechanical tamping.** Compaction to 95% of maximum dry weight Proctor values shall be required. In grass areas the top six inches shall be backfilled with finely divided, moist earth, mechanically tamped.

Payment for furnishing and placing the full depth granular backfill as specified above shall be included in the cost of the pipe installed under the bid item ***"Sewer Under Pavement" when the trench is more than 5' from the edge of pavement, even when the trench detail requires partial depth granular backfill or*** when material excavated from the trench is approved by the Engineer as a substitute for the granular material specified in areas which could be considered "Under Pavement", payment for the sewer installation shall be considered and paid for as a sewer not located under pavement.

Where trenches are completely or partially backfilled with granular material, the excess excavated material must be removed. The cost of removal shall be included in the price bid for the pipe installed.

Trenches outside the areas noted above and under unpaved (stone or dirt) streets, berms, alleys, sidewalks, driveways and parking areas shall be backfilled as follows:



Above the bedding material previously specified shall be placed 18 inches of finely divided soil, free of excessively large stones, boulders or other harmful debris, mechanically tamped in layers not exceeding six inches, loose measurement. Care shall be taken so as not to damage the joints or to displace the pipe, and no heavy or large quantities of backfill material shall be permitted to drop on the pipe until backfilling has progressed to a depth of at least three feet over the top of the pipe.

For the remainder of the trench, as much of the excavated material as possible shall be replaced by thoroughly compacting in layers of 12 inches, as the filling progresses. The balance of the excavated material shall be neatly ridged over the trench, and in general, any surplus material which, after riding, extends more than eight (8) inches above surrounding ground surface must be removed.

Special care shall be taken in backfilling any trenches under sidewalks to solidify the granular material for the full depth of the trench.

All trenches with or without special granular backfill shall be compacted to 95% of maximum dry weight.

#### 2.10 TRENCH BACKFILL TESTING

**The Contractor shall provide the services of an independent soil testing firm approved by Owner to conduct the necessary tests to insure that the compaction requirements of these specifications are met.** A test section shall be developed by the Contractor to determine the general compaction effort required to achieve the specified compaction requirements based on the material and compaction equipment to be utilized. Compaction tests shall then be conducted at the rate of one series of tests for each 400 linear feet of pipe, and at such other location as directed by the Engineer. Any change in material or compaction equipment shall require the development of a new test section. The allowance indicated on the bid form for trench backfill testing is for bidding purposes only. **Actual payment for this item will be based on the soil testing firm's invoices to the Contractor plus a five (5) percent administration fee.** Any additional costs associated with the testing requirement shall be included in the price bid for the various items requiring compaction control of the backfill material. **All costs associated with soil tests required in association with the correction of unacceptable work shall be at the Contractor's expense.**

#### 2.11 PROGRESS

The Contractor shall be required to complete backfilling operations and general cleanup within a reasonable distance of trenching and pipe laying operations and all other excavations. All trenches and excavations must be backfilled to existing ground level at the end of the normal working day in order that two-way traffic can be safely maintained during the night along State highways and other arterial streets, except where permitted elsewhere in these specifications. Power brooms shall be used nightly for cleanup of pavements. **The specific cleanup requirements shall be at the discretion of the Engineer, but the general intent is to require the Contractor to minimize the inconvenience to nearby residences and/or businesses.**

## 2.12 MAINTENANCE OF TRENCHES AND EXCAVATIONS

At all times during the progress of the work and until release of the Contractor from his guarantee by the Owner, the Contractor shall maintain the backfilled trenches and other excavations. **In particular, those trenches or excavations which are within 15 feet of the edge of pavements or the edge of traveled roadways shall be kept filled up to the same level as the adjacent, undisturbed ground. Any settlement which occurs during this period shall be immediately filled in to prevent the possibility of accidents.**

## 2.13 MAINTENANCE OF FLOW

During construction where existing sewers are encountered or replaced and are interfered with, flow shall be maintained in the existing sewers. Sewage or other liquid must be handled by the Contractor either by connection into the new sewers or by temporarily pumping to a satisfactory outlet, all with the approval of the Engineer. Sewage or other liquid shall not be pumped, bailed or flumed over the street or ground surfaces. **Sewage or other liquids may not be pumped or deposited into any waters of the United States in accordance with the Clean Water Act.**

## 2.14 REPLACEMENTS

Where any pavements, driveways, parking areas, curbs, gutters, berm stone, sidewalks, waterlines, gas lines, sewers, catch basins, drains, field tile, conduit pipes, driveway culvert, cables, or other existing facilities are damaged, destroyed or disturbed in carrying out this Contract, beyond that which is indicated on the plans or normal work limits, they shall be replaced in as good a condition as found, at the expense of the Contractor, and to the approval of the Owner. Any such material broken or disturbed to such an extent as to require replacement shall be replaced with new material at the expense of the Contractor. This includes streets and other roadways or parking areas.

Those replacements needed to conduct this work within the payment limits and/or approved by the Engineer shall be replaced with new material equal to existing conditions and paid for as specified in the Bid Documents and/or in subsequent sections of these specifications.

- A. Replace existing pavements, driveways, parking areas, curbs, gutters, berm stone, sidewalks, water lines, gas lines, sewers, catch basins, headwalls, drains, field tile, conduit pipes, cables, fences, grassed areas, and other existing facilities removed or otherwise disturbed in carrying out the work in as good a condition as found and to the approval of OWNER.
  - 1. Replace property markers and roadway monuments using a licensed surveyor.
- B. Existing mail boxes and traffic signs in the line of construction shall be removed and erected in temporary locations in a manner satisfactory to OWNER, and after completion of construction, moved to and re-erected in their original locations.

- C. Existing fences, decorative walls, advertising signs, and other such existing features in the line of construction shall be removed, stored, protected, and re-erected in their original locations, unless otherwise directed by OWNER.
- D. All materials broken or disturbed to such an extent as to require replacement shall be replaced with new material at the expense of CONTRACTOR.
- E. Exception to the above shall be made in the case of work and materials for which payment will be made under Sections subsequently specified and at the appropriate unit prices included in the Contract.
- F. Work and materials shall be in accordance with applicable requirements of these Contract Documents and, where not included herein, the requirements of applicable ODOT Items as approved by ENGINEER.
- G. In any event, CONTRACTOR shall be liable for any damage to public or private property caused by movement of equipment or by other operations shall repair or replace, to the condition existent prior to the Work, any public or private property damaged by his operations.

#### 2.15 SERVICE CONNECTIONS AND RISERS

Service connections for existing and future houses and businesses and existing and proposed sewers shall be provided as directed by the OWNER and paid per the Bid Documents.

Where service connections are to be installed to the property line, the pipe shall be laid on an open trench with a grade as ordered by the Engineer. The work performed for the installation of the service connections shall comply with the specifications for the main sewers. The building laterals shall include the cost of all bends and stoppers.

- A. Provide for existing and future houses and businesses; 6 inches in diameter unless otherwise shown.
- B. Locations and depths, where shown, are approximate only. Final locations and depths will be established by OWNER and CONTRACTOR at time of construction. It will be the responsibility of the CONTRACTOR to verify the elevation of the existing service lateral at the right of way line prior to installation of the new main connection to ensure the new lateral will be at an adequate depth to allow the existing service on the private property side to be connected.
- C. Connect to the main sewer by providing an appropriate wye.
- D. Where to be installed to the property line, install the pipe true to line and on at least 1 percent grade with a minimum depth of 8 feet at the property line or the maximum depth possible for main sewers less than 8 feet deep, plus deep enough to serve all basements where the main sewer allows.



- E. Install in open cut, except where otherwise required or permitted by ENGINEER.
- F. Close service connections not immediately connected to an existing service connection lateral with a suitable cap. Caps shall be specifically designed for use with the pipe, shall be for permanent or temporary use, shall be water-tight, and shall be removable without damaging the pipe.

In general, vertical risers will be required where depth to the sewer invert exceeds 12 feet, unless otherwise shown on the plans, or directed by the Engineer. The riser shall be fixed in place above the tee branch by thoroughly tamping the surrounding sand and earth backfill for its full height, as shown on the plans.

## 2.16 TESTING

**All sewers must be tested by the Contractor under the supervision of the Engineer prior to acceptance by the Owner.**

Test for the Owner's acceptance must be conducted at least 30 days after the full backfill is placed, although the Contractor is free to conduct his own unofficial test prior to that time. **The cost of testing is paid for in the price bid for pipe.**

If the tests are not passed, the Contractor shall be required to locate and remedy the defects in construction causing the infiltration and/or deflection, and the test shall be performed again on all sections failing the initial infiltration and/or deflection test. **Neither sections of the system nor the entire system will be accepted until a satisfactory infiltration and/or deflection test result is obtained.**

**It is understood that each manhole to manhole section must be tested and determined by the Engineer to conform to requirements of the specifications before the section is included in the month estimate at full contract price.** It is further understood that if the tests do not fall within the limits specified, the Contractor will be required to do such work as may be necessary to insure conformance even to the extent of reconstruction of the defective section or sections.

Any and all visible leakage in sewers or manholes shall be repaired, even if tests on the leaking sections or structures may have been satisfactory.

### 2.16.1 GRAVITY SEWERS

**All gravity sewers will be tested by the low pressure air infiltration leakage methods in accordance with ASTM F-1417.**

In all subsequent references to test pressure, a pressure adjustment shall be made where ground water is above the sewer line being tested, by adding 0.433 psi pressure for each foot the ground water level is above the invert of the pipe, based upon the maximum for the test section. The Contractor shall make provisions for determining the ground water level and the level shall be confirmed by the Engineer.

Test procedures shall be as follows: The section of pipe to be tested shall be plugged at each end. The ends of all branches, wyes and laterals shall be sealed or plugged. All plugs shall be braced to prevent slippage or blowout. One of the plugs provided shall have an inlet tap or other provision for connection to an air hose.

Connect one end of the air hose to the inlet tap on the plug and the other end to portable air control equipment, which shall consist of pressure gages and valves to control the rate at which air flows into the test section and to monitor the air pressure within the test section. Pressure gages shall have minimum graduations of 0.1 psi and an accuracy of  $\pm 0.04$  psi. The air control equipment shall be connected to a source of air supply such as an air compressor.

Air shall be applied slowly to the test section until the pressure reaches 4 psig (pounds per square inch, gage), plus any adjustment for ground water. The pressure inside the pipe shall not exceed 5 psig, plus any adjustment for ground water. When the pressure inside the test section reaches 4.0 psig, the air pressure shall be throttled so that the internal pressure is maintained between 4.0 and 3.5 psig for at least two minutes to permit temperature stabilization.

Upon expiration of the two minute period, the air supply shall be shut off or disconnected and the pressure allowed to drop to exactly 3.5 psig. At the exact time 3.5 psig is reached, a stop watch shall be started and the time required for the pressure to drop to exactly 2.5 psig shall be determined.

Make proper pressure adjustments for ground water, where applicable, in determining the beginning and end of the period for the 1.0 psig pressure drop. The permissible time allocation for the 1.0 psig pressure drop shall be calculated on the basis of the diameter and length of main sewer tested and no adjustment shall be made for service connections included in the test.

The air test for the test section shall be considered acceptable if the time elapsed for the 1.0 psig pressure drop, as previously specified, is equal to or greater than the time, in minutes, indicated on the following table:

**SPECIFICATION TIME REQUIRED FOR A 1.0 PSIG PRESSURE DROP  
FOR SIZE AND LENGTH OF PIPE INDICATED**

**Specified Minimum for Length (L) Shown (in minutes)**

<b>Pipe Diameter</b>	<b>100'</b>	<b>150'</b>	<b>200'</b>	<b>250'</b>	<b>300'</b>	<b>350'</b>	<b>400'</b>	<b>450'</b>
4	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33
27	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48
30	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15
33	43:05	64:38	86:10	107:43	129:16	150:43	172:21	193:53
36	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46
42	59:48	104:42	139:37	174:30	209:24	244:19	279:13	314:07
48	91:10	136:45	182:21	227:55	273:31	319:06	364:42	410:17

**Time for intermediate lengths shall be interpolated.**

**The air test shall be unacceptable if the elapsed time is less than the stated period.** All defects shall be corrected and the line retested. Unless the air test fails due to a leaking plug, a TV inspection of the test section shall be conducted to determine the cause of the failure, this shall be at the expense of the Contractor.

**If an infiltration leakage test is used rather than an air test, the maximum rate of infiltration is 100 gallons per inch diameter per mile of pipe, per twenty-four (24) hours (ASTM C969).** This test is to be conducted when the height of ground water is four (4) feet or more above the elevation of the crown of the pipe at the upstream end of the section of pipe to be tested. If the ground water does not provide sufficient head, the Contractor shall flood the trench to obtain the specified external head. The measuring device shall be V-notch weir or other measuring device approved by the Engineer.



**All tests for acceptance shall be conducted with the Engineer present.** Safety precautions shall be carefully observed by the Contractor during air testing, recognizing the danger from plugs blowing out and from loading the sewer line with the full pressure of the compressor. **No one shall be allowed in manholes during testing.**

**All sewers must be tested for infiltration.** When this cannot be achieved in sections of sewers that are being replaced in the same trench as the existing sewers, and upon approval of the Engineer, the lines must be televised internally to verify leakage points. Water head of at least 4' must be applied over the sewer during this procedure. Televising shall be limited to periods between midnight and 6:00 a.m. Leaking joints must be repaired as previously explained. This process (televising) **may not** be substituted in areas where air or leakage tests are feasible.

2.16.2 Sanitary sewers located in an area within a radius of 50 feet from any private well serving less than 25 people or less than 15 services.

1. All sewer pipe (except service laterals) in this type well field area shall be pressure tested between manholes at 10 psi for five minutes after all air has been expelled from the test section and after absorption and pressure stabilization has been achieved. Service laterals shall be tested to comply with plumbing code requirements.
2. Manholes will be permitted in this type well field area provided they are tested by filling with water to the top of risers and exfiltration shall not exceed 0.1 gallon/hour/ft. diameter/ft. head.

2.16.3 DEFLECTION TEST

Deflection testing shall be performed in accordance with ASTM D-2122.

If PVC or ABS pipe is used, deflection tests will be run not less than 30 days after final full backfill has been placed. The test is required on all PVC and ABS pipe deeper than 12 feet at points between two manholes and at depths shallower than 12 feet if the pipe has a stiffness of less than 200 psi.

Where possible, electronic equipment shall be used to measure and record the deflection in flexible pipe. **No pipe shall exceed a deflection of five percent.**

If such equipment is not available, the deflection test can be run by use of mandrels, having a diameter equal to 95% of the inside diameter of the pipe, pulled through the sewer line without mechanical pulling devices. Mandrels shall be constructed with at least nine (9) evenly spaced arms or prongs. A metal proving ring shall be provided to verify the accuracy of the mandrel to the Engineer. The length of the mandrel shall be 8" for 8" pipe, and 10" for 10" and 12" pipe.

**If any section of conduit exceeds a deflection of five percent, it shall be the Contractor's responsibility to make the necessary corrections to the satisfaction of the Engineer.** The costs of all materials, equipment, labor and all incidentals necessary for making the deflection test and for making any necessary corrections or replacement shall be included in

the price of the pipe. The deflection test is required to conditional and final acceptance. **At the discretion of the Engineer, it may be required that the PVC and ABS sewers be tested for deflection before expiration of the one year maintenance bond. Conduit, which has deflected more than five percent, must be corrected to the satisfaction of the Engineer by the Contractor.**

#### 2.16.4 FORCE MAINS

A leakage test shall be applied to all force mains. The force main shall remain isolated from adjacent force mains and a pressure of at least 100 pounds per square inch shall be applied by pumping clean water from a clean container through 1-inch corporation stops installed in the ends of the force main, with the Contractor to provide an initial pressure of 110-120 psi.

The pressure test shall be maintained for 2 hours by pumping water from the container. A minimum test pressure of 150 psi shall be assured by pumping until a pressure of 150-160 psi is attained. At the end of the 2 hour period, the water shall be measured and the loss by leakage shall not exceed that as determined by the formula:

$$L = \frac{S \times D \times (P)^{1/2}}{133,200}$$

in which the L is the allowable leakage, in gallons per hour; S is the length in feet of main line being 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 gage.

If the force main does not pass the leakage test, the leaks shall be located and repaired and the testing procedure repeated.

The cost of furnishing all material, labor, equipment, and the total volume of water for testing is to be included in the price of the force main.

#### 2.17 UNIT PRICE - MEASUREMENT AND PAYMENT

Payment for items included in this section shall be per the bid schedule. Measurements shall be based on actual field conditions. Measurement shall be made center to center of manholes and no deduction will be made for fittings.

- A. Pipe Sewers: By the price per linear foot for sanitary and storm sewers of the sizes included in the Bid items, and installed in open cut. Lengths shall include the lengths of fittings which are laid in the main line and shall be the distance measured from center to center of structures, except at existing structures where measurement shall be from the wall of the structure. Includes the pipe sewers, installed complete, except for portions of the Work for which separate payment is made under this or other Sections, and, the removal or abandonment of existing sewers shown on Drawings or indicated in Specifications. Upon installation of pipe in open cut and completion of bedding and backfilling operations, an amount equal to at least 10 percent of bid price per linear foot will be withheld for completion of testing, seeding and replacement of existing facilities,

where payment therefor is not made under other Sections. When items for which monies are withheld are completed, or partially completed, the amount withheld shall be appropriately reduced. Amounts withheld pursuant to this paragraph shall be in addition to retainage made pursuant to applicable requirements of the Contract Documents.

- B. Service Connection: By the price per linear foot. Lengths shall include lengths of fittings laid in the service connection from the connection to the main sewer to the end of the service connection; includes both risers and that portion laid to grade in open cut.
  - 1. Service connection cleanouts, which shall include the providing of the cleanout pipe, fittings, and appurtenances from and including the wye up to the treaded cap at grade, shall be included in this unit price.
  - 2. Service connection pipe and fittings associated with connections on existing sewers shall be included in this unit price.
- C. Connection on Existing Sewers: By the price each for the furnishing and installation of the compression fit service connection.
- D. Service Connection Wyes: By the price for each for the sizes included in the Bid items. Includes the furnishing and installation of a wye in the main line for a service connection.
- E. Cleanout Frame and Cover In Pavement: By the price each for frame and cover installed in pavement.

#### 2.18 PRICE BID

Payment for items included in this specification shall include all minor and miscellaneous details and costs to complete the work, all material, labor and placement, and shall be paid as follows per the bid schedule.

**END OF SECTION**

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### 3. REPLACEMENT OF EXISTING FACILITIES

3.1 SCOPE - This item includes the replacement of any existing facilities which cross or parallel the line of the proposed sewers and which must be removed and replaced during trenching and laying of the new sewers. Such replacement must be approved by the Owner and Engineer, and will be paid for as described later in this specification. **Any replacements situated outside the pay limits of each replacement item defined herein shall be replaced at the total expense of the Contractor.** Any removal costs shall be included in the cost of pipe installed, unless bid as an item separately.

3.2 EXISTING SEWERS - All existing sewers, and subsurface drainage or field tile damaged or interfered with during construction shall be replaced with new pipe matching the existing sewer or of a material approved by the Engineer. The replaced pipe shall be installed with proper bedding and backfill and shall be installed to match the grade and size of the existing sewer. **The Contractor shall report to the Engineer all existing sewer lines of any type which are exposed during trenching for the new sewer.**

All replaced sewers must be replaced securely so as to withstand any future settlement either by thorough tamping of their foundation in the trench or bridging by means of timber supports or reinforced concrete, all at the direction of the Engineer. Where timber bridging cannot be supported by a firm foundation, the Contractor shall provide vertical support for the timber bridging including any lateral bracing necessary to provide a firm and substantial support for the existing sewer, all at the direction of the Engineer. **All existing utilities (gasoline, telephone, gas, water, sewers of all types, field tile, driveway & culverts, etc.) that are shown on the drawings and that are disturbed by the Contractor, for whatever reason, shall be repaired or replaced at the expense of the Contractor.** The repair or replacement of utilities which are not shown on the drawings but disturbed by the Contractor shall be paid for at the unit price bid for "Twelve (12) inches and Under Conduit" and "Over Twelve (12) inches Conduit". The price bid shall include all work incidental thereto and all required fittings.

When the bedding of an existing utility is disturbed by the construction of the proposed sewer, the Contractor shall provide adequate vertical support to prevent any future settlement. In areas of adequate room, support shall be provided by placing bedding of a material and by a method as previously described. In areas of insufficient room, the Contractor shall use concrete to provide support. All work shall be approved by the Engineer. The replacement shall be completed at the expense of the Contractor.

3.3 CATCH BASINS, INLETS AND STORM MANHOLES - Catch basins, inlets and storm manholes which are too near the construction to avoid destruction, despite extreme care on the part of the Contractor, shall be removed and replaced by the Contractor, to the satisfaction of the Engineer. Construction shall be in accordance with standard ODOT design types where feasible and/or equal to the existing structure. The type of replacement shall first be approved by the Engineer. No catch basin or manhole shall be removed until the Contractor obtains approval of said removal from the Engineer. Payment of the repair and replacement of catch basins and manholes that are shown on the drawings shall be included in the cost of the item of construction requiring the removal and replacement. The repair or replacement of catch basins and manholes not shown on the drawings shall be paid for at the per each price bid for "Catch Basin Replacement" and for "Manhole Replacement". Replacement shall include all new pipe and fittings needed to reconstruct and reconnect the structures to the existing system.

#### MATERIALS:

- A. ODOT Standard 2-2-B catch basin modified to accept specified frame and grate. Comply with ODOT Item 604, except as modified herein.

#### FRAME AND GRATE:

- A. Curb Inlet: East Jordan No. 7020 with Type M-1 Grate and T-1 Back; or as approved.
- B. Inlet in Pavement: East Jordan No. 5250 standard frame and grate; or as approved

### 3.4 ROADSIDE DITCHES AND DRIVE PIPES

All existing drive pipes damaged and/or interfered with during construction shall be replaced with new pipe matching the existing pipe or be of a material approved by the Owner and Engineer. The replaced pipe shall be installed with proper bedding and backfill and shall be installed to match the grade and size of the existing drive pipe. It shall be the responsibility of the Contractor to verify the elevations of the existing drive pipe. Drainage through the drive pipe shall be restored at the conclusion of all construction activities and shall be to the satisfaction of the Owner and Engineer. The Contractor shall report to the Owner and Engineer all existing drive pipes which are interfered with during construction of the new utilities.

3.5 TREES, BUSHES AND SHRUBS - Trees and bushes, which are too near the construction to avoid destruction, despite extreme care on the part of the Contractor, shall be removed and disposed of by the Contractor to the satisfaction of the Engineer. The Owner and Engineer's permission shall be obtained prior to the removal of any tree or bush. Payment for tree removal shall be included in the cost of the item of construction requiring the removal.

Other trees, tree limbs and bushes that are so located that equipment of the Contractor will damage same during construction, shall be carefully trimmed and shaped by workmen skilled in tree trimming. All limbs and branches shall be flushed out. All exposed surfaces in excess of one (1) inch diameter shall be immediately painted with an approved pruning compound. Trees and bushes, other than those whose removal as approved by the Engineer, which are destroyed or damaged to the extent that their continued life is impaired, shall be replaced by the Contractor at his expense and to the satisfaction of the Owner. No payment will be made for tree trimming. The cost of said trimming shall be included in the cost of the construction requiring the trimming.

Prior to Final Acceptance of the work, the Contractor shall employ a competent arborist to inspect all trees and shrubs along the line of the work and to properly trim, prune, repair and protect any that have been damaged and to designate those which have been so damaged as to require replacement.

3.6 SURVEY MONUMENTATION - Any survey monumentation (i.e., iron pins, railroad, spikes, T-posts, monument boxes, etc.,) which are disturbed during construction, shall be restored by the contractor.

3.7 GUARDRAIL FENCES - Any guardrail or fence that must be interfered with during the project will be removed without damage and stored for re-use.

Reconstruction of guardrail or fences will be equal to existing conditions prior to removal. Any guardrail or fence destroyed or damaged to the extent that their continued use is impaired, shall be replaced by the Contractor at his expense and to the satisfaction of the Engineer. All costs associated with removing, repairing and replacing existing guardrails and fences, including furnishing any new materials required, shall be included in the cost of the item of construction requiring the removal.

### 3.8 PAVEMENTS, SIDEWALKS AND DRIVEWAYS

3.8.1. SCOPE - This item shall include the replacement, except as noted, of brick, concrete, asphalt concrete, stone or surface treated macadam pavement, driveways, berm areas, parking areas and installation of the sewer.

Payments for pavement, berms, driveway, parking areas and sidewalks replacement shall be limited to lines of measurement subsequently described and replacement of pavements removed or damaged by the Contractor beyond the lines of measurement shall be made in a manner identical to that within the lines of measurement, but at the expense of the Contractor. The State of Ohio, Department of Transportation Construction and Material Specifications shall be followed insofar as applicable. Driveways and parking areas shall be classified as pavements, according to the types of materials of construction.

3.8.2. CONCRETE PAVEMENT REPLACEMENT - Concrete pavement shall be broken up with neat straight edges by sawing, using care to preserve the reinforcement wherever possible, so that it can be bent back into place. The concrete shall be removed twelve (12) inches beyond each side of the trench excavation with sawed edge tapering toward the center of the trench.

All surplus material must be removed and disposed of at the Contractor's expense. After the sewers have been installed and the backfilling complete as previously specified, the concrete pavement shall be replaced with Class C concrete. All concrete materials shall be approved by the Engineer. An approved ready-mix concrete may be used. Concrete finish shall match that of the surrounding pavement. Reinforcement shall be substantially the same as in the existing pavement, but not less than mesh weighing fifty-four (54) pounds per one hundred square feet. Concrete shall be cured with water for at least 72 hours or cured with an approved waterproof membrane. Brick pavements removed shall be replaced with eight (8) inches of Class C concrete. Concrete pavements/bases replaced shall be replaced to a thickness equal to that removed, but no less than eight (8) inches thick.

Bases on non-State highways of brick or concrete, having an asphalt wearing surface, shall be replaced with one and one-half (1½) inch of ODOT 448 Type 1 Surface Course PG 64-22 and one and one-half (1½) inch of ODOT 448 Type 1 Intermediate Course PG 64-22 over an eight (8) inch ODOT 452 PPC Concrete Pavement base. A tack coat of bituminous material meeting the requirements of Item 407 of the State of Ohio Department of Transportation Construction and Material Specifications shall be applied at the rate of 0.20 gallons per square yard prior to the laying of the three (3) inches of asphalt concrete. State highway pavements with brick or concrete bases shall be replaced with ten (10) inches of 305 Class C concrete subbase. The wearing surface and tack coat shall be the same as previously cited.

Concrete driveway replacement shall consist of six (6) inches of Plain Portland Cement Concrete for residences and eight (8) inches of Plain Portland Cement Concrete for commercial and industrial facilities and mesh will not be required unless the existing driveway has it. The cost of driveway replacement must include within the price bid the removal and replacement of existing driveway

culverts equal to existing conditions. All other requirements of this section apply to driveway replacement. If remaining portion of concrete measures less than 5' to nearest joint remove and replace to nearest joint.

**3.8.3. ASPHALT OR MACADAM PAVEMENT REPLACEMENT** - Asphalt or Macadam drive and pavement shall be as follows:

For asphalt or macadam non-State highway, Type 1 Pavement, replacement there shall be laid eight (8) inches of 304 aggregate base. To the aggregated base shall be applied 408 Prime Coat at a rate of 0.40 gallons per square yard. The prime coat shall be followed by two (2) inches of 448 Intermediate Course Asphalt Concrete, and two (2) inches of 448 Surface Course Asphalt Concrete. For asphalt State highway, Type 2 Pavement, replacement, there shall be laid twelve (12) inches of 304 aggregate base with proper compaction. To the aggregate shall be applied 408 Prime Coat at a rate of 0.40 gallons per square yard. The prime coat shall be followed by two and one-half (2½) inches of 448 Intermediate Course Asphalt Concrete, and two and one-half (2½) inches of 448 Surface Course Asphalt Concrete. All pavement removal shall be saw cut. Asphalt driveway or sidewalk replacement shall have same amount of aggregate base and prime coat as specified previously for asphalt non-State highway pavement replacement.

Included within this pavement replacement item shall be asphalt related paved berm replacement. Paved berms shall be replaced with eight (8) inches of 304 Aggregate Base followed by a 408 Prime Coat at a rate of 0.40 gallons per square yard. The prime coat shall be followed by two (2) inches of 402 Asphalt Concrete and two (2) inches of 404 Asphalt Concrete.

**3.8.4 FULL WIDTH PAVEMENT MILLING AND REPLACEMENT** - Milling of 1 ½ inches existing asphalt pavement and replacement with 1 ½ inches asphalt concrete surface course may be required on streets in which new sanitary sewers are being installed by open cut. Prior to pavement replacement at trench excavation, place required base course followed by required leveling course to the same grade as the existing pavement after completion of milling.

**3.8.5. TRENCH PAVEMENT REPLACEMENT** - Full depth pavement replacement at trenches shall apply to all trench excavations, except, those where pavement milling is required. The surface course at those trenches is not needed as that surface course is included with full width pavement milling and replacement. A deduct of 1 ½" surface course trench repair to be provided in the supplement price.

**3.8.6. STONE REPLACEMENT** - All stone driveway, unimproved street, berm and parking area replacements shall be in kind, but not less in quality than ODOT Item 304 base. Stone Berm areas along roadways shall be replaced to existing conditions with eight (8) inches of properly compacted 304 Aggregate Base.

**3.8.7. MINIMUMS** - All depths of replacement materials (asphalt, concrete, macadam stone, etc.,) as previously specified shall be interpreted as to mean the minimum depths of replacement. In no case shall the replacements be less than the depth removed, unless approved by change order and a renegotiated price.

**3.8.8. TEMPORARY PAVEMENT** - No asphalt concrete pavement shall be placed before May 1 or after October 31, except by specific permission of the Engineer. Should pavement replacement not be completed within these dates, a temporary wearing course, meeting the requirements of 405 of the



State of Ohio, Department of Transportation Construction and Material Specifications, shall be provided. This temporary pavement shall be replaced in the spring as soon as weather permits. No payment will be allowed the Contractor for this temporary pavement.

3.8.9. CONCRETE SIDEWALKS - Existing concrete or brick sidewalks which must be removed to permit installation of the sewers, or which are damaged in connection with the work, shall be replaced upon conclusion of the pipe laying and granular backfilling, the full depth under the sidewalks with new concrete sidewalks of the same width as the original. New sidewalks shall be four (4) inches in thickness, except at driveways where they shall be six (6) inches thick, and shall be laid to the established sidewalk grade. All concrete shall be Class C with materials and workmanship as previously specified. All materials shall be approved by the Engineer. An approved ready-mix concrete may be used.

Concrete shall then be thoroughly mixed in a batch mixer for at least 1-1/2 minutes with not to exceed 6-1/2 gallons of water per sack of cement, and shall then be deposited in clean approved forms. The concrete shall be thoroughly spaded into place and struck off even with the top of the forms, after which it shall be wood floated to a smooth, skid-resistant surface.

After the concrete has had its initial set, it shall be kept wet for at least 72 hours by ponding, by the use of wet burlap or cured with an approved waterproof membrane. Grooves shall be made with a grooving tool at four or five foot intervals. Also provide one and one-half (1½) inch mastic expansion strips at intervals of 25 feet and at junctions with other walls or structures. Sidewalks other than concrete or brick shall be classified as pavement and shall be replaced, as previously specified, for the appropriate type of pavement.

3.8.10. CURBS, GUTTERS, ETC. - Any curb, curb drain or curb and gutter which are damaged or removed must be replaced. Construction shall be as indicated on the plans and/or comply with ODOT Item 609.

3.8.11. PAVEMENT MARKINGS AND MARKERS -

A. EXISTING PAVEMENT MARKINGS: Match existing in location, type, size, color, and material; comply with appropriate ODOT 640 Items and Item 621.

B. CROSSWALK MARKINGS AT NEW CURB RAMP LOCATIONS:

1. Follow ramp details on drawings.
2. Use 12 inch wide edge lines, located 6 feet apart (inside to inside) parallel to each other and centered on ramp opening at curb. Extend full width of pavement, curb ramp to curb ramp.
3. Comply with appropriate ODOT 640 Items
4. Line Color: White

3.8.12. CONCRETE STEPS - All concrete steps which must be removed to permit installation of the sewers, or which are damaged in connection with the work, shall be replaced upon conclusion of the pipe laying and backfilling, with new concrete steps of the same width as the original. All concrete steps shall be replaced in accordance with Item 608 of the State of Ohio of Transportation Construction and Material Specifications.

**3.8.13. CONTRACTOR'S INVESTIGATION** - The Contractor shall investigate the condition, quality, thickness and pavement base of all existing pavements and shall base his bid accordingly.

**3.9 MEASUREMENT** - Payment for replacement of items included herein shall be limited to the following unless specifically noted otherwise on the plans or in the specifications.

Pavement, berm and drives (temporary and permanent)- maximum allowable trench width at the top of pipe plus two (2) feet, as indicated on the trench details included in the plans.

Sidewalks and curbing - maximum allowable trench width at the top of pipe plus two (2) feet, as indicated on the trench details included in the plans. Parallel replacements shall be measured on actual lineal foot removed.

Existing Sewers - for crossovers, the actual length replaced, with a maximum of 10' allowed per crossing; for parallel lines, actual lineal feet measured and approved for replacement.

Curb Ramps - By the price for each, in new concrete walks, which includes the cost of any additional materials, grading, forming and finishing not included in the new walk.

Pavement Milling - By the price per square yard for removing 1-1/2 inches existing bituminous pavement using a self-propelled milling machine. Includes temporary pavement markings and disposal of cuttings. No separate payment will be made for temporary pavement markings and markers.

Catch Basins, Inlets and Storm Manholes - per each approved and replaced.

Trees - per each.

Shrubs, bushes - none.

Guardrail, fence - actual length removed and replaced.

Service Connection - per lineal foot of pipe approved and which includes all material and fittings as required.

Replacement beyond the lines of measurement shall be at the expense of the Contractor.

**3.10 CONSTRUCTION SPECIFICATIONS** - Where applicable the Ohio Department of Transportation Construction and Materials specifications shall govern all construction, as follows:

Concrete Pavement - (Plain).....	Item 452
Concrete Pavement - (Reinforced).....	Item 451
Asphalt Concrete .....	Item 402 & 404
Aggregate Base .....	Item 304
Concrete Walk and Steps .....	Item 608
Concrete Curb .....	Item 609
Prime Coat .....	Item 408
Tack Coat .....	Item 407
Concrete Base .....	Item 305
Fence .....	Item 607
Guardrail .....	Item 606
Removals .....	Item 202

3.11 PRICE BID - The price bid for replacements shall include the removal and disposal of the existing item and material and the furnishing of all necessary materials and construction as herein specified, within the limits defined, and shall be the price complete as follows:

Fence, Guardrail.....	Per Lineal Foot
Catch Basin, Inlet, Storm Manholes .....	Per Each
Concrete Pavement.....	Per Square Yard
Asphalt Pavement.....	Per Square Yard
Concrete Curb.....	Per Lineal Foot
Concrete Walk.....	Per Square Foot

**END OF SECTION**

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#### 4. SEEDING, CLEAN-UP

##### 4.1 SCOPE

Under this item, the Contractor shall furnish all labor, materials and equipment required to accomplish the fine grading, fertilizing, and seeding for all areas that are damaged during construction of the waterline including all backfilled trenches, where applicable. All seeding, mulching and fertilization shall conform to ODOT Item 659 or as stated herein.

##### 4.2 SURFACE PREPARATION

Prior to seeding, the project areas shall be uniformly graded as required for proper drainage, and a 2 inch layer of loose, friable, loamy topsoil shall be added to the top surface of the entire area. Topsoil from the excavation of existing soils are not acceptable. The surface shall then be raked, rolled and graded smooth and level with adjoining areas and made ready for fertilizing and seeding. All wheel marks or other evidences of damage shall be carefully filled and tamped level, then loosened to a depth of two (2) inches for fertilizing and seeding. Backfilled areas and cut areas shall be cleared of stones prior to the placing of the topsoil. Topsoil shall be free of refuse or any foreign materials and shall contain not less than five (5) percent nor more than 20 percent organic matter.

The Contractor shall take special care to insure that backfilling over trenches is well compacted prior to providing topsoil and starting the seeding. If the trenches settle after the seeding is completed, and for the duration of the term of the Contract, the Contractor shall fill the settled areas with approved topsoil, re-fertilize and seed the area as herein specified.

##### 4.3 FERTILIZATION

After providing topsoil and leveling as above specified, all areas to be seeded shall be given an application of an approved commercial fertilizer at the rate of 20 pounds per 1,000 square feet. Immediately prior to sowing the seed, the area shall be raked sufficiently to thoroughly mix the fertilizer with the soil.

- A. Fertilizer - Liquid or dry; recommended for grass, with 50 percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil to the following proportions: Nitrogen 12 percent, phosphoric acid 12 percent, soluble potash 12 percent.

##### 4.4 SEED MIXTURE

- A. Residential and Urban Area Seed Mixture:

Percent by Weight

- |    |  |    |
|----|--|----|
| 1. | Kentucky Bluegrass (Poa Pratensis):        | 30 |
| 2. | Creeping Red Fescue Grass (Festuco Rubra): | 30 |
| 3. | Annual Ryegrass (Lolium Multiflorum):      | 20 |
| 4. | Perennial Ryegrass (Lolium Perenne):       | 20 |

144000 00027

B. Steep Embankment Area Seed Mixture:

1.	Ingredients	Percent by Weight
a.	Rebell II Tall Fescue:	40
b.	Weeping Lovegrass:	20
c.	Reliant Hard Fescue:	10
d.	Jamestown II Chewing Fescue:	10
e.	Palmer II Perennial Ryegrass:	10
f.	White Clover:	5
g.	Blackwell Swichgrass	5

4.5 MULCHING MATERIALS

A. For all areas, except on slopes 3:1 or greater, provide oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry; anchor in place.

1. Mulch Anchoring: Fibre mulch or commercially available synthetic binder (non-asphaltic).

B. For slopes 3:1 or greater, provide erosion control blankets.

1. Manufacturers: PPS P Packaging Company, XCEL Superior Erosion Control Blanket, or as approved.

2. Description: Machine-produced mat of wood excelsior fibers, 80 percent of which are 6 inches or longer in length with a consistent width of fibers evenly distributed throughout the blanket, with a photo-degradable, extruded plastic netting covering the top and bottom of each blanket.

3. Weight: 1.0 pounds per square yard.

4. Accessories: 8 inch by 1 inch by 8 inch, 9 gage staples.

C. Hydroseeding: Wood cellulose fiber specifically prepared for hydroseeding.

4.6 SOWING

The specified seed shall be sown uniformly by means of mechanical distributors at the rate of four pounds per 1000 square feet. No seeding shall be done during windy weather or when the ground is wet or otherwise non-tillable. Neither shall seed be sown between June 1 and August 15, or between October 30 and March 15, except upon written permission of the Engineer. After seeding, the ground shall be lightly raked to cover the seed and shall be covered with non-toxic mulching material such as wheat or oat straw. Mulching material shall be evenly placed one (1) to two (2) inches thick, loose measurement, over the entire seeded area and securely tied. In the event mulching is displaced, it shall be replaced, but only after

the seeding and other work preceding the mulching, damaged because of the displacement of the mulching material, has been acceptably repaired.

4.7 MAINTENANCE

The Contractor shall properly protect and care for all lawn areas until the grass is a well established dense uniform growth at least four (4) inches high. At that time all excess mulch shall be removed and the grass, for two weeks after this, shall be mowed. If the grass shows good growth and a dense stand at this time, the Contractor's obligations shall have been fulfilled except for the repairs of future settlement.

All areas and spots that do not show a prompt "catch" shall be reseeded at intervals of 21 days, which shall continue until a good growth is established over the entire seeded area. The methods pursued in the renewal or replacement of lawn area shall be as previously specified. Areas damaged due to acts of neglect by the Owner or vandalism shall be resown only at the request of and at the expense of the Owner. The Contractor shall be responsible for weed control during the seeding procedures. Noticeable weed growth shall be properly controlled by the Contractor.

4.8 GENERAL CLEAN-UP

The contractor shall use proper care and consideration during construction clean-up procedures. The contractor shall include the cost of the general clean-up in the other items bid on the project. **The Contractor shall be responsible to restore all of the areas of construction to their original conditions prior to beginning the work, which includes but is not limited to, reestablishment of all surface drainage routes.**

4.9 MEASUREMENT AND PAYMENT

The price bid for seeding, mulching and fertilizing shall include all labor, tools, equipment and materials required for restoring and maintaining the areas as specified and shall be a lump sum price, complete, including topsoil.

4.10 TEMPORARY SOIL EROSION AND SEDIMENT CONTROL

Contractor shall prepare a Storm Water Pollution Prevention Plan in accordance with the Ohio EPA General Permit No. OHC000003 (see appendix) and the Mitigation Measures - Section 11.

This plan is to cover the sewer installation work and any material stockpiles (temporary/permanent) and any excess material disposal sites.

Contractor to complete and file with necessary fees and Notice of Intent (NOI).

Contractor to install and maintain all erosion control measures under this Item.

**END OF SECTION**

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## 5. WASTEWATER PUMPING STATION REHABILITATION

### 5.1 GENERAL

- A. The contractor shall furnish all labor and materials to rehab the East Maple and West Maple Street Pump Stations and Damascus Road Pump Station as shown on the plans and further described within these specifications. The pumping station shall be of the submersible type and shall include access doors, two submersible pumps with hydraulic sealing flanges, pump rail guides, pump mounting plates with discharge elbow and rail supports, access frame with covers and guide rail supports, pump lifting chains, rails, mercury free level control switches, electric alternator, high water alarm, all valves, discharge piping and electrical controls and alarms in stainless steel weatherproof boxes and relining of existing structures.
- B. The pumps and controls for all pumping stations included within the project shall be by the same manufacturer.
- C. Site work and electrical and telephone work are included in this item.
- D. All incidental work required to complete the installation of the pump stations is included within this item.

### 5.2 PUMP STATION DEMOLITION

Contractor shall remove all pumps, piping, valves, fittings, rails, level devices, control panels electrical components and misc., hardware for each of the pump stations.

Pump Station "C" East Maple Street will include removal of the steel "access" tube to a depth of 5' below grade. The remaining pump station shall have all holes plugged, it shall be filled with ODOT 57 aggregate. The wet well shall have the top slab removed and replaced per the drawings.

Pump Station "B" West Maple Street will also include removal and replacement of the top slab of the existing valve pit.

### 5.3 By-Pass Pumping

Prior to beginning any work the contractor shall establish by-pass pumping for each pump station. Pumps shall operate 24 hours/day 7 days a week till completion of the project. The by-pass pump shall be rated at a minimum of 200% of the rated capacity of the proposed pump see Section 5.6.

Where by-pass pumping hoses occupy pavement the contractor shall supply necessary "ramps and plating" in order to maintain traffic.



#### 5.4 CONCRETE WET WELL

- A. TOP SLAB - The top slab of the wet well shall be constructed of Class I reinforced concrete, as shown on the plans. A single leaf or double leaf (when installed above pumps) aluminum access door assembly shall be installed in the top slab **and shall be Heavy Traffic rated as follows:**  
**Access hatches are to be Bilco Hatches (non-draining as follows:**
- Valve vaults – Single 2' x2'.
  - Pump Station – Wet wells – double leaf 4' x 2'.
- Access door shall be a Bilco Company door hinged on the long side, or equal.**  
Frame shall be coated with tar base epoxy paint where it is in contact with concrete. Frame shall support guide rails and electrical wiring channel or NEMA 4X junction box. Wiring channel and junction box shall be stainless steel. Cover shall be provided with lifting handle and safety latch to hold cover in the open position. A locking hasp shall be furnished.
- C. VENT PIPE - Separate class 150 vent pipe shall be provided for the wet well and valve chamber areas. The outlet of each vent shall be provided with two #14 gauge mesh bronze wire screens secured to the vent inlet.
- D. PAINTING - Wet well piping, shall receive two (2) coats of Glide Guard Coal Tar Epoxy - 5270/5271 as manufactured by the Glidden Company or approved equal, to a dry film thickness of 8 mils per coat. Surface preparation shall be per manufacturer's recommendations.

#### 5.5 PIPING

Piping in the wet well basin shall be ductile iron, Class 52, **four (4)** inches in size. All penetrations of the wet well basin shall be made using a flexible boot. These joints shall consist of a rubber seal monolithically cast in place or mechanically held in place by a with stainless steel retainer.

Piping in the valve chamber shall include two swing check valves, with outside level and spring, five eccentric plug valves, necessary straight pipe, flanged elbows, tees, reducers, and discharge M.J. connector. All penetrations of the valve chamber shall be made using a flexible boot. These joints shall consist of a rubber seal monolithically cast in place or mechanically held in place by a with stainless steel retainer.

All piping shall be mounted in the valve chamber and supported in place ready to connect to the piping outside the chamber. A three-inch drain pipe shall be provided. At the end of the drain pipe a check valve shall be provided to prevent gas or liquid leakage into the valve chamber from the wet well.

All pressure force main shall meet the force main specifications noted elsewhere in the specifications.

Check valves shall be horizontal swing, cast iron body, bronze mounted and spring loaded for 175 psi working water pressure. An exterior operating handle shall be provided.

Plug valves shall be of the non-lubricated, tapered type conforming to AWWA C509. The valve shall be furnished with a drip-tight shutoff plug mounted in stainless steel or teflon over phenolic bearings. Valves shall be designed to pass 3" inch spherical solids. The working pressure shall be 200 psi. **All Valve shall be Mueller.**

A 4" inch ductile iron pipe connection shall be furnished in the valve chamber for use with a portable pump (4") which shall include a **check valve**. The connection shall be **as shown on the detail sheet**.

A connection shall be furnished in the wet well for use with a portable pump (4"). The 4" section of ductile iron pipe **shall be as shown on the detail sheet**. The lower end of the pipe shall terminate in a plain end below the pump off elevation of each station. **All Bolts to be stainless steel 304.**

#### 5.6 OPERATING CONDITIONS

	PS-B	PS-C
	West Maple Street	East Maple Street
Capacity	110 gpm	200 gpm
TDH	40'	20'
RPM	1750	1750
Horse Power	3 hp	3 hp
Voltage	230	230
Phase	1	1

#### 5.7 PUMP CONSTRUCTION

The pumps shall be Hydromatic, or approved equal of the non-clog submersible explosion-proof design. The motor shall be equipped with heat sensors and filled with dielectric oil. The pump shall have two independent carbon/ceramic mechanical seals with an oil chamber between the seals. The seal housing shall be fitted with a moisture sensing probe and connector to a monitoring alarm in the control panel. The pump shall have a two vane, non-clog impeller capable of passing 3" spherical solids. The pump shaft shall be 416 stainless steel and all fasteners shall be 300 series stainless steel.

#### 5.8 GUIDE RAIL SYSTEM

The pumps shall be installed on a guide rail system that allows removal without entering the wet well. Stainless Steel guide system. It shall bolt directly to the base elbow on the sump floor and extend up and bolt directly to the access frame.

#### 5.9 DISCHARGE ELBOW WITH GUIDE ARMS

A discharge base elbow, designed to mount directly to the sump floor shall be supplied for each pump. It shall have a standard 125 pound flange faced and drilled on the outlet side with the inlet flange faced and zinc spray coated to provide a smooth corrosion and abrasion resistant surface. Three stainless steel guide arms shall be bolted to the discharge elbow that will guide

and support the pump when it is lowered into the slump. All fasteners shall be 300 series stainless steel. The base elbow shall be painted with one coat of corrosive resistant zinc chromate enamel.

5.10 HYDRAULIC SEALING FLANGE

A cast iron sealing flange, complete with Buna N rubber diaphragm type sealing gasket, shall be mounted on each pump discharge. This diaphragm shall be held in place by a clamp ring with stainless steel fasteners.

5.11 LIFTING CABLE

Each pumping unit shall be provided with a stainless steel lifting cable of sufficient length to connect to the portable hoist. The access frame shall provide a stainless steel hook to attach the cable when not in use. The lifting cable shall be sized according to the pump weight.

5.12 PUMP REMOVAL

A portable hoist for pump removal shall be provided. The hoist shall be a Model 12649, 1,000 pound capacity, manufactured by U.S.F. Fabrication. It shall have an adjustable boom with a reach of 24" to 36". The hoist shall be hot dipped galvanized steel. The hoist shall include a 2,500 pound hand winch with disk break and include 35 feet of ¼" diameter stainless steel cable and a safety hook. A surface mounted socket for receiving the portable hoist shall be provided at each station. (For West and East Maple Street Only).

5.13 FLOAT MOUNTING BRACKET

A float mounting bracket shall be provided with strain reliefs that support and hold the level control cords. Continuous cords are to run from pump(s) and level controls to a lockable, NEMA 4X junction box (with terminal strip) below the control panel. No splices shall be made in the wiring. The bracket shall be fabricated from stainless steel. Cable hangers and restraints shall be of stainless steel.

5.14 ELECTRICAL CONTROL PANEL

The control panel shall have a Nema 4X weatherproof, stainless steel enclosure with hinged dead-front inner door. The indicating lights, operators, and meters shall be mounted on the inner door. The panel shall be mounted on a non-corrosive plate. A lock hasp shall be provided on the outside door.

The panel shall include a circuit breaker and a magnetic starter with overload and under-voltage protection for each pump. An alternating relay shall be provided to alternate pumps on each successive cycle of operation. H-O-A switches and run lights shall be provided for each pump. The switches shall be wired such that both pumps can be manually activated at the same time.

The run lights shall be green in color and shall be mounted on the exterior and be visible from the roadway along with a red common trouble light. Terminal strips shall be provided for connection pump and control wires. Additional terminals shall be provided to connect heat sensors and seal failure wires.

Terminals shall be provided for dry contacts within the panel that interface with the automatic telephone dialer system. The conditions to be monitored include the following:

1. High water.
2. Pump #1 run.
3. Pump #2 run.
4. Power/Phase failure.
5. Pump #1 seal leak.
6. Pump #2 seal leak.
7. Pump #1 motor overtemp.
8. Pump #2 motor overtemp
9. Pump #1 Overload Relay
10. Pump #2 Overload Relay
11. Spare
12. Spare

The transformer with primary and secondary circuit breakers shall be supplied to provide a 115 volt control circuit and power supply for other pump station accessories. A lightning and surge protection device on incoming power supply shall be provided in the control panel. A three phase power monitor shall be provided to protect the pumps from phase/power loss, under voltage, or phase reversal. The monitor shall shut down the pumps and provide a power failure signal to the auto-dialer system. The pump motor control circuitry shall be designed to allow the pump motors to run simultaneously, but shall not allow the pump motors to start simultaneously.

The panel shall include a non-resettable elapsed time meter for each pump to record the running time. A seal failure indicator shall be provided for each pump to detect water leakage through the bottom seal. Activation shall provide a contact closure for the auto-dialer and illumination of the indicator light on the panel. A heater strip and thermostat shall be provided to prevent condensation inside the enclosure. Provide a duplex receptacle in the panel protected by a dedicated breaker.

#### 5.15 LIQUID LEVEL CONTROL

- A. The manufacturer of the liquid level control system shall have a quality management system in place and shall be ISO 9001 certified.
- B. The level control system shall start and stop the pump motors in response to changes in wet well level, as set forth herein.
- C. The level control system shall be Mercury free float system.
- D. The level control system shall utilize the alternator relay to select first one pump, then the second pump, to run as lead pump for a pumping cycle. Alternation shall occur at the end of a pumping cycle.
- E. An alarm silence pushbutton and relay shall be provided to permit maintenance personnel to de-energize the audible alarm device while corrective actions are under way. After silencing the alarm device, manual reset of the alarm condition shall clear the alarm silence relay

automatically. The pushbutton shall be oil tight design with contacts rated NEMA A300 minimum.

#### 5.16 AUTOMATIC TELEPHONE DIALER

##### A. Description & Phone Number Dialing:

The dialer shall be a solid state component capable of dialing up to 16 phone numbers, each up to 24 digits in length. Phone numbers and standard pulse dialing or touch tone DTHF dialing are user programmable via the system's keyboard or touch tone phone.

The dialer system shall be furnished by the pump station manufacturer. The station manufacturer shall mount, wire, program, test and warrant the dialer.

##### B. Solid State Voice Message Recording and Playback:

1. The unit shall have two different categories of speech message capability, all implemented with permanent non-volatile solid state circuitry with no mechanical tape mechanisms. The unit shall allow for message recording from a remote telephone as well as from the front panel.
2. User Field Recorded Messages: The user may record and re-record his own voice messages, for each input channel and for the Station ID.
3. There shall be no limit on the length of any particular message, within the overall available message recording time, which shall be 40 seconds for 4 channel units; 80 seconds for 8 channel units, and 160 seconds for 16 or more channels.
4. The unit shall allow selective recording of both Normal and Alarm advisory messages for each input channel.
5. The unit shall provide for automatic setting of the optimum speech memory usage rate for the total set of messages recorded, in order to achieve optimum recording sound quality.
6. Circuit board switches or jumper straps shall not be acceptable means of manipulating message length or recording rates.
7. Permanent Resident Non-Recorded Messages: Permanent built-in messages shall be included to support user programming operations, to provide supplemental warning messages such as advising that the alarms have been disabled, and to allow the unit to be fully functional even when the installer has not recorded any messages of his own.



C. Local and Remote Programming Capabilities:

1. The user may optionally elect to alter the following parameters from their standard normal default values via keyboard entry or remotely from any Touch Tone phone.
2. Alarm call grouping: On alarm, system shall selectively call the correct phone numbers according to the current alarm(s).
3. Alarm response delay: .1 to 999.9 seconds.
4. Delay between alarm call outs: .1 to 99.9 minutes.
5. Alarm reset time: 0.1 to 99 hours or "NO RESET".
6. Incoming ring response (answer) delay: 1 to 20 rings.
7. Number of message repetitions: 1 to 20 repetitions.
8. Input alarm criteria: Each channel shall be independently configured for "Alarm On Open Circuit", "Alarm On Closed Circuit", "No Alarm".
9. Autocall Test: When enabled, the unit shall place a single round of test calls, both at the time this function is enabled and also at regular subsequent intervals until this function is disabled at the keyboard.
10. Run time meter: Selected inputs shall accumulate and report the number of hours that its input contacts have been closed.
11. Remote system microphone activation.
12. Remote and local arming and disarming of system.
13. Pulse totalizer function.

D. Nonvolatile Program and Memory Retention:

User-entered programming and voice messages shall be kept intact even during power failures or when all power is removed for up to ten years.

E. Acknowledgment:

Acknowledgment of an alarm phone call is to be accomplished by pressing a touch tone "9" as the alarm call is being received, and/or by returning a phone call to the unit after having received an alarm call.

F. Input Monitoring Function:

The unit shall continuously monitor the presence of AC power and the status of four contact closure inputs. Unit shall optionally be field upgradeable to incorporate a total of 8, 16, 24, or 32 dry contact inputs. AC power failure, or violation of the alarm criteria at any input, shall cause the unit to go into alarm status and begin dial-outs. Unit shall, upon a single program entry, automatically accept all input states as the normal non-alarm state, eliminating possible confusion about Normally Open versus Normally Closed inputs. Further, as a diagnostic aid, unit shall have the capability of directly announcing the state of any given input as currently "Open Circuit" or "Closed Circuit", without disturbing any message programming. Each input channel shall also be independently programmable, without need to manipulate circuit board switches or jumpers, as Normally Open or Normally Closed, or for No Alarm (Status Only), or for Pulse Totalizing, or for Run Time Metering.

G. Run Time Meter Inputs:

Any dry contact can be programmed to accumulate and report the number of hours their respective input circuits have been closed. Any such channels will never cause an alarm, but on inquiry will recite the channel's message according to the status of the input and then report the closed circuit time to the tenth of an hour. The input will accumulate and report in tenths of hours up to a total accumulated running time of 99,999.9 hours. The initial value of the Run Time Meter shall be programmable in order to agree with existing electromechanical Run Time Meters. Up to a total of 8 Run Time Meters may be programmed.

H. Pulse Totalizer Inputs:

Any dry contact input can be programmed to accumulate the number of pulses (momentary contact closures) occurring at the input.

I. Alarm Message:

Upon initiating an alarm phone call, the system is to "speak" only those channels that are currently in "alarm status".

J. Diagnostics:

The unit shall provide a complete verbal report of all programmable functions and their programmed values on command from any remote touch tone phone.

K. Speakerphone:

The unit shall be capable of dialing any phone number on command and function as a speakerphone.

L. Inquiry Message and Function:

Inquiry phone calls can be made directly to the unit at any time from any telephone, locally or long distance, for a complete status report of all variables being monitored, including power status.

M. Power Battery Backup:

Normal power shall be 105-135 VAC, 15 watts nominal. The product is to contain its own gel cell rechargeable battery which is automatically kept charged when AC power is present. The system shall operate on battery power for a minimum of 20 continuous hours in the event of AC power failure. A shorter backup time shall not be acceptable.

The built-in charger shall be precision voltage controlled, not a "trickle charger", in order to minimize recharge time and maximize battery life available.

N. Phone Line:

The dialer is to use a standard rotary pulse or Touch Tone "dial-up" phone line (direct leased line not to be required) and is to be F.C.C. approved. Connection to the telephone is through a 4-pin modular jack (RJ-11).

O. Integral Surge Protection:

All power, phone line, dry contact, and analog signal inputs shall be protected at the circuit board to IEEE Standard 587, category B (6,000 volts open circuit/3,000 amps closed circuit). Gas tubes followed by solid state protectors shall be integral to the circuit board for each such line. Protectors mounted external to the main circuit board shall not be an acceptable substitute. The installer shall provide a good electrical ground connection point near the unit to maximize the effectiveness of the surge protection.

P. Warranty:

The dialer shall be covered by a three (3) year warranty covering parts and labor performed at the Factory.

R. Additional Features: Sealed Switches, LED Indicators, Alarm Disable Warning, Talk Through:

All keyboard and front panel switches shall be sealed to prevent contamination. Front panel LED's shall indicate:

Normal Operation, Program Mode, Phone Call in Progress, Status for each channel, AC Power Present, AC Power Failure, and Low Discharging or Recharging Battery. On any Inquiry telephone call or on-site status check, the voice shall provide specific warning if no dial-out phone numbers are entered, or if the unit is in the "alarm disable" mode, or if AC power is off or has been off since last reset. A built-in microphone shall allow anyone at a remote phone to listen to local sounds and have a two-way conversation with personnel at the dialer.

5.17 AIR RELEASE VALVE

An air release valve shall be constructed at the location and in accordance with the detail shown on the drawings. The sewage combination air valve shall have a large orifice to allow air to escape or enter when filling or draining the pipeline and a small orifice to allow air to escape when the pipeline is pressurized. **The size of the ARV shall be sized appropriately for the size of the force main.** The small opening shall be sized for operating pressures of 0-150 psi. The valve inlet shall be 2" NPT. The outlet shall be 1" NPT for pipelines 6 inches and smaller and 2" NPT for pipelines 8 inches and larger. Inlet and outlet valves, quick disconnect couplings and 10 feet of hose for flushing shall be provided.

**Pump Station B to include 2-ARV Inside valve vault.**

5.18 MANUFACTURER

These specifications describe a sewage lift station as supplied by Ohio Pump Co. of Salem, Ohio. This product is deemed most suitable for the service anticipated, however, other products equally as good and efficient will be considered.

5.19 PERFORMANCE GUARANTEE

The manufacturer of the lift station shall guarantee for one year from the date of start-up that the structure and all equipment shall be free from faults in design, materials and workmanship. The manufacturer shall furnish replacement parts for any component proven defective, whether of his or other manufacturer, during the guarantee period.

5.20 PAINTING

All steel surfaces shall be painted in a color (s) to be selected by the Owner. Painting shall be in accord with ODOT Item 514.

5.21 ELECTRICAL AND TELEPHONE CONNECTIONS

Electrically and telephone work in connection with the pumping stations shall be as specified in Electrical Specifications, Wastewater Pumping Stations, or these specifications.

5.22 SITE WORK

After the structure and piping has been installed, the site shall be graded as shown on the plans and the driveway and walk area constructed. All areas disturbed by the Contractor shall be seeded in accordance with the specifications within the contract documents.

5.23 MINOR DETAILS

Minor details not specifically mentioned in these specifications, nor shown on the plans, but necessary to secure a workmanlike job and proper performance, shall be provided by the Contractor, at the expense of the Contractor.

#### 5.24 SUBMITTALS

Submitted data shall be provided to show compliance with these specifications, plans or other specifications that will influence the proper operation of the pumps.

Standard submittal data for approval must consist of:

- a. Performance Curves.
- b. Pump Outline Drawings.
- c. Station Drawing for Accessories.
- d. Detailed Electrical Data.
- e. Control Drawing and Data.
- f. Access Frame Drawing.
- g. Typical Installation Guides.
- h. Technical Manuals.
- i. Parts List.
- j. Printed Warranty.
- k. Manufacturer's Equipment Storage Recommendations.
- l. Manufacturer's Standard Recommended Start-up Report Form.
- m. Manufacturer's List of Recommended Spare Parts.
- n. Motor Performance Curve.
- o. Verification of power supply.

Lack of the above requested submittal data is cause for rejection.

#### 5.25 START-UP SERVICE

After the installation is complete, the manufacturer shall provide the services of a qualified factory trained representative for one eight-hour working day at the site to perform initial start-up of the pumping stations and to instruct the Owner's operating personnel in the operation and maintenance of the equipment. Three (3) copies of the Operating and Maintenance Manuals for each station will be supplied to the Owner prior to initial operation.

#### 5.26 PRICE BID

The price bid for the Pump Station shall include necessary excavation, backfill, site work, electrical and telephone work (including coordination with appropriate utility companies to provide any needed services) and the furnishing of all materials and construction, in accordance with the foregoing specifications and accompanying plans and shall be the lump sum price constructed, complete. In addition, the price bid for all Pumping Stations shall include all costs associated with furnishing the portable hoist.

**END OF SECTION**



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## 6. SANITARY SEWER MANHOLE LINING

### PART 1 GENERAL

#### 1.1 SCOPE OF WORK

- A. Work under this section shall include all materials, equipment and labor necessary to thoroughly clean, plug, patch, waterproof, optimize structural integrity, and seal all interior surfaces of the existing pump station wet wells. This repair is intended to provide leakproof protection for these structures.
- B. The lining of these structures shall be accomplished by applying high strength waterproof components to the structure wall and flow channels with the result being to stop infiltration.
- C. The wet wells are all precast constructed.
- D. This specification establishes the minimum standard for material and application technique for manhole rehabilitation by stopping leaks, repairing damaged areas with a design formulated corrosion resistant cementitious material, and lining the manholes. Contractor shall include in his price bid any necessary bypass pumping required to perform the work.
- E. Contractor is responsible for all necessary equipment and procedure regarding manhole isolation for lining application, including but not limited to, plugging off manhole, bypass pumping around manhole(s) requiring prep and relining.
- F. Contractor to comply with all local code requirements and specific details as it relates to this section.

#### 1.2 QUALIFICATIONS

- A. Contractor (or Subcontractor) to have experience on at least five (5) projects successfully completed using this technology and similar to this one being bid, specifically using the material specified.
- B. Contractor (or Subcontractor) to document manhole and structure rehabilitation experience in the last three (3) years. Contractor shall list the method of rehabilitation used in each installation.
- C. Contractor (or Subcontractor) shall be certified by the coating system manufacturer as a licensed applicator.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Materials required for rehabilitation are specified throughout Part 3 herein under the various execution procedures. Substitute items may be accepted pending approval of the Engineer. There are two (2) approved material manufacturers for liner material:
1. Sewpercoat PG, by LaFarge.
  2. Spectrashield, by CCI Spectrum, Inc.
  3. Or approved equal.
- B. Cementitious - Water Plug: A quick setting hydraulic cement compound shall be used to quickly stop running water or seepage leaks in masonry and/or concrete. The formulation shall be nonshrinking, nonmetallic, and noncorrosive. It shall require the addition of potable water only for mixing and shall achieve initial set in 1 to 3 minutes, even when applied under water. It may be used above or below grade, interior or exterior, to stop seepage and flowing water leaks in most concrete and masonry walls and floors. Approved material manufacturers for Cementitious Water Plug material:
1. Strong-Seal Strong Plug
  2. Parson Quick-Plug
  3. Or approved equal.
- C. Cementitious Patching: A fast setting, ready-to-use, calcium aluminate based concrete and masonry patching compound with fiber reinforcing shall be used to fill voids and pockets. It shall require only potable water for mixing and shall achieve its initial set in 3 to 5 minutes and its final set within 20 minutes even under water. After initial set, it may be shaved to conform to the contours of the surrounding surface. Properly mixed and applied, it shall quickly develop high strength and a tenacious bond. It may be used underwater or below grade on vertical, overhead, and horizontal surfaces. It is used for the patching of manholes in preparation for the liner application. Approved material manufacturers for Cementitious Patching material:
1. Parson CA Liner 1000
  2. Strong-Seal QSR Patching material
  3. Or approved equal.
- D. Materials shall be used that are compatible with each other and shall be from the same manufacturer as much as possible. Materials shall be for use in manholes where raw sewage exists and hydrogen sulfide corrosion has occurred in the past and/or will be present in the future. Contractor shall confirm that all materials are compatible for the intended use and for use with the other materials used.

- E. Water: Water shall be clean and potable. Questionable water shall be tested by a testing laboratory with ASTM C-94. Potable water does not need to be tested.

### PART 3 EXECUTION

#### 3.1 MATERIAL HANDLING

- A. The liner material shall be delivered in factory prepared packaging, cementitious materials shall be delivered in factory sealed containers and shall be suitable for mixing with just the addition of clean water at the prescribed rates. Special handling is not required, same as with any cementitious mortar. Normal precautions for "nuisance dust" should be observed. Consult Material Safety Data Sheet for details.
- B. Personnel entry is required to rebuild the interior walls of most existing structures and manholes. During personnel entry into the manholes, OSHA standards for confined space entry and proper ventilation shall be strictly observed.

#### 3.2 SURFACE PREPARATION

- A. Prior to any work inside of existing manholes, all interior wall and invert surfaces shall be thoroughly cleaned using a minimum of 5,000 psi water blast to remove all foreign matter and loose and contaminated concrete. All deposits must be removed from the manhole. All preparation work shall conform to the patch material and coating manufacturer's recommended practices. If waterblast washing is not effective in removing all deposits, a 10% solution of muriatic acid will be applied by spraying from above the manhole. Manholes treated with acid solutions shall be thoroughly flushed and the manhole allowed to dry. The mixing, application, and removal of the acid solution shall be done in strict accordance with the manufacturer's specifications and recommendations. All safety procedures and protective devices applicable to the handling of these acids shall be strictly adhered to. All material resulting from cleaning operation shall be removed from the manhole and properly disposed of by the Contractor in accordance with applicable regulations. Loose or protruding concrete shall be removed by mason's hammer and chisel. Surfaces of existing structures and manholes shall be neutralized to prevent further concrete deterioration as required by the repair and liner material manufacturers. Coating manufacturer shall verify that all conditions for proper surface preparation have been met prior to the contractor commencing the lining operation.
- B. All existing manhole steps shall be checked and removed and replaced if the steps are loose or pull out.

### 3.3 INFILTRATION STOPPAGE

- A. After proper wall cleaning, the wall repair shall include the plugging of all visible leaks in the manhole with application of water plug. All pressure leaks shall be sealed with a rapid setting material that will bond both mechanically and chemically to saturated surfaces. This compound shall be capable of setting in approximately 45 seconds.

### 3.4 PATCHING

- A. Patching of structure walls shall be required in areas where large voids exist (i.e., bricks missing, spalls in manhole walls, around steps, frames, pipes, and mortar joints). All cracked or disintegrated material shall be removed from the area to be patched exposing a clean, sound substrate. Patching shall be made in a manner consistent with the patching material manufacturer's recommendations concerning patch thickness and material buildup. Material shall be applied to match the original wall thickness.

### 3.5 BOTTOM REPAIR

- A. Bottom repair of bench and invert shall include the patching of the invert and bench areas in the structures and manholes as directed. The same cementitious mix will be used on these areas as used on the walls.
- B. The flow channel shall be checked for leaks, cracks, spalls, or other discrepancies by plugging the upstream side and visually inspecting channel.
- C. Repairs are to be made so as to make the surface smooth and provide smooth flow through the manhole.
- D. The invert shall have a depth through the manhole equal to one half the diameter of the sewer pipe with bench areas sloping toward the manhole walls at a minimum rate of 1" per foot.
- E. The sewer pipes allowing flow into and out of the manhole will be inspected for leakage around outside of pipe into manhole area. Any leaks will be sealed with appropriate material and methods and noted to Owner.
- F. All loose and deteriorated material shall be removed and disposed of by the contractor. Debris shall not be allowed to travel downstream to the treatment facility.

### 3.6 COATING APPLICATION

- A. Each existing structure or manhole is to be visually inspected by the Contractor to determine if the manhole has lost cement thickness (precast units) due to corrosion related problems. The patching or coating application will be required to bring "weakened" areas back up to original structural condition before applying the lining system.
- B. Many factors impact optimum design thickness, i.e. the condition of the existing structure or manhole, its material composition, depth, groundwater pressure, and

traffic loads. The repair system material manufacturer shall determine the most appropriate thickness for the manhole structure with a minimum applied thickness of 125 mils. Complete wall lining system shall be submitted to the engineer for approval prior to installation.

- C. The area behind the manhole steps shall be applied with a dual rotating spincaster to cover all areas behind obstructions. Single directional spincasting shall not be adequate. Coating may still require manual pre-application prior to spin coating. Also, if there are any other obstructions in the manhole, these will require handwork or removal and replacement after the application is completed.
- D. Position the rotating casting applicator within the center of the manhole at the lowest point desired for the new wall and commence pumping the material product. As the product begins to be centrifugally cast evenly around the interior, retrieve the applicator head at the prescribed speed for applying the thickness that has been selected. Controlled multiple passes are then made until the desired finished thickness is attained. If the procedure is interrupted for any reason, simply arrest the retrieval of the applicator head until flows are recommenced.
- E. The wall thickness shall be verified at several points throughout the manhole. Apply the full finished thickness during one visit. Multiple layers with time between applications is not recommended.
- F. Upon completion, the base covering shall be removed and any debris disposed of properly. Additional material shall be hand applied to bench surfaces at a thickness of 3 inches tapering from the wall to the edge of the channel.

### 3.7 REMOVE, REPAIR, AND REPLACE MANHOLE FRAMES AND COVERS

- A. Where required, manhole frames and covers shall be removed and reset at existing manholes. Existing frames and covers shall be reused to the extent possible. If existing manhole frames and covers cannot be reused, then new frames and covers will be provided by the Owner. All items scheduled for replacement will be approved by the Owner prior to installation.
  - 1. Frame and Cover Re-Installation - The manhole frames shall be firmly set on top of the manhole masonry with a full leveling bed of 1:1 cement mortar. Where manholes are located in paved areas, the surface of the cover shall be 1/4 inch below the pavement surface. Existing pavement shall be sawcut and removed to provide a minimum 4' x 4' box out upon replacement of frame. All pavement repair shall be concrete per ODOT Item 451 at least 8" thick but never less than existing. In unpaved streets and alley areas, the cover shall be set not to exceed 1 inch above the ground surface except for manholes constructed in ditches, where cover shall be set at the direction of the Engineer. Unpaved areas to be restored to existing conditions upon completion of repairs.
  - 2. Manhole Casting Elevation - All final top of casting elevations shall be approved by the Owner before final construction.



3. Chimney Seals shall be installed with Wrap-Id-Seal after resetting of existing or new castings on "non-lined" manholes.

#### 3.8 INSPECTION/ACCEPTANCE/WARRANTY

- A. Owner will have available a knowledgeable inspector to witness various work preformed by the Contractor.
- B. Once all structures and manholes have been lined and cured, the structures will be given a field visual inspection by the Owner and applicator. Visual inspection should verify a leak-free, uniform appearance.
- C. Structures may be tested as follows per Owner approval:
  1. Perform a manhole vacuum test in accordance with ASTM C1244 to be witnessed by the Owner's representative.

#### 3.9 FLOW INTERRUPTION

- A. Bypassing and/or blocking of the flow in the manholes shall be done only with prior coordination and approval of the Engineer and/or the Owner. Contractor shall meet with the Owner and Engineer to discuss and plan all proposed bypass flows and blockages. Bypass and blockage schedule shall be submitted for approval a minimum of one (1) week prior to the date bypasses or blockages are requested.

#### 3.10 WATER SUPPLY

- A. The water necessary for the water blasting shall be the responsibility of the Contractor. Any connection to fire hydrants shall be approved in writing by the water utility prior to the start of the project.

#### 3.11 TRAFFIC CONTROL

- A. It will be the Contractor's responsibility to supply traffic control as required by the particular location and/or jurisdiction. All traffic control setups shall comply with ODOT standards for signage and lane closures.

### PART 4 SUBMITTALS

#### 4.1 CONFORMITY

- A. All submittals shall conform to the requirements of the contract documents.

#### 4.2 REQUIREMENTS

- A. The following items may be required of the contractor to be submitted to the Engineer and Owner. This contract may not be considered complete until receipt and acceptance of the following:

1. Reference Submittals
  - a. Contractor Certification
  - b. Material Certification
2. Product Data
  - a. Patching and Plugging Material
  - b. Cementitious Materials
  - c. Lining Materials
  - d. Chimney Seal Materials

#### 4.3 WARRANTY

- A. The contractor and/or coating manufacturer shall provide a ten (10) year warranty against all defects in materials and workmanship. This shall include surface preparation. The contractor shall repair defects in materials or workmanship that may develop during the ten (10) year warranty period. This repair work shall be performed at the contractor's expense and no additional cost to the Owner.

**END OF SECTION**

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## SECTION 11307

### FOUR-INCH PORTABLE DIESEL TRAILER MOUNTED PUMPS

#### PART 1 GENERAL

##### 1.1 PROJECT SCOPE

- A. Requirements for portable, diesel driven pumps.

##### 1.2 GENERAL

- A. The specifications herein state the minimum requirements. All bids must be regular in every respect. Unauthorized conditions, limitations, or provisions shall be cause for rejection. The Village may consider as "irregular" or "non-responsive", any bid not prepared and submitted in accordance with the bid documents and specification, or any bid lacking sufficient technical literature to enable the Village to make a reasonable determination of compliance to the specification. It shall be the bidder's responsibility to carefully examine each item of the specification, failure to offer a completed bid or failure to respond to each section of the technical specification (exception yes or no) will cause the proposal to be rejected without review as "non-responsive". All variances, exceptions, and/or deviations shall be fully described in the appropriate section; deceit in responding to the specification will be cause for rejection.
- B. Interpretations: In order to be fair to all bidders, no oral interpretations will be given to any bidder as to the meaning of the specifications documents or any part thereof. Every request for each a consideration shall be made in writing to the Engineer. Based upon such inquiry, the Village may choose to issue an Addendum in accordance with Local Public Contract Laws.
- C. General specifications: Units described shall be new, unused and of the current years production. The style of pump being bid must be in production for a minimum of five (5) years. (Include users list) Unit shall be of the latest design and in current production completely serviced, ready for work and shall include all standard and optional equipment as specified herein. All bidders must have demonstrated the unit they are bidding prior to bid date.

##### 1.3 SYSTEM DESCRIPTION

- A. The portable diesel driven pumps.
- B. Pumps shall be fitted with a fully automatic priming system capable of repeated priming from a completely dry pump casing.
- C. The pumps and accessories shall be supplied by the pump manufacturer.

- D. The pumps offered shall be the manufacturer's standard production model. It shall have been in continuous use by municipal and industrial owners for a minimum of five years. A list of five user contacts including contact names and telephone numbers shall be provided with the bid submittal. Failure to supply a verifiable users list will be cause for rejection of the bid.

#### 1.4 DESIGN REQUIREMENTS

- A. Two (2) pumps, each.

Operating Speed (Maximum)	2200 Rpm
Maximum Solids Handling Size	1 3/16 Inches
Suction Size	4 Inches
Discharge Size	4 Inches
Maximum Suction Lift	28 Feet
Maximum Duty Point	400 GPM at 80'TDH

#### 1.5 REFERENCES

- A. ANSI B16.1 - Standard for Cast Iron Pipe Flanges and Flanged Fittings.

### PART 2 PRODUCTS

#### 2.1 EQUIPMENT

- A. Casing, Suction Cover: Pump casting shall be cast iron. It shall be constructed so that the suction flow path is in axial alignment with the impeller eye. There shall be no turns, chambers or Valves between the suction line (or inlet) and the impeller.
- B. Impellers: The pump impeller shall be an open, three-bladed, non-clog type with pump-out vanes on the back shroud and fabricated from hardened cast steel construction (minimum Brinell Hardness 200 HB).
- C. Wearplates: The wearplates shall be fully adjustable and replaceable, fabricated of cast iron. Wearplate clearances shall have no relationship to the ability of the pump to achieve a prime.
- D. Bearings and Shafts: Pump shall be fitted with a bearing bracket to contain the shaft and bearings. Bearings shall be tapered roller bearings of adequate size to withstand imposed loads for sustained pumping at maximum duty points. Minimum ISO L10 bearing life to be 100,000 hours. Impeller shafts shall be fabricated of 1.5% chromium alloy.

- E.     Seals: Seals shall be mechanical self-adjusting type with silicon carbide faces capable of withstanding suction pressures to 40 psi. The mechanical seal shall be cooled and lubricated in an oil bath reservoir, requiring no maintenance or adjustment. Pump shall be capable of running dry, with no damage, for periods up to twenty-four hours. All metal parts shall be of stainless steel. Elastomers shall be Viton.
- F.     Pump Suction and Discharge Flanges: Pump suction and discharge flanges shall be cast iron ANSI (B16.1) Class 150, raised faced.
- G.     Pump Gaskets: Pump gaskets shall be compressed fiber and/or Teflon.
- H.     Pump O-Rings: Pump o-rings shall be Buna-N.
- I.     PRIMING SYSTEM: Automatic priming system incorporates a twin-cylinder compressor and air ejector assembly, no vacuum pump. The compressor shall be mounted on the pump bearing frame, driven by the pump shaft, lubricated by the engine. The priming system shall require no fail-safe protection float gear or any adjusting at high or low suction lifts. Pumps with self-priming chambers modified with vacuum priming systems shall not be accepted as equal. The pump must be capable of running totally dry for periods up to 24 hours, then re-priming and returning to normal pumping volumes. Pump and priming system is capable of priming the pump from a completely dry pump casing. The pump shall be capable of static suction lifts to 28 vertical feet, at sea level. It shall also be capable of operation using extended suction lines. Equipment acceptance shall be contingent upon the pump's ability to run continuously at full speed in a completely dry condition for periods up to 24 hours. The engineer may require a demonstration.
- J.     Check Valve: Pump shall be supplied with an integral ball check valve mounted on the discharge flange of the pump, allowing unrestricted flow into the impeller. The check valve shall prevent in-line return of flow when the pump is shut off. Non-return valve elastomers shall be Nitrile Rubber, and shall be field replaceable.
- K.     Drive Unit: Diesel shall be water-cooled engine. Engine shall drive pump by use of direct connected intermediate drive plate. Starter shall be 12 volt electric. Safety shut down switches for low oil pressure and high temperature shall be provided. Battery shall have 180 Amp hour rating. Unit shall include a tachometer and a hour meter. Unit shall be a Yanmar 3TNV88C, final Tier 4 or equal, rated at 24 hp (continuous) at 2200 RPM. A certified continuous duty engine curve shall be supplied to the owner/engineer.
- L.     Engine Control Panel: Engine speed shall be adjustable to operate the pump between maximum and minimum design operation speeds in manual mode. See section 2.3 for Automatic mode.
- M.     Fuel Source: Integral trailer fuel tank capacity shall be sufficient to provide at least 36 hours of operating time at full load. The engine shall be capable of operating satisfactorily on a commercial grade of distilled No. 2 fuel oil.



- N. Exhaust: Engine shall include a muffler of suitable size.
- O. Trailer: The complete pump assembly shall be mounted in a single axle trailer with a pintle type trailer hitch. Tires and suspension shall be adequately sized for the required load range ratings. Trailers shall be equipped with fenders, electric brakes, front and rear support stands, lifting bar, safety chains and side and rear reflectors. Trailer design shall be in compliance with applicable DOT regulations.
- P. Factory Painting: Pump, engine, base, and trailer shall be shop primed and finish painted at the place of manufacturer. Materials and thickness for priming shall be in accordance with manufacturer's standards.

## 2.2 AUTOMATIC STARTING CONTROL SYSTEM

- A. The engine shall be equipped with a factory installed PrimeGuard microprocessor-based controller as supplied by Godwin Pumps of America, Inc. or approved equal and designed to start/stop the engine at a signal supplied by high and low level floats or a 4-20 mA transducer.

## 2.3 ENGINE/PUMP CONTROL SPECIFICATIONS

- A. The engine shall be started, stopped, and controlled by a high performance state of the art digital controller. The controller shall be weather proof enclosed, and contain an external weatherproof 12-position keypad accessible without the need to remove or open any protective cover or enclosure. It shall be designed to start/stop the engine at a signal supplied by high and low level floats or a 4-20 mA transducer. The controller shall provide the following functions without modification, factory recalibration, or change of chips or boards, by simply accessing the keypad.
- B. The keypad shall be a capacitive touch sensing system. No mechanical switches will be acceptable. The keypad shall operate in extreme temperatures, with gloves, through ice, snow, mud, grease, etc. and maintain complete weather-tight sealing of the controller.
- C. In automatic mode, the unit shall conserve energy and go to "sleep".
- D. The controller shall function interchangeably from float switches, pressure switch, or transducer, as well as manual start/stop by selection at the keypad. No other equipment or hardware changes are required.
- E. The start function can be programmed to provide two separate functions each day for seven days (i.e. a start, exercise cycle on two separate days at different times and for a varying length of time all via the keypad).
- F. Manual-Automatic Button:
  - 1. In Manual Mode, manual "Start" button starts engine and runs until "Stop" button is depressed or an emergency shutdown occurs.

2. In Automatic Mode, start/stop sequencing is initiated by either two normally-open narrow angler float switches, pressure switch, level transducer, pressure transducer, or a signal from a digital input.
- G. The controller shall integrate the engine safety shut-off for low and high oil temperature, and provide over-speed protection.
- H. The controller shall include standard, field-adjustable parameters for engine cycle crank timer, and shutdown time delay.
- I. The controller shall have only one circuit board with eight built-in relays. Each relay can be named to provide any function, all via the keyplay without changing relays, chips, printed circuits, or any hardware or software.
- J. Standard components shall consist of (24) digital inputs, (7) analog inputs, (1) magnetic pick-up input, (8) 20-amp form "C" relays, (1) RS232 port, (1) RS485 port, (1) RS232/RS485 port, (1) J1939 port, and (1) 64X128 pixel full graphic LCD display with backlight.
- K. The industrially-hardened Controller shall withstand Vibration of 3 g, 3 axis, frequency swept 10-1000 Hz, in an operating temperature Range of 4. to 176.F (-20. to 80.C) and an operating humidity range of 0-95% Non-Condensing.

## PART 3 EXECUTION

### 3.1 MANUFACTURER'S SERVICES

- A. The manufacturer shall furnish the services of a competent factory representative to do the following:
  1. Inspect the system prior to delivery, supervise the start up and testing of the system, and certify the system has been properly furnished and is ready for operation.
  2. Instruct the owner's operating personnel in the proper operation and maintenance of the system for a period of not less than one half day.

### 3.2 TOOLS AND SPARE PARTS

- A. The manufacturer shall furnish the following with each Portable Trash Pump System:
  1. A recommended list of spare parts.
  2. An Operations and Maintenance manual.

### 3.3

#### WARRANTY

- A. The manufacturer shall furnish the following to the owner:
1. A copy of the engine manufacturer's parts and labor warranty.
  2. A One year Warranty issued by the manufacturer on the Portable Pumps. This warranty must cover all pump parts, including the mechanical seal.

**END OF SECTION**

# **ELECTRICAL**



## SECTION 26 0500 – GENERAL ELECTRICAL PROVISIONS

### PART 1 - GENERAL

#### 1.1 SCOPE OF WORK

- A. Division 26 shall include all labor, materials, tools, equipment and services necessary for and/or reasonably incidental to the furnishing and installation of electrical work as shown on the contract documents and specified herein, for a complete and operable installation.
- B. The documents encompassed by these specifications and the attached drawings outline the work and/or materials required to furnish, install, alter, and/or expand the electrical system to provide a complete, finished and operational project. This shall include all associated cutting, patching, excavation, backfill, compaction, concrete bases, manholes, supports, auxiliary steel, inserts, anchors, chases, sleeves, etc., required to accomplish all portions of this Work, without relying upon other trades, or the work described in other divisions of the specifications, unless it is specifically stated in Division 26 or on the Electrical Drawings, that an item will be provided by another trade. Wherever the word "provide" is used, it shall be understood to mean: furnish and install complete and ready for proper use.
- C. This division of work includes, but is not limited to, the following major areas of electrical work:
  - 1. Replace existing pump station electrical feed from utility riser pole.
  - 2. Install the new MTS at the new control panel.
  - 3. Disconnect/reconnect 240/120V service for pump station control panel, including manual transfer switch and main breaker.
  - 4. Replace the pump station control panel.
  - 5. Furnish terminals, breakers and interconnecting wiring within new pump station control panel.
  - 6. Furnish and install any new wiring and conduit for the new Raw Sewage Pumps #1 and #2.
  - 7. Furnish and install expansion joint for conduit at new W. Maple St. Pump Station 'B' control panel from utility pole.
  - 8. Replace the existing submersible level sensors with new submersible level sensors.
- D. Work By Others:
  - 1. There is an existing electric service at each pump station. This underground electric service will be utilized from the same source. Toledo Edison will re-use meter and connect/reconnect service at the utility riser pole for Pump Station 'B' and 'C'.
  - 2. Hydromatic Pumps shall provide the pump motors and associated control panel. The E.C. shall install and provide any associated conduit, wire and disconnects for connection of these pumps and all associated peripheral devices, including making electrical connections.
  - 3. The E.C. shall install the new pump station control panel in a new NEMA 4X enclosure, with integral main service disconnect switch.
  - 4. The E.C. shall install and connect a new MTS in the new pump station control panel enclosure.
  - 5. The E.C. shall install and connect a new generator disconnect switch in the new pump station control panel enclosure.
  - 6. The Bergren Associates, Inc. shall install and provide SCADA communications equipment and programming for communications between the pump station and the customer's SCADA system.



7. All electrical work associated with temperature control systems, devices, and panels, shall be provided under division 26, unless specifically noted otherwise.
8. Any field painting of electrical equipment, conduit, boxes, supports, etc., other than touch-up work to repair factory finishes, will be provided by others (as specified elsewhere in these specifications).

## 1.2 DRAWINGS

- A. The accompanying drawings are complementary to the specifications. Work indicated by either, shall be considered as being required by both. No apparent omission from the Drawings shall relieve the Contractor from providing equipment, materials, or services described by the electrical specifications or drawings.
- B. Electrical contractor shall review Architectural, Structural and Mechanical Plans, etc., and shall adjust his work to conform to all conditions indicated thereon. Discrepancies shown on different plans, in specifications or field conditions, shall be promptly brought to the attention of the Engineer for a resolution.
- C. The Drawings may be superseded by later revised drawings or specification addenda and the Contractor shall conform to all reasonable changes without extra cost to the Owner. All items not specifically mentioned in the specifications or noted on the drawings but which are obviously necessary to make a complete working installation, shall be included.
- D. The electrical drawings are schematic in nature. The exact location of conduits, boxes, devices, fixtures, etc., (not referenced by dimension), shall be determined in the field considering interferences, structural conditions, appearance, and the work of other trades. Minor changes in the location of electrical items, from that shown on the drawings, shall not constitute a reason for additional compensation. Contractor shall field verify dimensions indicated by scaling the plans, since actual distances, locations and elevations will be governed by actual field conditions.

## 1.3 RELATED DOCUMENTS AND REFERENCES

- A. The Instruction to Bidders, General Conditions, Special Conditions, Addenda, Alternates, these Technical Specifications and the Drawings together with the Contract and Proposal Form comprise the Contract Documents for the Electrical Contract.
- B. Bidder shall refer to applicable portions of Division 1 - General and the drawings for Plumbing and HVAC items as many of the general requirements stated therein apply to or will affect the Electrical work and coordination between the trades is required.
- C. The term Engineer as used herein refers to the design team on the project.

## 1.4 REFERENCED CODES AND STANDARDS

- A. Perform all work in accordance with the latest edition of the National Electrical Code as issued by the National Fire Protection Association International, National Electrical Safety Code, Life Safety Code, State of Ohio Building Codes, and any local codes or ordinances.
- B. All work, materials and apparatus shall conform to the rules and regulations of the National Board of Fire Underwriters, to the Codes and Standards of the various National Engineering Societies applicable to the work in question, and to the following:

ACIL	American Council of Independent Laboratories
ANSI	American National Standards Institute
ASTM	American Society for Testing & Materials
AWS	American Welding Society
FM	Factory Mutual
IEEE	Institute of Electrical and Electronic Engineers
IES	Illuminating Engineering Society
NEMA	National Electrical Manufacturers Association
OSHA	Occupational Safety and Health Administration
UL	Underwriters Laboratories, Inc.
NEC	National Electric Code
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
	State Codes
	Local Codes

- C. The above standards are minimum requirements. When plans and/or specifications call for higher standards, the plans and/or specifications shall govern.
- D. All materials shall be installed using tools, methods, means, supports, etc., as may be recommended by the material manufacturer, even if more stringent than the governing codes or regulations specified by the NEC and the State Building Code.
- E. All new electrical equipment shall have Arc Flash labels to meet OSHA requirements.
- F. Materials and equipment for which there are Underwriters' Laboratories Standards requirements, shall have listing of Underwriters' Laboratories and be so labeled and installed per the manufacturers' recommendations.

#### 1.5 PERMITS AND FEES

- A. The Contractor will submit the electrical plans for approval and obtain the State Electrical Permit.
- B. The Contractor shall secure and pay for all plan approvals and permits, pay all associated fees and shall, after completion of the work, secure at his expense a certificate of final inspection and approval from the inspection authorities and fire marshall that have such jurisdiction.
- C. Engineer will provide three (3) sets of professional engineer sealed plans and specifications for use in obtaining plan approvals.

#### 1.6 QUALITY ASSURANCE

- A. All material manufacturers shall be firms regularly engaged in the manufacture of products for electrical work of the sizes, types and ratings as specified, and whose products have been in satisfactory use in similar service for not less than three (3) years.
- B. Contractors shall have at least three (3) years of successful installation experience on electrical projects similar to that required for this work. Upon request of the Engineer, such experience shall be outlined and documented in writing, including project names, locations, contract amounts, reference persons and phone numbers. If requested, these shall be submitted prior to award of contract.

## 1.7 SUBMITTALS

- A. The Contractor shall maintain such insurance as outlined in the General Conditions of the Contract, and shall submit evidence thereof prior to the execution of a contract with the owner.
- B. The Contractor shall submit all proposed sub-contractors to the Engineer within 10 days of the contract award. The award of Sub-Contracts shall be subject to approval and acceptance of the Subcontractor by the Owner and the Engineer.
- C. Within 10 days of the contract award, the contractor shall submit the name of the proposed project foreman, along with a brief description of his qualifications, experience, and prior work with this contractor. The selection of the foreman is subject to the approval and acceptance of the Owner and Engineer.
- D. Approval Drawings
  - 1. Approval Drawings are required for all materials enumerated in paragraph 5 below, and for any custom built and/or special purpose equipment.
  - 2. Prior to releasing any order for material for this project, this Contractor shall submit to the Engineer a PDF electronic set of approval drawings with each item clearly and completely identified and itemized on the transmittal sheet. Submittals shall be made sufficiently in advance of the required order release date, to allow the Engineer ample time to review such information. Multiple components intended to function together, shall be coordinated and submitted together.
  - 3. The Contractor shall review all shop drawings and forward to Engineer only when and if they meet his approval. All drawings submitted shall bear the approval stamp (or equivalent) of the contractor as evidence that the drawings have been checked by him and that the information submitted represents the actual material item or equipment that will be provided.
  - 4. Manufacturer's catalog cuts are acceptable for standard cataloged equipment where such cuts indicate all necessary data. Where any page lists multiple items, these pages shall be clearly noted or highlighted to indicate the item submitted for this project.
  - 5. Approval drawings are required for the following items, if they are used by the project:
    - a. Service Entrance Switchboard
    - b. Lighting Fixtures
    - c. PLC Control System Hardware
    - d. Safety Switches
    - e. PLC Control System Software
    - f. Handholes
    - g. Control System Primary Devices
    - h. Capacitors
    - i. Radio Telemetry System & Accessories
    - j. Electric Heat
    - k. Telephone/Data Cabling & Outlets
    - l. Timers
    - m. Communications Cabling
    - n. Lighting Controls
    - o. Automatic Transfer Switches
    - p. Motor Starters
    - q. Standby Power Equipment & Accessories
    - r. Primary Cables
    - s. Panelboards
    - t. Dry Transformers
    - u. Distribution Switchboards
    - v. Busways
    - w. UPS Equipment

- x. Surge Suppressors
  - y. Motor Control Centers
  - z. Padmounted Transformers
  - aa. Variable Frequency Drives
  - bb. Specialty Materials such as Fireproofing Materials
6. Additional information necessary to insure thorough or detailed approval and provide necessary information for installation may be requested and when requested shall be furnished promptly to avoid unnecessary delay in completing the approval or delaying the construction.
7. Review of manufacturers' approval drawings or schedules by the Engineer shall not relieve the contractor from responsibility for errors or omissions in manufacturers' drawings or schedules and deviations from the drawings and specifications. The Engineer shall not be responsible for material quantities, where referenced on the approval drawings.
8. Approval drawings for each item submitted shall be complete including physical dimensions, weight, color and shall list all electrical ratings, voltages, amperage, and construction details adequate to review installation methods, rough-in dimensions, type of rough in box, etc. Drawings shall also indicate all technical information, operating characteristics and capacities appropriate to the item, such as kVA, temperature rise, control devices, wiring diagrams, ballast data, lamps recommended, CU tables for fixtures, etc.
9. Items furnished by others: The Contractor will be provided complete manufacturers detailed shop drawings, wiring and connection diagrams, for all equipment to which his work connects. It shall be this Contractor's responsibility to request such drawings in advance of the time they are needed. Work that must be altered because of the Contractor's failure to request and obtain such shop drawings, shall be corrected without additional cost to the owner.

E. Record Drawings

- 1. Contractor shall keep in the field, and open to inspection, an accurate and current record of all deviations from Contract Drawings and Specifications. He shall neatly and correctly enter in colored marker any deviations on drawings affected. An extra set of drawings will be furnished for this purpose.
- 2. On completion of the work, the record drawings shall indicate actual routing of conduit (i.e. above ceiling, in slab), location of outlets, circuit numbering for all lighting, power and receptacle circuits. Underground feeders and ductbanks shall be located by dimension to assist in future excavations. Before final approval, contractor shall certify to the accuracy of each sheet by signature thereon and deliver same to Engineer.
- 3. At completion of the project, the Record Drawings will be delivered to the Owner by the Engineer along with the final Instruction Manuals.
- 4. All final operating and instruction manuals, record drawings, etc., shall be completed and turned over to the Engineer prior to request for final payment.

F. Instruction Manual: Bind the written operating instructions, shop drawings, equipment catalog cuts and manufacturer's maintenance instructions into a hard-backed binder, so that they can be accommodated into 8 1/2" X 11" size. Provide written instructions for each system requiring operator intervention under normal and design conditions. Submit one copy to the Engineer for approval. Upon approval, submit three (3) copies to the Engineer for delivery to the Owner. Materials shall be assembled as follows:

- 1. Title Page--Title of Job, Owner, Address, Date of Submittal, Name of Contractor and Name of Engineer.
- 2. Index of all sections
- 3. A section listing items requiring periodic service for proper operation, and either state the service needed or refer to the manufacturer's data in the binder that describes the proper service.

4. A section of all project shop drawings, complete with a section index.
5. A section of all material manufacturer's operating instructions, complete with a section index.
6. A list of all material (other than basic materials) and material suppliers used on the job, Contractor's purchase order numbers, supplier's name and address, for future use by the owner's maintenance personnel.

#### 1.8 VISITING THE SITE

- A. Contractor shall examine the site and compare it with the drawings and specifications, and shall satisfy himself as to all conditions under which the work is to be performed. Failure to do so shall be deemed as acceptance of existing conditions. The contractor shall ascertain and check the location of any existing structures or equipment which may affect this work.
- B. It shall be the responsibility of this Contractor to refer to any discrepancies upon examination of site and drawings to the Engineer before bid due date. No allowances shall be made on his behalf for any extra expense to which he may put due to failure or neglect on his part to make such examination.

#### 1.9 GUARANTEE

- A. This Contract shall guarantee his workmanship and materials (incandescent and quartz lamps excepted), for a period of one year from the date of final acceptance and leave his work in perfect order at completion. Should defects develop within the guarantee period, this Contractor shall, upon notice of same, remedy the defects and have all damages to other work or furnishings caused by the defects or the work of correcting same repaired and/or replaced at his expense, to the condition before such damage. The date of final acceptance is defined as the date of signature of the Engineer on the final payment of this Contract, unless otherwise defined in the General or Special Conditions.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Unless specified otherwise, all materials shall be new and of the best quality and, if applicable, materials shall bear certification of quality. If requested, Contractor shall furnish satisfactory evidence as to the kind and quality of materials.
- B. Provide all basic electrical materials including conduit, raceways, fittings, conductors, cabling, trays, boxes, supports, devices, connections, cover plates, grounding, controls, labeling, etc., whether or not specifically shown, specified or noted, as may be required for a complete and operable installation.
- C. All equipment and materials supplied shall contain no asbestos materials.

#### 2.2 STANDARDS AND SUBSTITUTIONS

- A. Those articles, devices, materials, forms of construction, fixtures, etc., named in the specifications to denote the kind and quality required, whether or not the words "or equal" are used, shall be known as "Standards" and all proposals shall be based on same. Where two or more "Standards" are named together, the successful bidder may furnish any one of the "Standards" named, but

Contractors shall make their selections known to Engineer within 10 days following award of their contract.

- B. Note that "substitutions" are not permitted except under the strict guidelines of the General Conditions. In no case will a "substitution" affect determining of the lowest bid.
- C. Approval of "substitutions" prior to the bid date, will be considered only if a request is submitted in accordance with the General Conditions, at least twenty-one (21) working days prior to the bid date, complete with appropriate specifications, drawings, performance data, electrical ratings, capacities & capabilities, samples and other information which may be required to assist the Engineer and Owner, in determining whether or not the proposed substitution is acceptable. Approval of such requests for substitutions of materials or methods other than that specified, will be contingent upon submission of proof, satisfactory to the Engineer and Owner, that:
  - 1. The proposed substitute is equal or superior in quality, serviceability and availability, to the specified item;
  - 2. The use of the substitute will not involve changes in construction details, design, or artistic effect;
  - 3. The warranty provided for the substitute, will be the same as would be provided for the specified item.
- D. Should a Contractor desire to furnish materials, systems or construction methods which are not specified, he may propose such items by submitting a "Voluntary Alternate" proposal, attached to the form of proposal. Such voluntary alternates shall include a clear and accurate description of the proposed items including quantities involved; an outline of other items, including the work of other trades, which may be affected by the alternate items; and a firm cost proposal which would be ADDED to or DEDUCTED from the base bid proposal. If the voluntary alternate is considered, the Contractor shall submit, upon request of the Engineer, all other such technical support data, similar to that referenced above for "substitutions", to provide the Engineer and Owner information upon which to base their decision.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. All work shall be done by mechanics skilled in the particular trade involved and shall be of the best quality, shall be done in a neat, workmanlike manner, up to present standards and practices.
- B. Installation shall be so made that its several component parts will function together as a workable system. It shall be complete with all accessories necessary for its operation and shall be left with all equipment properly adjusted and in working order.
- C. Work shall be executed in conformity with best practice and so as to contribute to efficiency of operation, minimum maintenance, accessibility and sightlines.
- D. All installations shall provide for efficiency of operation, ease of maintenance, efficient utilization of space, and good construction practice, in concert with all other trades and contractors. Special care shall be exercised to insure that proper equipment maintenance and normal component replacements may be accomplished after final project completion without removal of excessive unrelated items of equipment, raceways, boxes, etc.
- E. The Contractor shall have in charge of work at all times during construction a competent foreman or superintendent, experienced in the work to be installed under this division of the work and with

previous experience as a foreman for successful Contractor. Note that selection of the foreman shall be subject to the approval of the Engineer and Owner.

- F. Immediately correct all work which is found unacceptable by the Engineer. Work shall be unacceptable where it is not in conformance with the Drawings, Specifications or normal standards of good workmanship.
- G. The Contractor shall furnish and install raceway and wiring for all equipment that is supplied by others and requires electrical connection

### 3.2 COORDINATION

- A. This Contractor shall review the drawings and specifications of other trades involved in the project, and shall examine the work of such, to which his work must connect, attach, align, or otherwise coordinate. This Contractor shall, in no case, connect to, attach to, cover up, or finish work adjacent to defective or improper work, but shall notify the appropriate other contractor and the Engineer, upon such circumstance.
- B. The Contractor must be prepared to enter upon his work promptly and shall layout and conduct his work at all times so as not to interfere unnecessarily with the operations of the Owner or other contractors. He shall work in harmony with such other contractors and the Owner to the best interests of the job as a whole. Provide adequate and timely input to the contractor preparing "coordination drawings" where specified elsewhere. All conflicts shall be resolved in the best interest of the Owner and the successful completion of the project.
- C. Contractor shall lay out his work and be responsible for correct locations, elevations, and dimensions of all work executed under this contract. He shall exercise proper precautions to verify figures shown on drawings before laying out the work and shall be held responsible for any error resulting from his failure to exercise such precaution.
- D. No pleas as to acts, orders, directions or supervision of the Engineer or Owner shall be admitted as justification of any error or departure from the terms of the Contract, unless such order or directions are explicitly given in writing.
- E. If motors or equipment furnished by others, require more or larger starters, more or larger branch circuits, additional disconnects, etc., the contractor furnishing such motors or equipment shall reimburse the Electrical Contractor for the cost differential he incurs. It is the responsibility of each contractor furnishing motors, to advise the Electrical Contractor of the exact function of the systems to assure proper operation of the system.

### 3.3 SCHEDULING

- A. Contractor shall take special note of the construction phasing and time constraints in other portions of these specifications. It is necessary that the Electrical Contractor cooperate closely with the Engineer, Owner and General Contractor as to the areas of work and coordination of the various trades, etc. It shall be the responsibility of this Contractor to carefully plan his delivery and work schedule to coincide with operation and schedule of the other Contractors.
- B. Electrical Contractor shall work closely with the General Contractor and submit a Construction Schedule to coordinate with the General Contractors Schedule prior to actual start of construction and shall outline specifically those items whose delivery or installation may cause schedule difficulties.



- C. Exposed raceways and boxes installed after the room has been painted, shall be painted to match the room finish.

### 3.4 CLEANING AND FINISHING

- A. After all tests have been completed and approved by the Engineer and Owner, this Contractor shall clean all fixtures and equipment leaving everything in working order at completion of the work.
- B. All tags, stickers, markings, etc., shall be removed from fixtures, conduit and equipment. All operating instructions, connections diagrams, etc., furnished with equipment shall be turned over to the Engineer as part of the Operating Instruction Brochure.
- C. Finally, all debris created by execution of electrical work shall be removed by this Contractor in a timely manner.

### 3.5 IDENTIFICATION

- A. Provide engraved nameplates on all new equipment provided under this contract, as follows:
  - 1. Transformers
  - 2. Control Panels
  - 3. Motor Control Centers
  - 4. Panelboards
  - 5. Switchboards
  - 6. Backboards
  - 7. Motor Starters
  - 8. Large Junction Boxes
  - 9. Safety Switches
  - 10. Terminal Cabinets
  - 11. Control System Cabinets
  - 12. Transfer Switches
  - 13. Metering Devices
  - 14. Control System Primary Elements
  - 15. Variable Frequency Drives
- B. Lettering shall include name of equipment, the specific unit number and any reference to on-off or other instructions that are applicable.
- C. Nameplates shall be laminated phenolic with a white surface and black core. Items related with or fed via emergency power shall be red with white core. Use 1/16" thick material for plates up to 2" X 4". For larger sizes use 1/8" thick material.
- D. Lettering shall be condensed gothic. The space between lines shall be equal to the width of the letters. Use 1/4" minimum height letters which occupy four to the inch. Increase letter size to 1/2" on largest plates.
- E. Nameplates shall be securely fastened to equipment with screws or rivets except as specifically directed otherwise by the Engineer.
- F. Nameplates shall be provided on each branch feeder unit in distribution panels, switchboards and motor control centers.

- G. Both ends of each cable or grouping of wires shall be permanently marked with the same cable number.
- H. Each conductor shall be permanently marked with terminal number to which connected.

### 3.6 FIELD TESTING

- A. Contractor shall conduct such tests and adjustments of equipment as required by Engineer or necessary to verify performance requirements. Submit data taken during such tests to Engineer. Contractor shall pay all professional testing firm fees involved in required testing of equipment. Tests shall include the operation of all lights and equipment, and grounding and insulation resistance measurements on all major power feeders and not more than ten (10) other representative circuits and any others for which a technical reason exists for such testing.
- B. Electrical Contractor shall provide necessary electrical personnel and testing instruments as required or desired by the Engineer to insure proper performance or load balance, etc.
- C. Load Balancing: This Contractor shall furnish personnel and equipment and insure that building power, lighting, motor and appliance loads are balanced between phases of service entrances, distribution feeders and/or transformers to within ten (10) per cent under maximum load conditions. Special care shall be taken during load balance to assure that reverse rotation of motors is not caused.
- D. Phasing/Rotation: All panels, switches, switchgear, motor control, etc., shall be checked and verified in the presence of the engineer for "ABC" - "CLOCKWISE" rotation in accordance with NEMA Standards and Recommendations. This includes all existing panels and switchgear being re-fed. Exercise caution that reconnections of panel feeders, etc., does not cause any motor phase rotation reversal.
- E. At the completion of the project, Contractor shall verify complete Ground/Neutral separation except at the main service bonding jumper and shall clear and correct all other grounded neutrals within his scope of work.
- F. Systems: All alarm and signaling systems, such as Telemetry System, Programmable Controller System, etc., shall be checked out and tested by a qualified field representative of the equipment vendor. A report shall be submitted to Engineer by Vendor representative indicating results of such final checkout and tests. Final payment will not be approved until such report is submitted.

### 3.7 EQUIPMENT AND SYSTEM DEMONSTRATIONS

- A. All special purpose equipment and alarm and signaling systems, such as Standby Power Systems, Telemetry Systems, Programmable Controller System, Automatic Power Factor Control System Exterior Lighting Control, U.P.S., Security System, etc., shall be demonstrated in the presence of the Owner and Engineer including operation of random devices, components and wiring, to verify proper operation of the finished installation.
- B. System demonstrations shall be scheduled ONLY after all devices, components, etc., have been fully tested and system is in final operating condition.

3.8 ORIENTATION AND TRAINING

- A. Provide a minimum of 4 hours total instruction to personnel selected by the Owner. Schedule instructions with at least two weeks advance notice. Instructions shall include the following.
  - 1. Show location of items of equipment and explain what they do.
  - 2. Refer to operating instruction manual for record and clarity.
  - 3. Coordinate written and verbal instructions so that each is understood by personnel.
- B. Provide a receipt, signed by Owners Personnel that the instructions were conducted.
- C. Personnel instructions shall NOT be combined in any way with equipment start up, testing, debugging or system demonstrations.
- D. Electrical items anticipated to be covered by these instructions, include, but are not necessarily limited to, the following:
  - 1. Power System Connection and Operation
  - 2. Service and Panelboards
  - 3. Contactors and Control Functions
  - 4. Uninterruptible Power System
  - 5. Automatic Power Factor Correction
  - 6. Communication, Signal & Alarm Systems
  - 7. Electric Heating System
  - 8. Security System
  - 9. Electrical Control Systems
- E. See 266000 Series specification sections for separate and additional instructions for control panels, instrumentation, control wiring, and programmable controller and telemetry systems when required.

END OF SECTION 26 0500

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## SECTION 26 0501 – RELATED WORK

### PART 1 - GENERAL

#### 1.1 SCOPE OF WORK

- A. Provide work associated with the electrical installation, which is closely associated therewith, and required for a complete and operational installation. Such work may be non-electrical in nature, but shall be provided by this contractor, in order to assure coordination and installation responsibility by this contractor. Such work shall include cutting and patching, excavation and backfilling, concrete work, and other items as may be described on the plans.
- B. Where final interior or exterior finishes of this related work, is to remain exposed, such finishes shall be provided via workers or subcontractors specifically trained in the work to be performed, all at the expense of this contractor.

#### 1.2 RELATED DOCUMENTS

- A. Refer to Section 26 0500 for general requirements for the electrical work.

### PART 2 - PRODUCTS

#### 2.1 SEALANTS AND FIRE PROOFING MATERIALS

- A. Sealant material shall be Dow Corning RTV Silicone Foam, UL Listed and tested for fire penetration sealing, or equal by Nelson and Burndy.
- B. Areas around conduits or sleeves shall be filled with a dielectric, non-hardening putty such as I.P.C. Type #FSP1000 or expanding caulk materials such as Silicone R.T.V. Foam or I.P.C. #FS900.
- C. Large openings in floors or masonry walls may be sealed using light weight, low density expanding mortar similar and equal to I.P.C. Type "K.B.S. Mortar-Seal".
- D. Large openings around bus ducts or cable trays where passing thru fire rated wall shall be sealed using fire seal bags stuffed into the opening. Bags shall be coated fiberglass, conformable and shall be easily removable and re-usable for retrofit applications. Bag seals shall be I.P.C. "K.B.S. - Sealbags" or equal.
- E. All fire and smoke penetration seals shall be properly closed using U.L. Listed Products to match the penetration firestop system designation and all fire and smoke stop materials shall be free of asbestos, dangerous solvents, non-halogenated and shall not produce toxic fumes or smoke during exposure to fire. Fire stop shall be designed and installed to provide a minimum 2 hour rating.

### PART 3 - EXECUTION

#### 3.1 SLEEVES, INSERTS AND OPENINGS

- A. Contractor shall lay out and install his work in advance of constructing floors and walls. He shall furnish and install all sleeves and openings through floors and walls required for passage of all conduits, pipes or ducts installed by him. Sleeves shall be heavy gauge galvanized sheet steel, supported and packed to prevent ingress of concrete. All necessary cutting and patching to correct improperly installed material shall be done at this Contractor's expense. No horizontal chases will be allowed. Provide all necessary inserts for support of electrical equipment.
- B. All conduits, sleeves, outlet boxes, fittings, etc., shall be properly closed with fireproof materials and patched where passing through walls, floors or ceilings in accordance with the NEC for prevention of fire spread.
- C. Where conduits, cable tray, ducts, etc., pass thru solid walls, floors or ceilings the opening around said penetration shall be sealed against moisture and fire penetration.
- D. Pipe or duct penetrations through all floors, fire walls, or rated ceilings shall be sealed by this contractor to prevent spread of fire and smoke and ingress of moisture.

#### 3.2 CUTTING AND PATCHING

- A. Contractor shall work in advance of work of others wherever possible, eliminating all cutting and patching. Where such procedure is impossible, cutting and patching shall be done in a neat manner by various mechanics skilled in various trades involved, to the satisfaction of the Engineer. No excessive cutting will be permitted, and no structural members shall be cut without consent of the Engineer.
- B. Contractor shall do his own cutting and patching as required to properly complete his own work. All floors, walls, ceilings, etc., shall be left in an acceptable condition. Final finishes will be by General Contractor.
- C. Holes of excessive size caused by this Contractor will be repaired at this Contractor's expense, as directed by the Engineer and in accordance with other applicable portions of this specification.
- D. Where underfloor raceway is indicated in existing areas, this contractor shall cut existing concrete floor to proper depth to install the new metal raceway and shall patch the concrete at the new raceway. Final floor finish to be by General Contractor.
- E. Penetration of metal roof deck is not permitted for hangers, supports, clamps, fasteners, etc.

#### 3.3 HOUSEKEEPING PADS

- A. All floor mounted electrical equipment shall be mounted on 4" high poured concrete housekeeping pads.
- B. Pads shall be complete with chamfered or rounded corners and shall provide a smooth level surface for the equipment.
- C. All concrete housekeeping pads shall be "sealed" before equipment is set in place.

### 3.4 DEMOLITION

- A. All conduit, wiring, switches, electrical equipment, panels, etc., no longer remaining in service in the renovated areas shall be removed. Existing conduit in good condition may be reused where practicable. No wiring, conductors, conduit or equipment removed from the present installation shall be reused without the express consent of the Engineer, except as specifically noted on the drawings.
- B. All abandoned conduit shall be removed where accessible and shall be properly cut off where concealed. All wiring shall be removed where no longer remaining in service.
- C. Existing lighting fixtures no longer remaining in service shall be removed and stored on the site as directed by the Owner.

### 3.5 SALVAGE

- A. All salvageable material, in the opinion of the Engineer, shall remain in the property of the Owner and shall be stockpiled on the site as directed.
- B. All old cabinets, boxes, conduit, wiring, conductors, poles, etc., shall become the property of the Contractor and shall be removed from the site immediately.
- C. All equipment installed shall be new unless specifically noted otherwise. No wiring or equipment shall be reused without the consent of the Engineer except as specifically noted.

END OF SECTION 26 0501



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## SECTION 26 0502 – ELECTRICAL SITE WORK

### PART 1 - GENERAL

#### 1.1 SCOPE OF WORK

- A. Furnish and install the exterior underground cables, conduit, pull boxes, handholes, etc., as shown on the plans to accommodate the utility company services and exterior components as indicated.

#### 1.2 RELATED DOCUMENTS

- A. Comply with any applicable Division 31 specifications pertaining to excavation, backfill and other site related work.
- B. See Section 26 0514 for conduit requirements.

#### 1.3 COORDINATION

- A. Underground Utilities Notification: Per Section 153.64 of the Ohio Revised Code to provide procedures for identification of underground facilities:
  - 1. Each Contractor(s) to whom a contract for a public improvement is awarded shall, at least two (2) working days, excluding Saturdays, Sundays and legal holidays, prior to commencing work cause notice to be given to the utilities, in writing, by telephone or in person.
  - 2. Each Contractor shall alert immediately the occupants of nearby premises as to any emergency that he may create or discover on or near such premises of the underground facility any break or leak on its lines or any dent, gouge, groove or other damage.
- B. Prior to digging or drilling, Contractor shall contact the Ohio Utility Protection Service (800-362-2764) to have known public utilities located and marked to avoid damage to existing underground utilities.

#### 1.4 UNDERGROUND WARNING

- A. Underground warning tape shall be bright yellow or orange, 6 inches wide, with imprinted lettering "Caution--Buried Electric Line Below" (or "Buried Telephone"). Tape shall be laid continuously through the length of the trench. Warning tape shall be Allen "AMT" or equal.

#### 1.5 HANDHOLES AND JUNCTION BOXES

- A. Handholes shall be of non-metallic construction, mounted flush with grade, complete with heavy duty, gasketed covers, stainless steel bolts and descriptive wording molded into the cover. Pull box covers and box ring shall be polymer concrete. Body may be polymer concrete or fiberglass. Small handholes for individual lighting circuits shall be nominal 12 inches by 12 inches by 12 inches with closed bottom. Larger handholes for feeders or conduits 2 inch

diameter and larger, shall be comprised of multiple stacking type boxes. Larger handholes shall be nominal 18 inches by 30 inches by 24 inches deep with open bottom for natural drainage.

- B. Handholes shall be rated for ANSI Tier 15 loads unless otherwise indicated on the drawings.
- C. Handholes shall be Quazite "PG" Series, HighLine Products "PHA" Series, Highline Products: CHA or equal sized as indicated on the plans, described above or as required by the NEC per Article 370.

## PART 2 - EXECUTION

### 2.1 INSTALLATION

- A. All new underground conduit or cable runs outside the foundation walls, including telephone, electrical, lighting circuits, etc., shall be protected via plastic warning tape located 12 inches below grade and directly above the buried utility line.
- B. Provide new handholes where indicated or required to intercept and extend existing underground circuits, or to make splices in wiring. Handholes shall be set flush with grade, atop a 6 inch thick compacted, crushed stone base extending 3 inches beyond the handhole length and width.

### 2.2 EXCAVATION

- A. Trenches shall be opened in straight lines and bottomed out at least 4 inches below conduits or ducts. Minimum depth of 30 inches shall be maintained between top of cable, conduit, duct or concrete envelope, and finished grade.
- B. Contractor shall cut any interfering trees, remove all stumps, rocks, etc., in the line of excavation. Any shrubbery in line of excavation shall be removed with a ball of dirt and replaced at completion of excavation. Approval of the Engineer shall be obtained before any tree is removed.
- C. Where excavation crosses existing lawns, Contractor shall remove sod, properly store and replace sod at completion of excavation. Care shall be exercised during the work to see that no unnecessary damage is done to lawns in the storing of dirt or other construction material. Should unnecessary damage occur, in the opinion of the Engineer, the Contractor shall be required to repair lawns at his own expense.
- D. Where existing sidewalks, drives, and roadways must be cut, they shall be cut in straight lines, shall present a neat appearance when re-laid and shall match existing work.

### 2.3 BACKFILL

- A. Trenches shall be backfilled to a point 6 inches below grade. Fill material shall be clean earth free of rocks, sticks, etc., bank run gravel, clean sand, or other approved granular material.
- B. Fill shall be placed in 6 inch layers and compacted to 90 percent maximum density. Final 6 inches of fill in lawn or planting areas, shall be top soil free of vegetation, rocks, sticks or other unsuitable material. Top soil shall be compacted with a suitable roller or power tamper. Top

soil below sod shall be thoroughly worked to a depth of 6 inches mixed with commercial fertilizer. Sod shall be laid evenly, tamped and watered thoroughly.

- C. Backfill under sidewalks, roadways, drives and parking areas shall be bank run gravel or approved granular material to conform to ODOT conduit requirements. Backfill under building walls and/or footers shall be concrete of the same strength as walls or footers.

#### 2.4 EXTERIOR DUCTBANKS (Where Indicated)

- A. Selected underground raceways in larger sizes may be fibre or plastic duct (PVC) encased in a steel reinforced concrete envelope. Install multiple underground conduits in common trenches, with proper spacers, and other approved fittings including long radius bends, couplings, end bells, fibre to steel adapters, etc. Exercise special care to insure that joints or couplings in underground ducts are sealed to exclude water.
- B. Concrete envelopes shall encase raceways with not less than 3 inches of concrete, top, bottom and sides, and shall include a No. 4 continuous reinforcing bar at each corner. Underground concrete duct banks shall be dyed "RED" via sprinkling or mixing as a warning for future excavations.
- C. Where raceways pass through concrete walls below grade, set galvanized steel conduit or sleeves, 1 ½ inch larger than OD of conduit. Caulk both sides with oakum and wool, or otherwise adequately waterproof opening around conduit.
- D. Underground raceways serving only exterior lighting units may be direct burial rated non-metallic raceways without concrete encasement.

#### 2.5 DIRECT BURIAL (Where Indicated)

- A. Where direct buried cables pass under paved areas, they shall be enclosed in Schedule 80 PVC conduit. Conduit shall be minimum of next larger size than required by "NEC" 40 percent fill rule. Conduit shall extend a minimum of 5 feet beyond edge of pavement.

END OF SECTION 26 0502

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## SECTION 26 0503 – EQUIPMENT WIRING CONNECTIONS

### PART 1 - GENERAL

#### 1.1 SCOPE OF WORK

- A. Provide power wiring, connections and terminations to particular items of equipment provided by others, such as exhaust fans, air handling units, chillers, pumps, door operators, kitchen and lab appliances, etc., all as required for a complete and operating component installation. All necessary starters and controls for the indicated items will be furnished with the equipment, unless specifically noted otherwise.
- B. Provide control and instrumentation components and wiring only where specifically described herein or shown on the drawings.
- C. Terminate wiring as shown on the equipment shop drawings and instruction manual for all equipment whether contractor supplied or supplied by others.
- D. Internal and intra-panel wire (e.g. control panels) shall be furnished and installed by this contractor.

#### 1.2 RELATED DOCUMENTS

- A. Refer to Section 260500 for general requirements for the electrical work.
- B. Refer to other Division 26 sections for basic materials described herein.
- C. Refer to Section 26 6000 sections for Process Control and Monitoring Systems and Equipment included in the electrical contract.

#### 1.3 QUALITY ASSURANCE

- A. Comply with the wiring and connection requirements provided with the equipment, by the equipment supplier, or by the equipment manufacturer. In making electrical conduit and wiring connections, do not modify the equipment in such a way as to degrade the equipment, its enclosure, function or warranty.

#### 1.4 COORDINATION

- A. All rough-in, wiring, and interconnection requirements for the special equipment shall be verified with the supplier, prior to installation.

## PART 2 - PRODUCTS

### 2.1 BASIC MATERIALS

- A. Hard-wiring connections from equipment connection boxes shall be run in neoprene jacketed flexible conduit. Portable or plug in connections, and those subject to regular movement, shall be made with type SJ-600 volt rubber insulated cord and approved fittings.
- B. Provide devices, disconnects, plugs, receptacles, etc., as shown on the drawings, specified or required for a complete installation.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Provide the wiring and devices for the equipment or systems listed as required.
  - 1. Heat Tracing
    - a. Electric heat tracing, if required, will be furnished and installed by the Mechanical or General Contractor, on selected piping systems or sections, complete with insulation, controls, etc., where noted on the plans.
    - b. Electrical Contractor shall provide a local disconnect adjacent to the power wiring connection point, where shown, and provide a separate 30 milliamp, ground fault interrupting type circuit breaker for the branch circuit serving the heat tracing. Field verify exact heat tracing wattage and voltage, prior to beginning this work.
  - 2. Process Equipment Power and Controls
    - a. Provide conduit, wiring, connections, starters and disconnects as indicated, for the owner's new and relocated process equipment. Selected items shall be provided by the equipment vendor, with a preassembled and prewired control package which includes all necessary starters and controls.
    - b. All rough-in requirements, branch circuit sizes, control wiring quantities and final connection details, shall be verified in the field with the owner's process equipment vendor drawings prior to installation. Where electrical installation requirements vary substantially from that indicated on the contract documents, Contractor shall notify the Engineer immediately for field direction and resolution.
    - c. Selected process control devices (i.e. limit switches, level switches, pushbutton control stations, product measurement devices, process monitoring equipment, etc.) shall be provided by other contractors. Where these and other incidental (not equipment mounted) electrical items are furnished loose by the equipment vendor, this contractor shall mount, wire and connect these items as directed by the Owner.
  - 3. Control and Instrumentation Equipment
    - a. Provide the remote control and interlock wiring for package type control panels, as provided through other contracts or by the owner, as indicated on the plans or as specified in other portions of these specifications.



- b. Selected meters and instrumentation equipment will be furnished by the General Contractor. All interconnections and wiring shall be provided by the Electrical Contractor, as recommended by the equipment supplier and as specified in other portions of these specifications.

END OF SECTION 26 0503

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## SECTION 26 0514 – BASIC ELECTRICAL REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

##### A. Work Includes

1. It is the intention of the specification for all work that each part shall be completed as related to the other, and that there shall be no omission necessary for the operation of the system as intended, even though each and every item may not be mentioned.
2. This work shall be complete to the extent indicated and in first class mechanical and electrical condition upon completion of all contracts pertaining to the entire structure. Structure to be as shown on the Drawings.

#### 1.2 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, equipment, insurance and service necessary for the proper and entire completion of the electrical work, rough-in, and supply designated equipment as hereinafter specified and as called for on the drawings.
- B. The Electrical Contractor shall provide temporary construction power to the site and shall coordinate temporary and permanent service with the local power utility. Provide service drop pole/pedestal and all service conduit and wire required by utility standards. Mount meter base as required by utility standards where applicable.

#### 1.3 QUALITY ASSURANCE

##### A. Codes and Fees

1. Perform all work in accordance with the latest edition of the National Electric Code as issued by the National Fire Protection Association, National Electrical Safety Code, Standards of the National Bureau of Fire Underwriters, State of Ohio Building Codes and any local codes or ordinances.
2. The above standards are minimum requirements. However, when plans and/or specifications call for higher standards, the plans and/or specifications shall govern.
3. Should these specifications conflict with the rules of the above codes or regulations, the Contractor shall notify the Architect/Engineer of such before proceeding with the work so that same can be adjusted to the satisfaction of all concerned.
4. This Contractor shall obtain all necessary permits and pay fees for such. Owner shall secure State of Ohio Plan Approval.

##### B. Visiting Site and Premises

1. It will be assumed that those tendering proposals shall have made all necessary examinations of the Premises and Site shall have satisfied themselves as to the conditions under which the Contract is to be executed. No allowance will be subsequently made by the Owner due to any error or omission on the part of the Bidder in this connection.

## PART 2 - PRODUCTS

### 2.1 DRAWINGS

- A. Electrical system layouts indicated on the drawings are generally diagrammatic and locations of outlets and equipment shall be governed by structural conditions and obstructions. This is not to be construed to permit redesigning systems; all outlets shall be interconnected as shown on drawings. Locate and install equipment requiring maintenance and operation so it will be readily accessible.
- B. The right is reserved to make any reasonable change in location of outlets and equipment prior to roughing-in, without involving additional expense.
- C. The Contractor shall examine the electrical drawings in conjunction with the architectural and mechanical drawings and if any discrepancies occur between them and these specifications, he shall report them to the Architect/Engineer in writing before the bids are opened and obtain written instructions of changes in the work. If not reported before the opening of bids, rectifying the same becomes the responsibility of this Contractor. The architectural drawings shall take precedence over the electrical and mechanical drawings.

### 2.2 SHOP DRAWINGS

- A. Shop Drawings are required for electrical equipment including light fixtures, disconnects, receptacles, enclosures and switchgear. Manufacturers catalog cuts are acceptable for shop drawings. Drawings shall identify the exact item and rating to be furnished.
- B. Drawings shall be submitted to cause no delay in construction.
- C. Drawings shall bear the stamp of approval of the Contractor prior to submitting to Architect/Engineer.

### 2.3 LOCATIONS

- A. The exact location of lights, panels, switches, receptacles and other work shown on drawings are approximate and any shift in location of these items due to construction of the structure or equipment shall be done by this Contractor without any cost to the Owner, but with the approval of the Architect/Engineer. This Contractor shall check all roughing-in plans, shop drawings of mechanical work, sinks, cabinets, cases, etc., where applicable, before roughing-in.
- B. Contractor shall refer to interior elevation for mounting heights for some equipment where applicable.

## PART 3 - EXECUTION

### 3.1 CLEANING AND FINISHING

- A. After all tests have been completed and approved by the Architect/Engineer and Owner, this Contractor shall clean all fixtures and equipment leaving everything in working order at the completion of the work.

- B. All tags, stickers, markings, etc., shall be removed from fixtures, conduit and equipment. All operating instructions connection diagrams, etc., furnished with the equipment shall be turned over to the Owner. All debris created by execution of the electrical work shall be removed by the party performing said portion of this work.

### 3.2 GUARANTEE

- A. The Electrical Contractor shall guarantee that all electrical wiring equipment furnished by him and installation shall conform to State of Ohio codes, National Electric Code and NFPA Standard No. 70. All work and equipment shall be subject to the approval of the District Inspector assigned by the State Department responsible for building inspections.

END OF SECTION 26 0514

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## SECTION 26 0515 – BASIC MATERIALS AND METHODS

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

- A. All work including, but not limited to, complete installation of service disconnects, distribution panels, conduit, conduit fittings, receptacles, light switches, boxes, light fixtures, conductors, etc., as called for on the drawings or hereinafter specified.
- B. Materials and equipment for which there are Underwriters' Laboratories Standard requirements, shall have listing of Underwriters' Laboratories and be so labeled.
- C. Materials other than those listed herein shall be the size, type and capacity indicated on the Drawings and the specifications. Insofar as possible, use one type and quality.

### PART 2 - PRODUCTS

#### 2.1 WIRE AND CABLE

- A. Material shall be new copper conductors with 600 volt 75° C rated insulation and as follows:
  - 1. Conductors #8 AWG and smaller shall be stranded with THHN or THWN insulation. Minimum wire size shall be #12 unless noted or specified otherwise.
  - 2. Conductors #6 AWG and larger shall be stranded with XHHW insulation.
  - 3. Panel internal conductors shall be THHN, #16 minimum.
  - 4. Multi-conductor cables shall be used where indicated.
  - 5. Wire shall be as manufactured by Houston Wire, General Cable, Triangle, Essex, Colonial, Pirelli or Engineer approved equal.
  - 6. Instrumentation cable shall be twisted pair or triad consisting of bare stranded copper conductors (#16 minimum) with PVC insulation rated 600V, 75°C (minimum), double faced, 100% coverage, aluminum/synthetic polymer shield tape, #18 minimum tinned copper drain wire and PVC jacket. The cable shall be rated 300V for above ground installation and 600V with water resistant jacket for underground installation. The cable shall be Okonite Type P-OS or Belden Type 8719, 8618 or 9342, or engineer approved equal.
  - 7. Variable frequency drives shall be cable connected using a three (3) conductor shielded cable with grounding wire, crosslinked polyethylene insulation (XLPE) with 90°C rating, 100% foil shield tinned copper braid, drain wire and PVC jacket. Belden Type 29500 or Engineer approved equal.
  - 8. Conductors installed in underground raceways shall have type RHW, RHH, or XHHW insulation for wet locations.
- B. All wiring throughout building shall be color coded to identify phases, neutral and ground. Color code shall be in accordance with NEC and as follows unless special color coding is required by local Electrical Inspector.

CONDUCTORS	THREE PHASE 208/120V	THREE PHASE 480/277/V
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	Gray
Ground	Green	Green

## 2.2 WIRE CONNECTIONS AND DEVICES

- A. Connectors for wire sizes up to and including No. 6 AWG shall be "Scotchlock" as manufactured by Minnesota Mining and Manufacturing or Engineer approved equal.
- B. Exposed joints shall be covered with Minnesota Mining and Manufacturing Co., "Scotchfil" roll form insulation putty and "Scotch" No. 88 electrical tape or Engineer approved equal. Tape shall be 150 percent of insulation value of the conductor insulation.

## 2.3 SWITCHES, RECEPTACLES AND COVERPLATES

- A. Furnish and install all wall switches and wall receptacles where called for on the drawings. The devices shall be specification grade of the types and ratings as called for. Devices shall be as manufactured by Hubbell, Pass & Seymore, Arrow-Hart or Engineer approved equal.
- B. All devices furnished shall be of the same manufacturer except as noted. GFCI Grounded type receptacles shall be used throughout the well field. Use weatherproof covers for all receptacles.
- C. Switches shall be specification grade, quiet operating type rated at 20 amperes.
- D. Receptacles shall be specification grade, 3 wire grounded type rated at 20 amperes. Receptacles shall be mounted with "U" ground at top. GFCI receptacles shall be installed at locations required or indicated on drawings.
- E. All coverplates shall be stainless steel except outdoor weatherproof covers shall be "suitable for wet locations while in use" by Tay Mac or Engineer approved equal.

## 2.4 DISCONNECTS

- A. Furnish and install disconnect switches, fused or unfused as called for or as required by N.E.C.
- B. Switches shall be heavy duty type with quick-make, quick-break operating mechanism which shall be independent of the cover, visible blades when switch is in the open position and interlocking cover. Switches shall be suitable for use as service equipment.
- C. In general, switches shall be mounted in NEMA Type 1 enclosures. Switches exposed to the weather or other wet areas shall be mounted in NEMA 3R RAINPROOF OR NEMA 4X enclosures.
- D. Switches shall be as manufactured by General Electric, Square "D", Siemens, Cutler Hammer or Engineer approved equal.



## 2.5 FUSES

- A. Furnish and install dual-element indicator fuses in all fused switches unless otherwise indicated. Fuses shall be as manufactured by Bussman, Gould Shawmut, Littlefuse or Engineer approved equal.
- B. Fuses for motors shall be sized for the running current; fuses of other purposes shall be sized for the capacity of the conductors they protect.
- C. In general, fuse types shall be similar to the following:
  - 1. 0 to 600 Amp for 250 Volt Fustron FRN or Engineer approved equal
  - 2. 0 to 600 Amp for 600 Volt Fustron FRS or Engineer approved equal

## 2.6 LOW-VOLTAGE PANELBOARDS

- A. Furnish and install factory-finished, dead-front assemblies of individually removable circuit breakers, NEMA Standard copper busses, surface/flush mounted NEMA 1 steel cabinet, with hinged door. Panelboards shall be UL listed and shop tested in accordance with NEMA standards.
- B. 120/208 Volt, 3-Phase
  - 1. Circuit breakers shall be UL listed for minimum 10,000 Amp interrupting rating with visible trip indicator and quick make/break toggle mechanisms.
  - 2. Panelboard and breakers shall be Square D type "QO" or equal approved by Engineer.
- C. 277/480 Volt, 3-Phase
  - 1. Circuit breakers shall be UL tested for minimum 35,000 amp interrupting rating. Panelboard shall be Square D type I-LINE or Engineer approved equal.

## 2.7 GROUNDING

- A. Furnish and install grounding as required.
- B. Ground rods shall be copper clad and a minimum 3/4" diameter by 10' long as manufactured by Copperweld or Engineer approved equal.
- C. Ground connectors shall be Burndy (or Engineer approved equal) compression or bolted type where accessible and Cadweld exothermic type where inaccessible.
- D. Ground conductor shall be stranded copper #4 minimum or as required by NEC if larger.

## 2.8 CONDUIT

- A. Unless otherwise specified, all conduit shall be rigid galvanized steel conforming to UL-6 specification.
- B. All flexible steel conduit shall be liquid-tight per NEC.
- C. Minimum conduit size shall be 3/4".

- D. All PVC conduit shall be minimum schedule 40 unless otherwise indicated. Schedule 80 shall be required for all exposed applications unless otherwise indicated on the drawings. Conduit shall be high impact type with integral bells.
- E. Conduit fittings shall be designed for use with the type of conduit in use.
- F. Underground conduits installed by directional boring for short lengths up to 500' with conduit pull back shall be Carlon-Bore-Gard or Engineer approved equal.
- G. High Density Polyethylene (HDP) may be installed for long length directional bores at connection points to PVC steel and HDP to HDP mechanical watertight connectors specifically designed and recommended by the manufacturer for the application shall be installed.

## 2.9 LIGHT FIXTURES

- A. All lighting fixtures shall be of the size and type designated in the "Light Fixture Schedule" on the drawings. Flush mounted lighting fixtures shall include all mounting accessories required for complete installation in the ceiling system involved.

## 2.10 SURGE PROTECTIVE DEVICES (SPD)

- A. All panels indicated shall have SPD as manufactured by Advanced Protection Technologies, Inc. (APT), Square D, or Architect/Engineer approved equal. The TVSS shall be modular and have a rating of 160 KA/phase for L-N and N-G and provide surge suppression paths for L-N, L-L, L-G, and N-G. The enclosure shall be NEMA 1 for indoor installations and NEMA 4X for outdoor installations. The TVSS shall be APT Type TE-XGA or Engineer approved equal and shall have visual indication of reduction of surge capacity or loss of protection. The rating of the SPD shall be as required for the electrical system connection configuration and voltage.

# PART 3 - EXECUTION

## 3.1 COORDINATION

- A. This contractor shall coordinate his work with the work and equipment of others, including General, Plumbing and Heating in order to determine the height of equipment. This includes motors, fans, heating elements, duplex outlets and special outlets above base cabinets, and all other built-in equipment. Check with Architect/Engineer superintendent.

## 3.2 WIRING

- A. Identification of Conductors:
  - 1. All branch circuits shall be left tagged in the panelboards, in all gutters, and in all junction boxes where unused circuits terminate for the purpose of identifying the various circuits.
  - 2. Feeders and mains shall be tagged in the main distribution panelboard.
  - 3. The method of tagging shall be with adhesive type of marker. Tags shall be applied after wire is installed in conduit.
  - 4. Where it is impractical to use printed markers on certain wires or cables, use blank type with identification marked thereon in indelible pencil.

- B. Conductors in vertical conduit runs shall be supported with split wedge type fittings which clamp each conductor and automatically tighten under the weight of the conductors at intervals per NEC.
- C. All wiring shall be installed in conduit unless indicated or specified otherwise.
- D. Install #12 galvanized steel pull wire or 200 lb. test hand line in all empty conduits.
- E. Underground conduits or conduits carrying fiber optic cable shall have the metallic pull wire installed.
- F. Single phase loads shall be balanced throughout the system.
- G. Pull all conductors into raceway at same time.
- H. No mixing of wire/cable types shall be permitted in the same raceway.
- I. AC wire/cable raceways shall be separated from DC signal and communication cable raceways with a minimum separation of 18 inches.
- J. Use suitable wire pulling lubricant for wire and cable where necessary.
- K. Protect exposed cable from damage.
- L. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- M. Clean conductor surfaces before installing connectors.
- N. Instrumentation cables and VFD cables shall not be spliced.
- O. Make connections and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- P. Instrument cable shields shall be connected to ground at one end only, typically at the controller not at the transmitter/transducer.

### 3.3 CONNECTIONS

- A. Splices shall only be made in outlet boxes, panel gutters, junction boxes, or other boxes suitable for the purpose.

### 3.4 WIRING DEVICES

- A. This Contractor shall furnish and install all local switches, convenience receptacles, special purpose outlets, etc., as shown on the drawings, specified or required. This contractor shall furnish and install all backboxes, etc. as required.
- B. All wiring devices shall be mounted flush and at the heights herein specified or indicated on the drawings and all devices of the same type throughout the facility shall be of the same manufacturer.

- C. Outlet locations as indicated shall be considered diagrammatic and approximate only. When interferences occur the outlet shall be located so as to avoid said interference without additional cost.

### 3.5 CONVENIENCE RECEPTACLES

- A. Receptacles shall be mounted vertically, and shall be installed sixteen inches (16") above floor and properly set in block courses, unless otherwise noted.
- B. Where located at bench, counter, radiator or lavatory locations, receptacles shall be mounted six inches (6") above top of unit. Outlets located adjacent to lavatories in Toilet Rooms shall be Ground Fault interrupter type receptacles and shall be mounted 42" above floor.
- C. Where receptacles are served by an individual branch circuit, its ampacity rating shall match that of the branch circuit (i.e. 20 ampere device on a 20 ampere circuit).

### 3.6 LOCAL SWITCHES

- A. Switches, in general, shall be located at four feet (4'0") above the floor. Where more than one switch is shown at an outlet, switches shall be set under a gang plate in an order appropriate to the outlet locations.

### 3.7 GROUNDING

- A. Ground resistance of made grounds shall be tested by the contractor and shall not exceed 5 ohms. Contractor shall add additional ground rods as required to bring resistance down to required level. Ground Enhancement Material (GEM) as manufactured by ERICO Products or Engineer approved equal may be used to achieve ground resistance requirements.

### 3.8 RACEWAY

- A. Unless otherwise indicated on the plans or specifically noted herein, all raceways shall be rigid galvanized steel. All raceways shall be run concealed in finished areas and wherever practicable in unfinished spaces. Complete raceway installation before starting conductor installation.
- B. Install raceways level, square, and at proper elevations, allowing adequate headroom. Raceways shall run parallel to the building foundation construction in the area of the run. Conduit runs in or below slab may be routed as direct as possible but conduit crossings shall be kept to an absolute minimum. Large conduits, feeders, major system raceways, etc., where routed below the slab shall be routed in straight lines with proper spacing between conduits. Maintain minimum of 2 inches of concrete cover over all "in slab" conduits. Conduits larger than one inch (1") trade diameter shall not be cast within slabs or floors. Protect stub-ups from damage during construction. Use temporary closures to prevent foreign matter from entering raceway. Actual routing of raceways shall be determined by the Contractor, routings indicated on drawings are for clarity only.
- C. Keep raceways at least 6 inches away from parallel runs of flues, steam and hot water piping. Where crossing within 6 inches, install horizontal raceway runs above water and insulated steam piping.

- D. All raceways shall be sized in accordance with the latest edition of the NEC but in no case shall raceways be smaller than indicated on the plans. Contractor shall install larger raceways than indicated and pull boxes where necessary (and approved by the Engineer) due to length of continuous runs or number of bends.
- E. Conduit supports shall be in accordance with the NEC using conduit clamps approved for the use and location. Conduit clamps shall be galvanized malleable clamps with galvanized bolt. Expansion bolts shall be of the galvanized lead wedge type firmly set. One-hole, steel straps shall be used to fasten raceways on flat surfaces; two-hole straps shall be used for uneven surfaces or where raceways are mounted to auxiliary steel.
- F. No conduit shall rest on or be supported from acoustical tile ceilings or ceiling tie wires.
- G. Openings around conduits shall be sealed where entering refrigerated spaces or "air handling chambers" or where passing thru floors.
- H. Bends or offsets shall be made using standard conduit ells; field bends may be made with an approved bender for the raceway system used.
- I. Swab conduits to clean moisture, dirt, and grease before pulling conductors.
- J. Underground raceways shall be cleaned by use of properly sized mandrels and swabs.

### 3.9 SPD

- A. Where SPD is indicated on drawings, it shall be connected according to manufacturer instruction, and wire length kept as short as possible. Wire shall be sized for current rating of fuses.
- B. The Contractor shall verify the voltage and connections by measurement and with the utility proper to ordering and energizing the SPD.
- C. Contractor shall be responsible for replacement of the SPD if incorrectly rated or damaged.

END OF SECTION 26 0515

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## SECTION 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. All items in this specification may not be required. See contract drawings for applicable items.

#### 1.2 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment.
- B. Ground all conduits, cabinets, trays, motors, panels, meters, fixtures, boxes and other exposed non-current carrying metal parts of electrical equipment in accordance with all provisions of the National Electric Code (NEC). Provide the required bonding at the service entrance, and elsewhere as required by the NEC.
- C. Bond metal building structures as required to provide an effectively grounded structural frame.
- D. Work shall include necessary conductors, rods, connectors, lugs, terminals, and necessary accessories.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

#### 1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

### PART 2 - PRODUCTS

#### 2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
  2. Stranded Conductors: ASTM B 8.
- C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 4 inches 2 feet in cross section, unless otherwise indicated; with insulators.
- D. Use bare stranded copper cable for all exposed and below grade "grounding electrode" conductors. Where subject to mechanical injury, protect by encasing in non-metallic raceway.
- E. "Equipment grounding" conductors shall be building wire, copper conductors with 600 volt green insulation.

## 2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors, Pipes and Concrete Encased Electrodes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Concealed and underground connections and splices for grounding electrode conductors shall be thermally welded similar to the "Cadweld" process as manufactured by Erico Products, Inc. or Engineer approved equal by Thermoweld. All connections to steel columns, beams and other heavy gauge structural components shall also be thermally welded. Exposed connections to equipment shall be made by the use of compression clamps or bolted type connectors. Solder lugs are not permitted.
- E. Bonding bushings shall be O.Z. Type "BLG" or equal.
- F. Connections to pipes or conduits shall be made with the use of an approved grounding clamps, similar to: Burndy type "GAR", Penn Union type "GPL", O.Z. type "ABG" or "CG", Anderson type GC111, equal by T&B, or Engineer approved equal.

## 2.3 GROUNDING ELECTRODES

- A. Ground Rods "UL" listed: Copper-clad steel, 3/4 inch in diameter by 10 feet in length.

## 2.4 GROUND ENHANCEMENT MATERIAL

- A. Ground Enhancement Material (GEM) shall be permanent, maintenance free, maintain its earth resistance with time and be as manufactured by Erico Products, Inc. or Engineer approved equal.



## PART 3 - EXECUTION

### 3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2 AWG minimum or as indicated on drawings.
  - 1. Bury at least 24 inches below grade.
  - 2. Duct-Bank Grounding Conductor: Install integral with ductbank.
- C. Grounding Bus: Install in electrical and telephone/data equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
  - 1. Install bus on insulated spacers 1 inch minimum, from wall 6 inches above finished floor, unless otherwise indicated.
- D. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  - 2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
  - 3. Connections to Structural Steel: Welded connectors.

### 3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

### 3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Metal and Wood Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

### 3.4 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
  - 1. Size of grounding electrode conductors shall conform to the NEC, or larger, where noted with No. 4 as a minimum. Provide isolated ground or equipment grounding conductors, sized in accordance with NEC or larger where noted, for all branch circuits and feeders. These grounding conductors shall be installed in the raceway with the branch or feeder conductors. Equipment grounding conductors entering any box shall be bonded to that enclosure, by the use of UL listed grounding screws or lugs. If there are more than four ground wires entering a box, provide a ground assembly securely bonded to the enclosure.
  - 2. Metallic conduit system shall be electrically continuous throughout and be grounded at the service entrance equipment. All cable trays shall also be bonded and grounded to the building grounding system. Conduit connections to enclosure shall include locknuts cutting through paint on enclosures. Where reducing washers are used or where concentric or eccentric knockouts are not completely removed, bonding bushings shall be required. Conduits enclosing feeders No. 2 AWG or larger, shall be terminated with grounding type bushings.
  - 3. All cord connected appliance frames shall be grounded at the conduit system through a grounding conductor in the cord. Flexible connections to motors shall be jumpered with a green equipment grounding conductor. Provide a green bonding jumper between the outlet box and the receptacle grounding terminal on all flush mounted receptacles.
  - 4. Bond and ground all steel building structure, metal roof deck, metal siding roof equipment enclosure, and other exposed non-current carrying metal parts in accordance with all provisions of the NEC and O.B.B.C.
  - 5. The secondary neutrals of all dry type, step down transformers shall be grounded to the metal structure or nearby water line with a conductor sized per the NEC.
  - 6. All conduits and raceways, regardless of type and material, shall include a separate insulated ground conductor, whether shown on the Drawings or not, sized no less than required by the NEC and by the Drawings if larger and connected to the ground grid. Each circuit grounding shall be dedicated for that circuit.
- B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
  - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
  - 2. For grounding electrode system, install one to three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

E. Grounding for Steel Building Structure: Install a copper grounding conductor, in conduit, from building steel to building's main service equipment ground bus.

F. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70. Coordinate with General Contractor for fabrication of concrete-encased grounding electrode prior to pouring of foundations/footings.

1. Install a copper grounding conductor from building's main service equipment ground bus to exposed concrete encased electrode. Provide connectors listed for that purpose.
2. Turn up concrete encased electrode (minimum ½" in diameter and minimum 20' within and near bottom of concrete foundation), minimum 12" above finished floor near building's main service equipment. Coordinate with Generator Contractor prior to pouring of concrete slab for stub-up location.

### 3.5 SERVICE ENTRANCE AND SEPARATELY DERIVED SYSTEMS

- A. Provide a copper grounding conductor from the neutral bus at the service entrance or main disconnect enclosure to a ground electrode or grid outside the foundation wall as required by the NEC for grounding purposes.
- B. Ground rods at the building service entrance location shall be driven into undisturbed soil, at least three feet from the building foundation. Minimum of three rods shall be installed and bonded together with a grounding electrode conductor to form a grid. Ground rod spacing shall be at least 20 feet. Where rock prevents the ground rod installation, each rod may be replaced with 20 feet length of bare copper conductor, sized per NEC 250-66, laid horizontally at the deepest area of excavation outside the foundation wall adjacent to the service entrance.
- C. Extend a grounding electrode conductor to the nearest structural steel member of the building, and to the inlet side of the water meter setting or water service and provide a bonding jumper around the meter setting and all insulating unions. Connection to water pipes must be by means of a cast-bronze bus or iron ground clamp.

- D. Extend a separate ground conductor, No. 4 AWG for lengths up to 50 feet, from the ground electrode system to a grounding assembly with at least eight (8) screw terminals, mounted on the Telephone Service Entrance Backboard.
- E. Provide at least one (1) ground rod at each outdoor medium voltage pad-mounted transformer, located within the underground conductor window or with a copper grounding grid conductor extended thereto, to ground the primary cable shield, secondary neutral and transformer case.

### 3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
  - 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal. Make tests at ground rods before any conductors are connected.
    - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    - b. Perform tests by fall-of-potential method according to IEEE 81.
- B. Report measured ground resistances that exceed the following values:
  - 1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
  - 2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
  - 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
  - 4. Substations and Pad-Mounted Equipment: 5 ohms.
  - 5. Manhole Grounds: 10 ohms.
- C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.
- D. Ground resistance at the new service entrance and each new separately derived system (including dry transformers) shall be checked to insure a maximum ground resistance of 5 ohms. Provide additional rods and/or GEM material as necessary to meet the ground resistance requirement.

END OF SECTION 26 0526

## SECTION 26 0533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. All items in this specification may not be required. See contract drawings for applicable items.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Metal conduits and fittings.
  - 2. Nonmetallic conduits and fittings.
  - 3. Metal wireways and auxiliary gutters.
  - 4. Nonmetal wireways and auxiliary gutters.
  - 5. Surface raceways.
  - 6. Boxes, enclosures, and cabinets.
  - 7. Handholes and boxes for exterior underground cabling.
- B. Related Requirements:
  - 1. Section 26 0543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
  - 2. Section 27 0528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.

#### 1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. IMC: Intermediate metal conduit.
- D. EMT: Electrical metallic tubing.
- E. ENT: Electrical nonmetallic tubing.
- F. EPDM: Ethylene-propylene-diene terpolymer rubber.
- G. FMC: Flexible metal conduit.
- H. LFMC: Liquidtight flexible metal conduit.
- I. LFNC: Liquidtight flexible nonmetallic conduit.

- J. NBR: Acrylonitrile-butadiene rubber.
- K. RNC: Rigid nonmetallic conduit.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
  - 1. Structural members in paths of conduit groups with common supports.
  - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- B. Qualification Data: For professional engineer.
- C. Source quality-control reports.

#### 1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.
- C. Comply with the applicable requirements of UL standards 50, 514-series and 866 pertaining to boxes and fittings.
- D. Comply with NEMA standard publications 051, 052, and 250 pertaining to outlet and devices boxes, covers, and box supports.

### PART 2 - PRODUCTS

#### 2.1 METAL CONDUITS AND FITTINGS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. AFC Cable Systems, Inc.
  - 2. Alflec Inc.
  - 3. Allied Tube & Conduit; a Tyco International Ltd. Co.
  - 4. Anamet Electrical, Inc.; Anaconda Metal Hose.

5. Electri-Flex Co.
6. Manhattan/CDT/Cole-Flex.
7. Maverick Tube Corporation.
8. O-Z Gedney; a unit of General Signal.
9. Wheatland Tube Company.
10. Or engineer approved equal.

B. Metal Conduit:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AFC Cable Systems; a part of Atkore International.
  - b. Allied Tube & Conduit; a part of Atkore International.
  - c. Anamet Electrical, Inc.
  - d. Calconduit.
  - e. Electri-Flex Company.
  - f. FSR Inc.
  - g. Korkap.
  - h. NEC, Inc.
  - i. Opti-Com Manufacturing Network, Inc (OMNI).
  - j. O-Z/Gedney; a brand of Emerson Industrial Automation.
  - k. Patriot Aluminum Products, LLC.
  - l. Perma-Cote.
  - m. Picoma Industries, Inc.
  - n. Plasti-Bond.
  - o. Republic Conduit.
  - p. Southwire Company.
  - q. Thomas & Betts Corporation; A Member of the ABB Group.
  - r. Topaz Electric; a division of Topaz Lighting Corp.
  - s. Western Tube and Conduit Corporation.
  - t. Wheatland Tube Company.
  - u. Or engineer approved equal.
2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. GRC: Comply with ANSI C80.1 and UL 6.
4. ARC: Comply with ANSI C80.5 and UL 6A.
5. IMC: Comply with ANSI C80.6 and UL 1242.
6. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
  - a. Comply with NEMA RN 1.
  - b. Coating Thickness: 0.040 inch, minimum.
7. EMT: Comply with ANSI C80.3 and UL 797.
8. FMC: Comply with UL 1; zinc-coated steel.
9. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

C. Rigid Steel Conduit: ANSI C80.1.

1. Rigid galvanized steel (RGS) conduit shall be standard weight, schedule 40, hot-dipped galvanized, rigid steel, complete with threaded couplings, in trade sizes 3/4 inch thru 6 inch diameter.
2. PVC coated RGS conduit shall be completely encapsulated RGS conduit providing total protection against corrosion. A minimum thickness of 40 mil. PVC exterior coating shall be permanently fused to the RGS conduit. A urethane or polyurethane interior coating

shall be applied at a nominal 2 mil. thickness to the interior of the conduit and over the threads. Conduit fittings shall be similarly covered and lined and by the same manufacturer as the conduit. All supports and clamps shall be corrosion resistant. All conduit joints shall be sealed per manufacturer's recommendations.

3. Intermediate Metal Conduit (IMC) shall be medium weight, hot-dipped galvanized, steel, complete with threaded or integral slip-ring fittings, in trade sizes 2 inch thru 4 inch.
- D. Aluminum Rigid Conduit: Not allowed.
- E. EMT: ANSI C80.3.
1. Electrical Metallic Tubing (EMT/thin wall conduit) shall be per ANSI C80.3, corrosion resistant, concrete tight, in trade sizes ½ inch thru 2 inch diameter, complete with threadless compression or set screw type steel couplings and connectors. No die cast metal fittings will be permitted.
- F. FMC: Zinc-coated steel.
1. Flexible metal conduit shall be zinc coated steel, single strip type, complete with approved steel fittings, in trade sizes ½ inch thru 4 inch. No die cast metal fittings will be permitted. Only permitted for fixture wiring above grid ceiling in lengths not to exceed 6'-0".
- G. LFMC: Flexible steel conduit with PVC jacket.
1. Liquidtight flexible metal conduit shall be as specified above, but complete with neoprene jacket, and approved compression fittings. Permitted for connection to motors and equipment.
- H. Fittings for Conduit (Including all Types and Flexible and Liquidtight) and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
1. Fittings for EMT: Steel compression type for outdoor and steel set-screw type for indoor.
  2. Conduit bodies for metal conduit shall be cast, malleable iron products, with threaded hubs, and matching screw covers. Where located outdoors or subject to dampness, covers shall be gasketed.
  3. Conduit bodies for non-metallic conduit shall be of similar material by same vendor.
- I. Joint Compound for Rigid Steel Conduit: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.
- J. Metal Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. AFC Cable Systems; a part of Atkore International.
    - b. Allied Tube & Conduit; a part of Atkore International.
    - c. Anamet Electrical, Inc.
    - d. Calconduit.
    - e. Electri-Flex Company.
    - f. FSR Inc.



- g. Korkap.
  - h. NEC, Inc.
  - i. NewBasis.
  - j. Opti-Com Manufacturing Network, Inc (OMNI).
  - k. O-Z/Gedney; a brand of Emerson Industrial Automation.
  - l. Patriot Aluminum Products, LLC.
  - m. Perma-Cote.
  - n. Picoma Industries, Inc.
  - o. Plasti-Bond.
  - p. Republic Conduit.
  - q. Southwire Company.
  - r. Thomas & Betts Corporation; A Member of the ABB Group.
  - s. Topaz Electric; a division of Topaz Lighting Corp.
  - t. Western Tube and Conduit Corporation.
  - u. Wheatland Tube Company.
  - v. Or engineer approved equal.
- 2. Comply with NEMA FB 1 and UL 514B.
  - 3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 4. Fittings, General: Listed and labeled for type of conduit, location, and use.
  - 5. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
  - 6. Fittings for EMT:
    - a. Material: Steel.
    - b. Type: compression.
  - 7. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
  - 8. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- K. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

## 2.2 NONMETALLIC CONDUITS AND FITTINGS

### A. Nonmetallic Conduit:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AFC Cable Systems; a part of Atkore International.
  - b. Anamet Electrical, Inc.
  - c. Arnco Corporation.
  - d. CANTEX INC.
  - e. CertainTeed Corporation.
  - f. Champion Fiberglass, Inc.
  - g. Condux International, Inc.
  - h. Electri-Flex Company.
  - i. FRE Composites.

- j. Kraloy.
    - k. Lamson & Sessions.
    - l. Niedax Inc.
    - m. RACO; Hubbell.
    - n. Thomas & Betts Corporation; A Member of the ABB Group.
    - o. Or engineer approved equal.
  - 2. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 3. Fiberglass:
    - a. Comply with NEMA TC 14.
    - b. Comply with UL 2515 for aboveground raceways.
    - c. Comply with UL 2420 for belowground raceways.
  - 4. ENT: Comply with NEMA TC 13 and UL 1653 (Not Allowed)
  - 5. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
  - 6. LFNC: Comply with UL 1660. (Not Allowed)
  - 7. Rigid HDPE: Comply with UL 651A.
  - 8. Continuous HDPE: Comply with UL 651A.
  - 9. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.
  - 10. RTRC: Comply with UL 2515A and NEMA TC 14.
  - 11. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.
- B. Nonmetallic Fittings:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. AFC Cable Systems; a part of Atkore International.
    - b. Anamet Electrical, Inc.
    - c. Arnco Corporation.
    - d. CANTEX INC.
    - e. CertainTeed Corporation.
    - f. Champion Fiberglass, Inc.
    - g. Condux International, Inc.
    - h. Electri-Flex Company.
    - i. FRE Composites.
    - j. Kraloy.
    - k. Lamson & Sessions.
    - l. Niedax Inc.
    - m. RACO; Hubbell.
    - n. Thomas & Betts Corporation; A Member of the ABB Group.
    - o. Or engineer approved equal.
  - 2. Fittings, General: Listed and labeled for type of conduit, location, and use.
  - 3. Fittings for ENT (not allowed) and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
    - a. Fittings for LFNC: Comply with UL 514B (Not Allowed)

4. Solvents and Adhesives: As recommended by conduit manufacturer.

## 2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. B-line, an Eaton business.
  2. Hoffman; a brand of Pentair Equipment Protection.
  3. MonoSystems, Inc.
  4. Square D.
  5. Or engineer approved equal.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 or Type 4 unless otherwise indicated, and sized according to NFPA 70.
  1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Screw-cover type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

## 2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Allied Moulded Products, Inc.
  2. Hoffman; a brand of Pentair Equipment Protection.
  3. Lamson & Sessions.
  4. Niedax Inc.
  5. Or engineer approved equal.
- B. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.
- D. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.
- E. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

- F. Solvents and Adhesives: As recommended by conduit manufacturer.

## 2.5 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. Hubbell Incorporated; Wiring Device-Kellems.
  - b. MonoSystems, Inc.
  - c. Panduit Corp.
  - d. Wiremold / Legrand.
  - e. Or engineer approved equal.
- C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. Hubbell Incorporated.
  - b. MonoSystems, Inc.
  - c. Panduit Corp.
  - d. Wiremold / Legrand.
  - e. Or engineer approved equal.
- D. Tele-Power Poles:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. MonoSystems, Inc.
  - b. Panduit Corp.
  - c. Wiremold / Legrand.
  - d. Or engineer approved equal.
2. Material: Galvanized steel with ivory baked-enamel finish.
3. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

## 2.6 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Adalet.
  - 2. Crouse-Hinds, an Eaton business.
  - 3. EGS/Appleton Electric.
  - 4. Erickson Electrical Equipment Company.
  - 5. FSR Inc.
  - 6. Hoffman; a brand of Pentair Equipment Protection.
  - 7. Hubbell Incorporated.
  - 8. Hubbell Incorporated; Wiring Device-Kellems.
  - 9. Kraloy.
  - 10. Milbank Manufacturing Co.
  - 11. MonoSystems, Inc.
  - 12. Oldcastle Enclosure Solutions.
  - 13. O-Z/Gedney; a brand of Emerson Industrial Automation.
  - 14. Plasti-Bond.
  - 15. Or engineer approved equal.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Metal Floor Boxes:
  - 1. Material: sheet metal.
  - 2. Type: Semi-adjustable.
  - 3. Shape: Rectangular.
  - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Nonmetallic Floor Boxes: Nonadjustable, rectangular.
  - 1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- H. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- I. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.
  - 1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- J. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- K. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- L. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- M. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- N. Gangable boxes are allowed.
- O. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 or Type 4 with continuous-hinge cover with flush latch unless otherwise indicated.
  - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2. Nonmetallic Enclosures: Plastic.
  - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- P. Cabinets:
  - 1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
  - 2. Hinged door in front cover with flush latch and concealed hinge.
  - 3. Key latch to match panelboards.
  - 4. Metal barriers to separate wiring of different systems and voltage.
  - 5. Accessory feet where required for freestanding equipment.
  - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 7. Indoor cabinets shall be rated NEMA 1, with galvanized tub, removable interior steel panel, removable front trim with hinged front cover, flush latch and concealed hinge. Cabinets in dusty or dirty environments shall be rated NEMA 12/13, complete with gasketed hinged door and latch. Provide metal barriers to separate terminations of different wiring systems and voltages. Provide accessory feet where cabinets are free-standing.
  - 8. Outdoor cabinets shall be rated NEMA 4X, with stainless steel construction, removable interior steel panel, gasketed piano hinged door, lockable latch, stainless steel hardware and external mounting straps.

## 2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:
  - 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
  - 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Armorcast Products Company.
    - b. NewBasis.
    - c. Oldcastle Enclosure Solutions.
    - d. Oldcastle Precast, Inc.
    - e. Quazite: Hubbell Power Systems, Inc.
    - f. Or engineer approved equal.
  2. Standard: Comply with SCTE 77.
  3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
  4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
  5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  6. Cover Legend: Molded lettering, "ELECTRIC."
  7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
  8. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.
- C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of fiberglass.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Armorcast Products Company.
    - b. NewBasis.
    - c. Nordic Fiberglass, Inc.
    - d. Oldcastle Enclosure Solutions.
    - e. Oldcastle Enclosure Solutions.
    - f. Oldcastle Precast, Inc.
    - g. Quazite: Hubbell Power Systems, Inc.
    - h. Or engineer approved equal.
  2. Standard: Comply with SCTE 77.
  3. Color of Frame and Cover: Gray.
  4. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
  5. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
  6. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  7. Cover Legend: Molded lettering, "ELECTRIC."
  8. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
  9. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

## 2.8 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
1. Tests of materials shall be performed by an independent testing agency.
  2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

## PART 3 - EXECUTION

### 3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC.
2. Concealed Conduit, Aboveground: GRC.
3. Underground Conduit: RNC, Type EPC-40-PVC or Type EPC-80-PVC.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
6. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
7. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units SCTE 77, Tier 8 structural load rating.
8. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: (Above 10' AFF) EMT.
2. Exposed, Not Subject to Severe Physical Damage: (Above 10' AFF) EMT.
3. Exposed and Subject to Severe Physical Damage: (Above 10' AFT) GRC. Raceway locations include the following:
  - a. Loading dock.
  - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
  - c. Mechanical rooms.
  - d. Gymnasiums.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing



- conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
- 3. EMT: Use cast-metal fittings. Comply with NEMA FB 2.10.
- 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- G. Install surface raceways only where indicated on Drawings.
- H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

### 3.2 INSTALLATION

- A. Comply with requirements in Section 26 0529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.
- D. Do not fasten conduits onto the bottom side of a metal deck roof.
- E. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- F. Complete raceway installation before starting conductor installation.
- G. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
- J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- K. Support conduit within 12 inches of enclosures to which attached.
- L. Raceways Embedded in Slabs:
  - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.

2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
  3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
  4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
  5. Change from ENT to GRC before rising above floor.
- M. Stub-Ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC or engineer approved equal for raceways.
  2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- O. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- P. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- Q. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- R. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- S. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- T. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- U. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- V. Surface Raceways:
1. Install surface raceway with a minimum 2-inch radius control at bend points.
  2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- W. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

- X. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
  - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  - 2. Where an underground service raceway enters a building or structure.
  - 3. Conduit extending from interior to exterior of building.
  - 4. Conduit extending into pressurized duct and equipment.
  - 5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
  - 6. Where otherwise required by NFPA 70.
- Y. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- Z. Expansion-Joint Fittings:
  - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
  - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    - d. Attics: 135 deg F temperature change. Formula in first subparagraph below provides about 15 percent safety factor (extra expansion-contraction capability).
  - 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
  - 4. Install expansion fittings at all locations where conduits crossbuilding or structure expansion joints.
  - 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- AA. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 36 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
  - 1. Use LFMC in damp or wet locations subject to severe physical damage.
  - 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- BB. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.

- CC. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- DD. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- EE. Locate boxes so that cover or plate will not span different building finishes.
- FF. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- GG. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- HH. Set metal floor boxes level and flush with finished floor surface.
- II. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

### 3.3 INSTALLATION OF UNDERGROUND CONDUIT

#### A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom for pipe less than 6 inches in nominal diameter.
2. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction.
3. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
  - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
  - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
5. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits but a minimum of 6 inches below grade. Align planks along centerline of conduit.
6. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

### 3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.
- E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

### 3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 0544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

### 3.6 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

### 3.7 THREADED METAL CONDUIT

- A. All conduit threads shall be cleanly cut with not less than five (5) full threads provided at any conduit ends. Conduit ends shall be reamed smooth and drawn up tight with standard couplings with field-cut threads coated with asphaltum, Z.R.C. cold galvanizing spray or other rust-inhibiting material immediately AFTER being tightly coupled together.
- B. Bends or offsets shall be made using standard conduit ells; field bends may be made with an approved hickey or bender or hub-type conduit fittings. The use of running thread either exposed or concealed is prohibited. Use three piece or "Erickson" couplings only where required.
- C. Exposed conduits rising from floor to surface panels or boxes shall be provided with a 3" high concrete curb encasing the conduits at the floor line.

- D. PVC coated RGS conduit shall have all jacket damage repaired with PVC sealant per manufacturer's recommendations. All reducing fittings shall be installed horizontally or downward and totally covered with PVC sealant.

### 3.8 THINWALL CONDUIT

- A. Electrical Metallic Tubing (EMT/thin wall) may be installed in the following locations only:
  - 1. Concealed in dry interior partitions.
  - 2. Concealed above suspended ceilings.
- B. Electrical metallic tubing is not approved for installation in concrete slabs, underground, in fully "grouted" walls, exposed in finished type areas or in exterior masonry walls.
- C. E.M.T. may be used "exposed" above the 10 ft. level in "unfinished" non-process type areas such as Mechanical and Electrical Rooms, etc., and may be mounted on exposed surfaces. NO EMT will be permitted in the tunnels, crawl spaces, chemical treatment rooms, pump rooms, water filter rooms, generator rooms, vehicle storage or maintenance rooms, or areas subject to physical abuse.
- D. Where routed thru steel joists, etc., EMT shall be installed tight to or above the bottom cord. Where routed on concrete deck, etc., raceways shall be run tight to structure.

### 3.9 ELECTRICAL NON-METALLIC TUBING (ENT)

- A. Electrical Non-metallic Tubing shall be installed per NEC 331 and may be installed in the following locations only:
  - 1. Concealed in walls, floors, and ceilings.
  - 2. Encased in poured concrete slab on grade where ENT is placed on sand or approved screenings and fittings are identified for this purpose.

### 3.10 NON-METALLIC CONDUIT

- A. Non-metallic conduit shall be installed with factory fittings and elbows for raceways 2 inch diameter and larger. In smaller sizes, raceway bends, offsets, etc., shall be field formed using approved heating tools and procedures. Where routed in underground ductbanks, conduits shall be separated and supported with approved spacers to provide not less than two inch (2") separation the entire length of the raceway.
- B. Non-metallic conduit may be used for "in slab" or "under slab" wiring within the building at the Contractors option. Such PVC raceways shall be continuous, outlet to outlet with no exposed lengths. At exposed stub-ups or connections to surface mounted equipment, where subject to physical damage, transition to RGS within or below the slab.
- C. A separate green-colored ground conductor, sized per NEC or larger as noted on the plans, shall be installed in each non-metallic raceway.
- D. Utilize non-metallic conduit for protection of individual grounding and bonding conductors, except in air handling plenums.

- E. Inside the chlorine room only, exposed PVC raceways may be installed, but shall be supported on three feet centers and shall be complete with similar PVC boxes, conduit bodies, connectors, non-metallic flexible conduit, and gasketed PVC box covers and cover plates for a complete non-metallic raceway system.

### 3.11 FLEXIBLE CONDUIT

- A. Flexible metallic conduit shall only be used for all fixed (hard) wiring connections from equipment connection boxes to recessed lighting fixtures. Flexible conduit in lengths exceeding six feet will not be permitted under any condition.
- B. Where subject to water, dampness or oily environments, use liquidtight, neoprene jacketed conduit. This shall include all pump motor connections, kitchen/laboratory area equipment connections, and boiler and water heater connections.

### 3.12 FITTINGS

- A. All threaded raceways shall be secured at box entrances with double locknuts and bushings. All bushings on conduits one and one half inch (1 ½") diameter and larger shall be insulating bushings. Insulation and/or grounding type bushings shall be installed on all conduits where required by NEC or specifically noted.
- B. All conduits stubbed at backboards, cable trays, plenums, attics, etc., for conversion to "open wiring" methods, shall be complete with insulating bushings. Where conduits are not connected to metallic enclosures, grounding bushings or other approved accessories shall be utilized to assure raceway bonding. Short vertical conduit sleeves from communications or alarm system outlets to ceiling plenum or attic spaces need not be bonded or grounded.
- C. All conduits, where crossing building expansion joints or greater than 200 feet in continuous length, shall be provided with properly bonded expansion fittings, similar to O.Z. Mfg. Co. Type AX, weatherproof.
- D. At exterior enclosures or where subject to occasional water (splashing, washdown, etc.) provide watertight conduit hubs, Meyers or equal, for all conduit entrances. Locate such entrances in the bottom of exterior enclosures wherever possible, or in the sides otherwise.
- E. Provide raceway sealing fittings in accessible and suitable locations, and fill with UL-listed sealing compounds. Raceways seals shall be installed where required by the NEC.

### 3.13 SURFACE METAL RACEWAYS AND WIREWAYS

- A. NEMA 1 wireways may be installed in unfinished areas or above accessible ceilings. Where exposed to dampness, oil, or similar but non-corrosive environments, wireways shall be NEMA 12/13 rated. All installation and wire fill shall be in accordance with NEC Article 376. Wall mounted wireways shall be supported on five feet centers. Suspended wireways shall be provided with hangers to accommodate opening of the covers. Contiguous suspended ten feet lengths of wireway may be supported on eight feet centers, with additional supports at elbows, tees, crosses and changes in elevation or direction.
- B. All surface metal raceways shall be mounted to clear counter tops, door trim, obstructions, etc., and shall be installed true and level and as inconspicuously as possible. Single channel raceways shall be supported on five feet centers. Dual compartment raceways shall be

supported on three feet centers. All installation and wire fill shall be in accordance with NEC Article 386.

- C. In new construction and fully renovated spaces, surface metal raceways are acceptable only where specifically approved by the Engineer or shown on the plans.

### 3.14 CABLE TRAY/BUSWAY/BUSDUCT

- A. Cable tray, Busway and Busduct may be installed in finished or unfinished areas, exposed or above accessible ceilings as indicated on the project drawings. Cable tray, Busway and Busduct supports shall be as recommended by manufacturer.

### 3.15 BOX INSTALLATION

- A. Provide a box for each fixture (or contiguous fixture row), switch, receptacle, junction or equipment connection outlet unless specifically noted otherwise.
- B. Outlet locations indicated on the plans shall be considered diagrammatic and approximate only. Final locations shall be coordinated with other trades and building architecture before installation. Coordinate with masonry coursing, tile joints, chair rails, counters, door trim, etc., for a neat, workmanlike installation. Wall mounted outlets at architectural components or features shall be centered on the mirror, door, column, window, etc. Refer to door swings shown on the architectural plans for locations of local switches. In the case of a discrepancy, the architectural plans shall govern. When interferences occur, the outlet shall be located so as to avoid said interference without additional cost. The Associate reserves the right to move any outlet six feet from the scaled location on the drawing, prior to its rough-in, without additional cost.
- C. Lighting fixture boxes shall be installed so that each fixture or fixture row is fed through a separate raceway. Fixtures installed in walls or ceilings shall be located to present properly coordinated and neat appearances. Locate boxes so that when fixtures are installed, they will be symmetrically located according to room layout and will not interfere with other work or equipment.
- D. All boxes shall be rigidly supported or fastened to the building structure. Boxes shall NOT be supported from tie wires or other piping system supports. Provide structural steel or other approved auxiliary supports as needed.
- E. Boxes feeding recessed fixtures in inaccessible ceilings shall be located one foot away from fixture, and shall be accessible through the fixture opening. All boxes upon which lighting fixtures are to be installed, shall be equipped with  $\frac{3}{8}$  inch fixture studs. Ceiling lighting outlets shall be located symmetrically between walls, beams, ceiling breaks, etc. Refer to the reflected ceiling plan for the exact location of fixtures in grid-type ceilings.
- F. Do not install boxes "back-to-back". No "tangle boxes" shall be used without the express consent of the Engineer.
- G. Where combustible wall covering, carpet, etc. is installed, provide non-combustible box extensions.
- H. Unless otherwise noted on the plans, install device boxes at the following heights, above the finished floor to the bottom. In exposed masonry walls, adjust to the next higher block course, as required to put the top or bottom of the box on a grout line.



- |    |                        |           |
|----|------------------------|-----------|
| 1. | Receptacle boxes:      | 16 inches |
| 2. | Local switch boxes:    | 44 inches |
| 3. | Motor control stations | 44 inches |

- I. Where located at a bench, counter, radiator or lavatory location, device boxes shall be mounted 6 inches above top of unit.

### 3.16 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.
- D. If conduits do not enter enclosure through open bottom, field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

END OF SECTION 26 0533

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## SECTION 26 0543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Metal conduits and fittings, including GRC and PVC-coated steel conduit.
2. Rigid nonmetallic duct.
3. Flexible nonmetallic duct.
4. Duct accessories.
5. Precast concrete handholes.
6. Polymer concrete handholes and boxes with polymer concrete cover.
7. Fiberglass handholes and boxes with polymer concrete cover.
8. Fiberglass handholes and boxes.
9. High density plastic boxes.
10. Precast manholes.
11. Utility structure accessories.

#### 1.2 DEFINITIONS

- A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
- C. Duct Bank:
1. Two or more ducts installed in parallel, with or without additional casing materials.
  2. Multiple duct banks.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
1. Precast or Factory-Fabricated Underground Utility Structures:
    - a. Include plans, elevations, sections, details, attachments to other work, and accessories.
    - b. Include duct entry provisions, including locations and duct sizes.
    - c. Include reinforcement details.
    - d. Include frame and cover design and manhole chimneys.
    - e. Include ladder details.
    - f. Include grounding details.
    - g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.

- h. Include joint details.

2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

- a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
- b. Include duct entry provisions, including locations and duct sizes.
- c. Include cover design.
- d. Include grounding details.
- e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.4 INFORMATIONAL SUBMITTALS

- A. Duct and Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures. Drawings shall be signed and sealed by a qualified professional engineer.
- B. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.
- C. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.
- D. Source quality-control reports.
- E. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND FITTINGS

- A. GRC: Comply with ANSI C80.1 and UL 6.
- B. Coated Steel Conduit: PVC-coated GRC.
  - 1. Comply with NEMA RN 1.
  - 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.2 RIGID NONMETALLIC DUCT

- A. Underground Plastic Utilities Duct: Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.

- B. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
- C. Solvents and Adhesives: As recommended by conduit manufacturer.

## 2.3 FLEXIBLE NONMETALLIC DUCTS

- A. HDPE Duct: Type EPEC-40 HDPE, complying with NEMA TC 7 and UL 651A.
- B. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

## 2.4 DUCT ACCESSORIES

- A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
- B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

## 2.5 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
- B. Comply with ASTM C 858 for design and manufacturing processes.
- C. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
- D. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
- E. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
  - 1. Cover Hinges: Concealed, with hold-open ratchet assembly.
  - 2. Cover Handle: Recessed.
- F. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- G. Cover Legend: Molded lettering, "ELECTRIC."
- H. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
- I. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
  - 1. Extension shall provide increased depth of 12 inches (300 mm).
  - 2. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

- J. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
- K. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
- L. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
- M. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

## 2.6 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

- A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
- B. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- C. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
- D. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- E. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- F. Cover Legend: Molded lettering, "ELECTRIC."
- G. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

## 2.7 FIBERGLASS HANDHOLES AND BOXES WITH POLYMER CONCRETE FRAME AND COVER

- A. Description: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
- B. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- C. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
- D. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- E. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

- F. Cover Legend: Molded lettering, "ELECTRIC."
- G. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

## 2.8 FIBERGLASS HANDHOLES AND BOXES

- A. Description: Molded of fiberglass-reinforced polyester resin, with covers made of reinforced concrete.
- B. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- C. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
- D. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- E. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- F. Cover Legend: Molded lettering, "ELECTRIC."
- G. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
- H. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- I. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) larger shall have factory-installed inserts for cable racks and pulling-in irons.

## 2.9 PRECAST MANHOLES

- A. Description: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.
- B. Comply with ASTM C 858.
- C. Structural Design Loading: Comply with requirements in "Underground Enclosure Application" Article.
- D. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
- E. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
- F. Ground Rod Sleeve: Provide a 3-inch (75-mm) PVC sleeve in manhole floors 2 inches (50 mm) from the wall adjacent to, but not underneath, the duct entering the structure.

- G. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

## 2.10 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
- B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
  - 1. Tests of materials shall be performed by an independent testing agency.
  - 2. Strength tests of complete boxes and covers shall be by an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
  - 3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.

### 3.2 UNDERGROUND DUCT APPLICATION

- A. Duct for Electrical Feeders 600 V and Less: RNC Type EPC-40-PVC, concrete-encased unless otherwise indicated.
- B. Duct for Electrical Feeders 600 V and Less: RNC Type EPC-40-PVC, direct-buried unless otherwise indicated.
- C. Duct for Electrical Branch Circuits: RNC Type EPC-40-PVC, direct-buried unless otherwise indicated.
- D. Bored Underground Duct: Type EPEC-40 HDPE unless otherwise indicated.
- E. Underground Ducts Crossing Paved Paths, Walks, Driveways, Roadways, and Railroads: RNC Type EPC-40 PVC, encased in reinforced concrete.



### 3.3 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less:
  - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete, AASHTO HB 17, H-20 structural load rating.
  - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 or Fiberglass enclosures with polymer concrete frame and cover, SCTE 77, Tier 15 structural load rating.
  - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 or Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8 structural load rating.
  - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin or High-density plastic, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.
  - 5. Cover design load shall not exceed the design load of the handhole or box.
- B. Manholes: Precast concrete.
  - 1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
  - 2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

### 3.4 EARTHWORK

- A. Excavation and Backfill: do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restoration: Replace area after construction vehicle traffic in immediate area is complete.
- C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures according to "Cutting and Patching" Article in Section 01 7300 "Execution."

### 3.5 DUCT AND DUCT-BANK INSTALLATION

- A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
- B. Install duct according to NEMA TCB 2.
- C. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.

- D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches (1200 mm), both horizontally and vertically, at other locations unless otherwise indicated.
  - 1. Duct shall have maximum of two 90 degree bends or the total of all bends shall be no more 180 degrees between pull points.
- E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.
- F. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing the duct will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.
- G. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) duct, and vary proportionately for other duct sizes.
- H. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches (150 mm) o.c. for 4-inch (100-mm) duct, and vary proportionately for other duct sizes.
- I. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet (3 m) outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Install GRC penetrations of building walls as specified in Section 26 0544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- J. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.
- K. Pulling Cord: Install 200-lbf- (1000-N-) test nylon cord in empty ducts.
- L. Concrete-Encased Ducts and Duct Bank:
  - 1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms for pipes less than 6 inches (150 mm) in nominal diameter.
  - 2. Width: Excavate trench 12 inches (300 mm) wider than duct on each side.
  - 3. Width: Excavate trench 3 inches (75 mm) wider than duct on each side.
  - 4. Depth: Install so top of duct envelope is at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
  - 5. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
  - 6. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per 20 feet (6 m) of duct. Place spacers within 24 inches (600 mm) of duct ends. Stagger spacers approximately 6 inches (150 mm) between tiers. Secure spacers to earth and to duct to prevent floating during concreting.

- Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
7. Minimum Space between Duct: 3 inches (75 mm) between edge of duct and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and communications ducts.
  8. Elbows: Use manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.
  9. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.
  10. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
  11. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
  12. Concrete Cover: Install a minimum of 3 inches (75 mm) of concrete cover between edge of duct to exterior envelope wall, 2 inches (50 mm) between duct of like services, and 4 inches (100 mm) between power and communications ducts.
  13. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
  14. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 03 3000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.

M. Direct-Buried Duct and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms for preparation of trench bottoms for pipes less than 6 inches (150 mm) in nominal diameter.
2. Width: Excavate trench 12 inches (300 mm) wider than duct on each side.
3. Width: Excavate trench 3 inches (75 mm) wider than duct on each side.
4. Depth: Install top of duct at least 36 inches (900 mm) below finished grade unless otherwise indicated.
5. Set elevation of bottom of duct bank below frost line.
6. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per 20 feet (6 m) of duct. Place spacers within 24 inches (600 mm) of duct ends. Stagger spacers approximately 6 inches (150 mm) between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
8. Install duct with a minimum of 3 inches (75 mm) between ducts for like services and 6 inches (150 mm) between power and communications duct.
9. Elbows: Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
10. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.
11. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches (100 mm) over duct and hand tamp.

Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction.

- a. Place minimum 3 inches (75 mm) of sand as a bed for duct. Place sand to a minimum of 6 inches (150 mm) above top level of duct.
- b. Place minimum 6 inches (150 mm) of engineered fill above concrete encasement of duct.

- N. Underground-Line Warning Tape: Bury nonconducting underground line specified in Section 26 0553 "Identification for Electrical Systems" no less than 12 inches (300 mm) above all concrete-encased duct and duct banks and approximately 12 inches (300 mm) below grade. Align tape parallel to and within 3 inches (75 mm) of centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

### 3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

#### A. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

#### B. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches (375 mm) below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch (25 mm) above finished grade.
3. Install handholes with bottom below frost line, below grade.
4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.

- C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

#### D. Manhole Access: Circular opening in manhole roof, sized to match cover size.

1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.

### 3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box

extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.

- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
- D. Install handholes and boxes with bottom below frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
- F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

### 3.8 GROUNDING

- A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

### 3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
  - 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch- (300-mm-) long mandrel equal to duct size minus 1/4 inch (6 mm). If obstructions are indicated, remove obstructions and retest.
  - 3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 26 0526 "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.
- C. Prepare test and inspection reports.

### 3.10 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump.

1. Sweep floor, removing dirt and debris.
2. Remove foreign material.

END OF SECTION 26 0543

## SECTION 26 0544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

#### 1.2 ACTION SUBMITTALS

##### A. Product Data: For each type of product.

### PART 2 - PRODUCTS

#### 2.1 SLEEVES

##### A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

##### B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

##### C. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:
  - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
  - b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

## 2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
  - 1. Sealing Elements: EPDM or Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 2. Pressure Plates: Stainless steel.
  - 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

## 2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, water stop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber water stop collar with center opening to match piping OD.

## 2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## 2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
  - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

## PART 3 - EXECUTION

### 3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:



1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

- a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.
  - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
  3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
  4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
  5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

### 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### 3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water stop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.

- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 26 0544

## SECTION 26 0553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. All items in this specification may not be required. See contract drawings for applicable items.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Underground-line warning tape.
  - 2. Equipment identification labels.
  - 3. Miscellaneous identification products.
  - 4. Identification for conductors.
  - 5. Identification for raceways.

#### 1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Operation and Maintenance Data: For identification materials to include in emergency, operation, and operational manuals.

#### 1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.

#### 1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

## PART 2 - PRODUCTS

### 2.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Marker: Permanent, waterproof, black ink marker.

### 2.2 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Write-On Tags: Polyester tag, 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
  - 1. Marker for Tags: Machine printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

### 2.3 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
  - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
  - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
  - 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- B. Color and Printing:
  - 1. Comply with ANSI Z535.1 through ANSI Z535.5.
  - 2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.  
Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.
- C. Tag: Type ID:
  - 1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
  - 2. Overall Thickness: 5 mils
  - 3. Foil Core Thickness: 0.35 mil.
  - 4. Weight: 28 lb/1000 sq. ft.
  - 5. 3-Inch Tensile According to ASTM D 882: 70 lbf, and 4600 psi.

## 2.4 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

## 2.5 CABLE TIES

- A. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, self- locking.
  - 1. Minimum Width: 3/16 inch.
  - 2. Tensile Strength at 73 deg, According to ASTM D 638: 7000 psi.
  - 3. UL 94 Flame Rating: 94V-0.
  - 4. Temperature Range: Minus 50 to plus 284 deg F.
  - 5. Color: Black.

## 2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- E. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
  - 1. Outdoors: UV-stabilized nylon.
  - 2. Indoors: Plenum rated.
- F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade.
- G. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

### 3.2 IDENTIFICATION SCHEDULE

- A. Raceways: Identify the covers of each junction and pull box with permanent, waterproof, black ink marker. System legends shall be as follows:
  - 1. Source name(s).
  - 2. Circuit number(s).
- B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
  - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
    - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
    - b. Colors for 208/120-V Circuits:
      - 1) Phase A: Black.
      - 2) Phase B: Red.
      - 3) Phase C: Blue.
    - c. Colors for 480/277-V Circuits:
      - 1) Phase A: Brown.
      - 2) Phase B: Orange.
      - 3) Phase C: Yellow.
    - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- C. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use write-on tags.
- D. Locations of Underground Lines: Identify with underground-line warning tape for power and communication.
- E. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems.
  - 1. Labeling Instructions:
    - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
    - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
    - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
    - d. Fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
    - e. Include on label electrical source name(s) and circuit number(s) as applicable.

2. Equipment to Be Labeled:

- a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
- b. Enclosures and electrical cabinets.
- c. Access doors and panels for concealed electrical items.
- d. Switchgear
- e. Switchboards
- f. Transformers: Label that includes for the transformer, primary source, and panelboards or equipment supplied by the secondary.
- g. Substations.
- h. Emergency system boxes and enclosures.
- i. Motor-control centers.
- j. Enclosed switches.
- k. Enclosed circuit breakers.
- l. Enclosed controllers.
- m. Variable-speed controllers.
- n. Push-button stations.
- o. Power transfer equipment.
- p. Contactors.
- q. Remote-controlled switches, dimmer modules, and control devices.
- r. Battery-inverter units.
- s. Battery racks.
- t. Power-generating units.
- u. Monitoring and control equipment.
- v. UPS equipment.
- w. Switches
- x. Receptacles

END OF SECTION 26 0553

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## SECTION 26 2414 – DISCONNECT SWITCHES

### PART 1 - GENERAL

#### 1.1 SCOPE OF WORK

- A. Furnish and install the disconnects as shown on the drawings, specified or required, including fuses, spare fuses and accessories where noted.

#### 1.2 RELATED DOCUMENTS

- A. Refer to Section 26 0500 for general requirements.

#### 1.3 QUALITY ASSURANCE

- A. Comply with the applicable requirements of UL standard 98, pertaining to enclosed and dead front switches.
- B. Comply with NEMA standard publications KS1 and 250 pertaining to switches and enclosures.

### PART 2 - PRODUCTS

#### 2.1 DISCONNECT SWITCHES

- A. All disconnects shall be heavy duty, 250 volt or 600 volt (to match circuit requirement) fusible type switches with quick-make, quick-break mechanism, horsepower rated, with visible blades when switch is OFF (and cover is open), integral fuse pullers in ratings 200 ampere and larger, removable arc suppressors, and provisions for a field installable interlock kit.
- B. Current-carrying parts shall be of plated copper construction.
- C. Disconnects shall have rejection type fuse clips to accommodate the fuses specified. Provide non-fusible switches where shown or noted.
- D. Enclosures shall include a full cover with interlock, and enclosed in a NEMA 12 enclosure (indoors) or NEMA 4X (outdoors and in damp or corrosive environment) unless otherwise noted on plans. Handle shall have padlocking provision.
- E. Disconnects shall be Square D Co., Type HD, or equal as manufactured by General Electric, Siemens, or Cutler-Hammer or engineer approved equal.

#### 2.2 FUSES

- A. All fuses shall be arranged for a coordinated selective system of over-current protection. All fuses shall hold a 500 percent load for 10 seconds and shall be rated 200,000 amperes symmetrical interrupt.

- B. 250 volt fuses shall be time delay type RK-5, 480 volt fuses shall be time delay, type RK-5.
- C. Main or branch fuses larger than 600 amperes shall be Class L, bolt-in style.
- D. Control circuit fuses shall be miniature, 600 volt, fast acting, Class CC, Bussmann KTK-R or equal.
- E. Line voltage fuses shall be blow fuse indicating type as made by Littlefuse, Inc. or equal.
- F. At the completion of the project, Contractor shall furnish to the Owner one (1) spare fuse of each size, type and rating for each set so installed. In no case shall less than three (3) fuses of any size or type be furnished. Provide a detailed list of fuses to Engineer and obtain Owner receipt when fuses are given to Owner.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Switches shall be rigidly mounted to the building structure at 6 feet above floor to top, typical. Provide auxiliary steel supports where necessary. Outdoor switches shall be located adjacent to equipment served; mounting height may be lowered for aesthetic reasons.

#### 3.2 FIELD TESTING

- A. Adjust any operating mechanism for full and unrestricted movement.

END OF SECTION 26 2414

## SECTION 26 2913 - SOFT-START MOTOR CONTROLLERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes soft-start motor controllers that are designed for reduced-voltage start and full-voltage run duty.
  - 1. Enclosed soft-start controllers.
  - 2. Combination soft-start controllers.
  - 3. Bypass motor controller.
  - 4. Enclosures.
  - 5. Accessories.
  - 6. Identification.

#### 1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. FLA: Full-load current.
- C. MCCB: Molded-case circuit breaker.
- D. MCP: Motor circuit protector.
- E. NC: Normally closed.
- F. NO: Normally open.
- G. OCPD: Overcurrent protective device.
- H. SCCR: Short-circuit current rating.
- I. SCPD: Short-circuit protective device.
- J. SCR: Silicon-controlled rectifier.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each type of controller.

1. Include plans, elevations, sections, and mounting details.
2. Indicate dimensions, weights, required clearances, and location and size of each field connection.
3. Wire Termination Diagrams and Schedules: Include diagrams for signal and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
4. Include features, characteristics, ratings, and factory settings of individual OCPD and auxiliary components.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around soft-start controller. Show soft-start controller layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Product Schedule: For each enclosed controller.

1. Each installed soft-start controller type.
2. NRTL listing.
3. Factory-installed accessories.
4. Nameplate legends.
5. SCCR of integrated unit.
  - a. For each combination soft-start controller, include features, characteristics, ratings, and factory setting of the SCPD and OCPD.
    - 1) Listing document proving Type 2 coordination.
  - b. For each series-rated combination, state the listed integrated SCCR (withstand) of SCPDs and OCPDs by an NRTL acceptable to authorities having jurisdiction.

E. Qualification Data: For testing agency.

F. Source quality-control reports.

G. Field quality-control reports.

H. Provide operation and maintenance manuals per Section 01 7823 Operation and Maintenance Data.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

- D. IEEE Compliance: Fabricate and test soft-start controller according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

## 1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace soft-start controllers that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.
- B. Provide a written warranty that delivered equipment is in accordance with specifications, and that, should any defect develop during warranty period due to improper materials, workmanship, or arrangement, such defect shall be made good by the vendor without additional expense to the Owner.
- C. Provide an extended 24 month, minimum, warranty from the date of start-up. Warranty shall include all parts, labor, travel time and expenses.
  - 1. Warranty shall be for a period of 3 years from date of final acceptance by owner. Final acceptance shall not take place until satisfactory completion of start-up testing.

## PART 2 - PRODUCTS

### 2.1 MOTOR CONTROLLER PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. UL Compliance: Fabricate and label enclosed controllers to comply with UL 508.
- C. NEMA Compliance: Fabricate motor controllers to comply with NEMA ICS 2.

### 2.2 ENCLOSED SOFT-START MOTOR CONTROLLERS

- A. Description: Controllers designed for reduced-voltage start, full-voltage run, and optional soft stop. The controller shall be an integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and user interface module, run-bypass contactor, and overload relay(s); suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.
  - 1. Run-Bypass Contactor: Magnetic contactor in parallel with the SCR of the soft-start controller, bypassing the SCR when full voltage is achieved.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton.
  - 2. General Electric Company.
  - 3. Rockwell Automation, Inc.

4. SIEMENS Industry, Inc.; Energy Management Division.
  5. Square D; by Schneider Electric.
  6. Engineer approved equal
- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- D. Configuration:
1. At least two SCRs per phase to control the starting and stopping of the motor.
  2. Microprocessor control shall continuously monitor current and proper operation of the SCRs.
  3. Bypass Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Soft-start controller protective features and deceleration controls shall remain active when this contactor is in the bypass mode.
  4. Power Electronics Disconnect Contactor. Where indicated, installed ahead of the power electronics equipment, and shall open automatically when the motor is stopped, or a controller fault is detected, or when an SCR shorts.
  5. Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.
  6. Surge Protection: Comply with NEMA ICS 2 requirements for surge suppression.
- E. Control Power:
1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
  2. Spare CPT Capacity: As indicated on Drawings, available in increments of 100 VA, from 100 to 500 VA.
- F. Controller Diagnostics and Protection:
1. Microprocessor-based thermal-protection system for monitoring SCR and motor thermal characteristics, and providing controller overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
  2. Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and under-load conditions; and line frequency over or under normal.
  3. Input isolation contactor that opens when the controller diagnostics detect a faulted soft-start component or when the motor is stopped.
  4. **<Insert items>**.
- G. Cover mounted-controller status panel with LED lights or alphanumeric display to show the following:
1. Starter Status: "Ready," "starting," "stopping," or "run."
  2. Motor current in amperes.
  3. Faults:
    - a. Motor overcurrent trip.
    - b. Motor thermal overload.
    - c. Starter thermal fault.
    - d. Low line voltage.
    - e. Loss of a phase.
    - f. Phases reversed.
    - g. Maximum stating time exceeded.
    - h. Serial communications error.

H. Interface Panel:

1. Guarded adjustable set points, not readily accessible.
  - a. Motor FLA, adjustable from 40 to 110 percent of the controller's rating.
  - b. Current limitation on starting, adjustable from 200 to 500 percent of FLA, typically set at 300 percent.
  - c. NEMA ICS 2 overload class. Selections shall include the following tripping classes: Class 5, Class 10, Class 15, Class 20, and Class 30.
2. Adjustable set points, readily accessible, password protected.
  - a. Linear acceleration, adjustable from 1 to 60 s.
  - b. Maximum start time, adjustable from 1 to 250 s.
  - c. Selector switch; select coast to stop or soft stop.
  - d. Linear deceleration, adjustable from 1 to 60 s.

I. Remote Output Features. All outputs shall be prewired to terminal blocks.

1. Analog output for field-selectable assignment of motor operating characteristics; 0- to 10-V dc or 4- to 20-mA dc.
2. Form C status contacts that change state when controller is running.
3. Form C alarm contacts that change state when a fault condition occurs.

J. Digital Communication Module: Modbus TCP/IP, Ethernet I/P protocol or other approved protocol to transmit the following to SCADA:

1. Instantaneous root mean square (rms) current each phase, and three-phase average.
2. Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average - rms.
3. Active Energy (kilowatt-hour): Three-phase total.
4. Power Factor: Each phase and/or three-phase total.

## 2.3 COMBINATION SOFT-START MOTOR CONTROLLERS

A. Description: Factory-assembled, combination, reduced-voltage soft-start controller with a disconnecting means, SCPD and OCPD, in a single enclosure. The reduced-voltage soft-start controller shall consist of an integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and user interface module, run-bypass contactor, and overload relay(s); suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.

1. Run-Bypass Contactor: Magnetic contactor in parallel with the SCR of the soft-start controller, bypassing the SCR when full voltage is achieved.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton.
2. General Electric Company.
3. Rockwell Automation, Inc.
4. SIEMENS Industry, Inc.; Energy Management Division.
5. Square D; by Schneider Electric.
6. Engineer approved equal.

- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- D. Configuration:
  - 1. At least two SCRs per phase to control the starting and stopping of the motor.
  - 2. Microprocessor control shall continuously monitor current and proper operation of the SCRs.
  - 3. Bypass Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Soft-start controller protective features and deceleration controls shall remain active when this contactor is in the bypass mode.
  - 4. Power Electronics Disconnect Contactor. Where indicated, installed ahead of the power electronics equipment, and shall open automatically when the motor is stopped, or a controller fault is detected, or when an SCR shorts.
  - 5. Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.
  - 6. Surge Protection: Comply with NEMA ICS 2 requirements for surge suppression.
- E. Control Power:
  - 1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
  - 2. Spare CPT Capacity: As indicated on Drawings, available in increments of 100 VA, from 100 to 500 VA.
- F. Controller Diagnostics and Protection:
  - 1. Microprocessor-based thermal-protection system for monitoring SCR and motor thermal characteristics, and providing controller overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
  - 2. Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and under-load conditions; and line frequency over or under normal.
  - 3. Input isolation contactor that opens when the controller diagnostics detect a faulted soft-start component or when the motor is stopped.
- G. Cover mounted-controller status panel with LED lights or alphanumeric display to show the following:
  - 1. Starter Status: "Ready," "starting," "stopping," or "run."
  - 2. Motor current in amperes.
  - 3. Faults:
    - a. Motor overcurrent trip.
    - b. Motor thermal overload.
    - c. Starter thermal fault.
    - d. Low line voltage.
    - e. Loss of a phase.
    - f. Phases reversed.
    - g. Maximum starting time exceeded.
    - h. Serial communications error.
- H. Interface Panel:
  - 1. Guarded adjustable set points, not readily accessible.



- a. Motor FLA, adjustable from 40 to 110 percent of the controller's rating.
  - b. Current limitation on starting, adjustable from 200 to 500 percent of FLA, typically set at 300 percent.
  - c. NEMA ICS 2 overload class. Selections shall include the following tripping classes: Class 5, Class 10, Class 15, Class 20, and Class 30.
2. Adjustable set points, readily accessible, password protected.
  - a. Linear acceleration, adjustable from 1 to 60 s.
  - b. Maximum start time, adjustable from 1 to 250 s.
  - c. Selector switch; select coast to stop or soft stop.
  - d. Linear deceleration, adjustable from 1 to 60 s.
- I. Remote Output Features. All outputs shall be prewired to terminal blocks.
  1. Analog output for field-selectable assignment of motor operating characteristics; 0- to 10-V dc or 4- to 20-mA dc.
  2. Form C status contacts that change state when controller is running.
  3. Form C alarm contacts that change state when a fault condition occurs.
- J. Digital Communication Module: Modbus TCP/IP, Ethernet I/P protocol or other approved protocol to transmit the following to SCADA:
  1. Instantaneous root mean square (rms) current each phase, and three-phase average.
  2. Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average - rms.
  3. Active Energy (kilowatt-hour): Three-phase total.
  4. Power Factor: Each phase and/or three-phase total.
- K. Fusible Disconnecting Means:
  1. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate fuses.
  2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
  3. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
- L. MCP Disconnecting Means:
  1. UL 489 and NEMA AB 3 (with interrupting capacity to comply with available fault currents) instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
  2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
  3. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
  4. Alarm contact that operates only when MCP has tripped.
    - a. Current-limiting module to increase controller SCCR (withstand) to 100 kA.
- M. MCCB Disconnecting Means:
  1. UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
  2. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  3. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

4. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
5. Alarm contact that operates only when MCCB has tripped.

N. Molded-Case Switch Disconnecting Means:

1. UL 489 and NEMA AB 3, with in-line fuse block for Class J or Class L power fuses (depending on ampere rating), providing an interrupting capacity to comply with available fault currents; MCCB with fixed, high-set instantaneous trip only.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
3. Auxiliary contacts "a" and "b" arranged to activate with molded-case switch handle.
4. Alarm contact that operates only when molded-case switch has tripped.

## 2.4 BYPASS MOTOR CONTROLLER

- A. Description: Factory-assembled, combination, full-voltage electromagnetic motor controller with a disconnecting means, SCPD and OCPD, in a single enclosure. Connected as a bypass controller, operating manually, with NORMAL/BYPASS selector switch.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton.
  2. General Electric Company.
  3. Rockwell Automation, Inc.
  4. SIEMENS Industry, Inc.; Energy Management Division.
  5. Square D; by Schneider Electric.
  6. Engineer approved equal.
- C. Standard:
1. Comply with NEMA ICS 2, general purpose, Class A.
  2. Fabricate and label the bypass motor controllers to comply with UL 60947-4-1.
- D. Configuration: Across-the-line start, electrically held.
- E. Contactor Coils:
1. Operating Voltage: Manufacturer's standard unless otherwise indicated.
- F. Control Power: 120-V ac; obtained from integral CPT, with primary and secondary fuses, and with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
- G. Overload Relays:
1. Thermal-Overload Relays:
    - a. Inverse-time-current characteristic.
    - b. Class 10 tripping characteristic.
    - c. Heaters in each phase shall be matched to nameplate FLA of actual protected motor and with appropriate adjustment for duty cycle.
    - d. Ambient compensated.
    - e. Automatic resetting.

2. Solid-State Overload Relays:

- a. Switch or dial selectable for motor running overload protection.
- b. Sensors in each phase.
- c. Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

H. Class II Ground-Fault Protection: Comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system shall include circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

I. Digital Communication Module: Modbus TCP/IP, Ethernet I/P protocol or other approved protocol to transmit the following to SCADA:

1. Instantaneous root mean square (rms) current each phase, and three-phase average.
2. Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average - rms.
3. Active Energy (kilowatt-hour): Three-phase total.
4. Power Factor: Each phase and/or three-phase total.

J. Fusible Disconnecting Means:

1. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

K. Nonfusible Disconnecting Means:

1. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

L. MCP Disconnecting Means:

1. UL 489 and NEMA AB 3 (with interrupting capacity to comply with available fault currents) instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

M. MCCB Disconnecting Means:

1. UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
2. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
3. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.5 ENCLOSURES

A. Comply with NEMA 250, Type designations as indicated on Drawings, to comply with environmental conditions at installed location.

B. Construction of the enclosures shall comply with NEMA ICS 6.

- C. Controllers in hazardous (classified) locations shall comply with UL 1203.

## 2.6 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
  - 1. Push Buttons, Pilot Lights, and Selector Switches: Standard duty, except as needed to match enclosure type. Heavy-duty or oiltight where indicated in the controller schedule.
    - a. Push Buttons: As indicated in the controller schedule.
    - b. Pilot Lights: As indicated in the controller schedule.
  - 2. Elapsed Time Meters: Heavy duty with digital readout in hours resettable.
  - 3. Meters: Panel type, 2-1/2-inch (64-mm) minimum size with 90- or 120-degree scale and plus or minus 2 percent accuracy. Where indicated, provide selector switches with an off position.
- B. Breather assemblies, to maintain interior pressure and release condensation in enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- C. Space heaters, with NC auxiliary contacts, to mitigate condensation in enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- D. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

### 3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wall-Mounted Controllers: Install controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on slotted support systems complying with Section 260529 "Hangers and Supports for Electrical Systems," and bolted to wall.
- C. Freestanding Controllers: Provide slotted support systems complying with Section 260529 "Hangers and Supports for Electrical Systems."
- D. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- E. Control Wiring: Separate control wiring from power wiring. Where unavoidable, use twisted pair cabling or shielded cables for control wiring.

- F. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- G. Setting of Overload Relays: Select and set overloads on the basis of FLA rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for high-torque, high-efficiency, and so on motors.

### 3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
  - 1. Comply with provisions of NFPA 70B, Chapter "Testing and Test Methods."
  - 2. Visual and Mechanical Inspection:
    - a. Compare equipment nameplate data with Drawings and the Specifications.
    - b. Inspect physical and mechanical condition.
    - c. Inspect anchorage, alignment, and grounding.
    - d. Verify that the unit is clean.
    - e. Ensure that vent path openings are free from debris and that heat-transfer surfaces are clean.
    - f. Verify correct connections of circuit boards, wiring, disconnects, and ribbon cables.
    - g. Inspect Contactors:
      - 1) Verify mechanical operation.
      - 2) Verify that contact gap, wipe, alignment, and pressure are according to manufacturer's published data.
    - h. Motor-Running Protection:
      - 1) Verify that motor FLA is at, or under, the controller current rating.
      - 2) Verify that overload element setting is correct for its application.
      - 3) Apply minimum- and maximum-speed set points. Verify that set points are within limitations of the load coupled to the motor.
      - 4) If motor-running protection is provided by fuses, verify correct fuse rating.
    - i. Inspect bolted electrical connections for high resistance using one of the following two methods:
      - 1) Use a low-resistance ohmmeter. Compare bolted-connection-resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

- 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.

- j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

D. Motor controllers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

### 3.5 SYSTEM FUNCTION TESTS

A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality-control tests have been completed and all components have passed specified tests.

1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
3. Verify the correct operation of sensing devices, alarms, and indicating devices.

B. Motor controllers will be considered defective if they do not pass the system function tests and inspections.

C. Prepare test and inspection reports.

### 3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor controllers.

END OF SECTION 26 2913.06

## SECTION 26 4313 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
  - 2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For manufacturer's special warranty.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

#### 1.5 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 GENERAL SPD REQUIREMENTS

- A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Comply with UL 1449.

- D. MCOV of the SPD shall be the nominal system voltage.

## 2.2 SERVICE ENTRANCE SUPPRESSOR

### A. Manufacturers:

1. ABB USA
2. Advanced Protection Technologies
3. ALLTEC
4. Atlantic Scientific
5. Citel, Inc.
6. Current Technology Inc.
7. Eaton
8. General Electric Company
9. Intermatic, Inc.
10. LEA International
11. Leviton Manufacturing Co.
12. Liebert
13. Mersen USA
14. Northern Technologies, Inc.
15. Raycap, Inc.
16. SSI, an ILSCO Co.
17. Schneider Electric USA
18. Siemens Industry, Inc.
19. Square D
20. Staco Energy Products Co.
21. Or engineer approved equal.

### B. SPDs: Comply with UL 1449, Type 1.

1. SPDs with the following features and accessories:
  - a. Integral disconnect switch.
  - b. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
  - c. Indicator light display for protection status.

### C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 320 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

### D. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V.
2. Line to Ground: 1200 V for 480Y/277 V.
3. Line to Line: 2000 V for 480Y/277 V.

### E. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V.
2. Line to Ground: 700 V.
3. Line to Line: 1000 V.



- F. SCCR: Equal or exceed 100 kA.
- G. Inominal Rating: 20 kA.

## 2.3 PANEL SUPPRESSORS

### A. Manufacturers:

1. ABB USA
2. Advanced Protection Technologies
3. ALLTEC
4. Atlantic Scientific
5. Citel, Inc.
6. Current Technology Inc.
7. Eaton
8. General Electric Company
9. Intermatic, Inc.
10. LEA International
11. Leviton Manufacturing Co.
12. Liebert
13. Mersen USA
14. Northern Technologies, Inc.
15. Raycap, Inc.
16. Schneider Electric USA
17. Siemens Industry, Inc.
18. Square D
19. SSI, an ILSCO Co.
20. Or engineer approved equal.

### B. SPDs: Comply with UL 1449, Type 1.

1. Include LED indicator lights for power and protection status.
2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.

### C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

### D. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V.
2. Line to Ground: 1200 V for 480Y/277 V.
3. Neutral to Ground: 1200 V for 480Y/277 V.
4. Line to Line: 2000 V for 480Y/277 V.

### E. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V.
2. Line to Ground: 700 V.
3. Neutral to Ground: 700 V.
4. Line to Line: 1200 V.

- F. SCCR: Equal or exceed 100 kA.
- G. Inominal Rating: 20 kA.

## 2.4 ENCLOSURES

- A. Indoor Enclosures: NEMA 250, Type 1.
- B. Outdoor Enclosures: NEMA 250, Type 3R.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.
- C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
- D. Use crimped connectors and splices only. Wire nuts are unacceptable.
- E. Complete startup checks according to manufacturer's written instructions. Energize SPDs after power system has been energized, stabilized, and tested.

### 3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
  - 1. Compare equipment nameplate data for compliance with Drawings and Specifications.
  - 2. Inspect anchorage, alignment, grounding, and clearances.
  - 3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. An SPD will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.3 DEMONSTRATION

- A. Train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 26 4313

## SECTION 26 6000 – ELECTRIC CONTROL PANELS

### PART 1 - GENERAL

#### 1.1 SCOPE OF WORK

- A. Provide the Auxiliary Control System equipment and accessories as indicated on the plans including relays, photocells, contactors, pushbuttons, selector switches, pilot lights, timers, panels, etc., for a complete and operable control system. Provide the indicated control devices, control panels, control systems and associated wiring where specifically shown and detailed on the plans. Connect such control equipment to the starters, contactors and power equipment specified elsewhere in Division 26, or to the HVAC, plumbing, architectural and owner's appliances and/or process equipment as indicated on the plans.
- B. This Contractor shall provide remote interlock and control wiring for package type control panels for process equipment all as shown or described in other sections of these specifications.

#### 1.2 RELATED DOCUMENTS

- A. Refer to Section 26 0500 for general requirements for the electrical work.
- B. Refer to Section 26 6005 for SCADA System work.
- C. Refer to other specification divisions for equipment supplied by others, which requires control wiring by this Contractor.

#### 1.3 SUBMITTALS

- A. Submit standard catalog cuts for control components and devices, indicating electrical ratings and physical sizes, mounting details, and rough-in-data.
- B. For all custom built or assembled panels, submit layouts of front covers and interior equipment, preliminary wiring schematics and bills of material for components.
- C. Contract close-out documentation shall include update submittal drawings indicating the "as installed" condition of all panels, cabinets, and control components.

### PART 2 - PRODUCTS

#### 2.1 AUXILIARY CONTROL PANELS AND RELAY CABINETS

- A. Enclosure and Wiring:
  - 1. Panels shall be custom fabricated and assembled, complete with cover mounted visual annunciator units and all internal components, as detailed on the drawings.
  - 2. Panels shall be housed in a wall or stand mounted NEMA 12 (indoor) or NEMA 4X SS (outdoor) enclosure with backplate, hinged cover door with latch, similar to Hoffman Bulletin #A-12. NEMA 12 panels shall be constructed of code gauge steel, primed and

- painted with two (2) coats of oven baked enamel. The exterior finish shall be free of scratches and blemishes. Any damage to the finish during installation shall be touched up in kind. The finish shall be cleaned of all dirt and smudges after installation.
3. Panel wiring shall be front accessible and connected, adequately supported and neatly routed in plastic wireway (Panduit) or bundled with plastic tie-wrap devices. Wiring shall be identified at each termination, to correspond with the numbering system indicated on the schematic diagram. Internal wiring shall be color-coded per J.I.C. standards and sized to match system requirements.
  4. Major components and relays shall be provided with painted or stenciled nameplates inside the enclosure with lettering to correspond with the designation on the schematic diagram. DYMO Type adhesive labels are not acceptable.
  5. The panel shall be provided with cover mounted engraved laminate nameplates as indicated on the plans.
- B. Relays shall be 3 pole, double throw with 10 ampere contact and 120 volt continuous duty AC coils as shown on the drawings. Relays shall be Ice Cube Type, enclosed, complete with 11 Pin Tube Type Plug-In Termination. Relays shall be Square D Co. Class 8501 Type KP-13 with Type NR-62 sockets, or equal by Potter-Brumfield, Allen-Bradley, Struthers-Dunn, or Cutler Hammer.
- C. Heavy Duty Relays shall be multi-pole industrial units with field reversible contacts, 20 ampere continuous load rating, 120 volt coils, and screw terminals. Heavy Duty Relays shall be individually mounted to backplates as shown or required. Heavy Duty Relays shall be Square D Co. Class 8501 Type XMO, or equal by Cutler Hammer, or Allen Bradley.
- D. Terminal strips shall be modular, track mounted, rated for 600 volts, 20 amperes minimum, with solderless box lug terminal. Square D Co. class 9080, type GK6 or equal.

## 2.2 AUXILIARY CONTROL COMPONENTS

- A. Pushbuttons, selector switches and separately mounted pilot lights shall be heavy duty oil tight control devices as manufactured by Square D, General Electric, Allen Bradley or engineer approved equal complete with engraved legend nameplate. Separately mounted devices shall be located in NEMA 12 device boxes where indoors, or in NEMA 4X stainless steel gasketed enclosures where outdoors or in damp corrosive environments. Pilot lights shall be LED type for 120 Volt operation.
- B. Photocells are integral to the light fixture.
- C. Occupancy sensor: See drawings for specifications.

## 2.3 CONTROL SYSTEM WIRING

- A. All 120 volt control wiring shall be No. 14 AWG minimum; wiring for 24 volt (or lower) systems shall be No. 18 AWG minimum. Wiring shall be color-coded to match the control panel wiring. Route AC conductors and DC conductors in separate raceways.
- B. Special control or instrumentation cables shall be matched to the requirement of the device manufacturer. Provide multiple solid or stranded conductors, complete with foil shield and an overall jacket in accordance with the device manufacturer's recommendations. Maintain separation of special instrumentation cables from other panel wiring as required.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Timers shall be located where shown, rigidly mounted with top of enclosure at six feet, (6'0") above the floor. Provide each timer with nameplate and designated as shown on plans; affix to inside of door.
- B. All meters and instrumentation will be furnished by the General Contractor or the Owner. All interconnections and wiring shall be by Electrical Contractor, all as described in other portions of these specifications, and as recommended by the Equipment Supplier.
- C. Control panels and relay cabinets shall be installed and rigidly mounted with top of enclosure at six feet (6'0"), above the floor. Provide all field wiring, connections and terminations at remote components as indicated on the system schematic diagram. Identify all field wiring at each termination, to correspond with the numbering system indicated on the system schematic diagram.

#### 3.2 FIELD TESTING

- A. Verify proper operation of timers and photocells. Obtain preliminary timer set points from owner and adjust equipment accordingly.
- B. Control panels and system provided under this section, shall be field checked with all functions tested and demonstrated in the presence of the Owner and Associate at the site.

#### 3.3 TRAINING

- A. Train designated Owner's personnel in the operation and adjustment capabilities of each control component.

END OF SECTION 26 6000

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## SECTION 26 6005 – SCADA SYSTEM

### PART 1 - GENERAL

#### 1.1 SCOPE

- A. The work covered by this section of the specifications consists of furnishing all plant, labor, equipment, and materials in connection with the supply and installation of one (1) telemetry systems equipment and appurtenant work. Training of Owner personnel shall be included.
- B. The telemetry systems shall include all required equipment, software, and programming for complete operating systems. The systems are located at the raw sewage pump stations on W. Maple St. and E. Maple St. and Damascus Street in Liberty Center, Ohio. The site will communicate via licensed radio connection.
- C. The system components shall consist of:
  - 1. New Raw Sewage Pump Stations/RTUs
    - a. New RTUs with communications via licensed radio frequency currently in use by the city Water Dept.
- D. The contractor is responsible for reprogramming the user interface, backup equipment, operator interfaces, and communication systems at the pump station and any required remote location to incorporate the additional RTU inputs, screens, reports, etc. and any remote operator interface equipment.
- E. The radio communication system shall be configured as required for proper communication with the master station. The method and data path shall be determined by the telemetry system vendor.

#### 1.2 RELATED SECTIONS

- A. Section 26 0500 - General Electrical Provisions.
- B. Section 26 0515 - Basic Materials and Methods.

#### 1.3 SUBMITTALS

- A. Submit three copies of the following documentation for review.
- B. Submit product data:
  - 1. Material list of items to be provided under this Section.
  - 2. Manufacturer's product data and other related information to prove compliance with specified requirements.
  - 3. Wiring diagrams with I/O points shown.
  - 4. Operation and Maintenance manual for the new equipment.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site in a manner acceptable to the manufacturer so as to not void any warranties.
- B. Accept products on site in factory containers. Inspect for damage.
- C. Store products in clean, dry area; maintain temperature and humidity within limits acceptable to the manufacturer.

1.5 MAINTENANCE SERVICE

- A. Furnish manufacturer's service and maintenance of all materials furnished under this Section until the date of Substantial Completion.
- B. All materials furnished under this Section shall be warranted by the manufacturer for a minimum of one year commencing with the date of Substantial Completion.

1.6 QUANTITIES

- A. All materials specified as part of this Section shall be provided in quantities as required by contract documents and as required for a complete operational system.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Shall conform to the following requirements. Configuration and quantities of devices shall be as specified or shown on the Drawings. Should additional appurtenances be required, but not specifically indicated here or elsewhere, in order to affect the intent of the contract documents, such appurtenances shall be provided.

2.2 MANUFACTURER REFERENCES

- A. The system described and shown by the contract documents has been designed around the manufacturers identified. The equipment from these manufacturers must be used as the base bid. Substitutions to the listed manufacturers must be identified in the bid documents.
- B. The RTU equipment and programming requirements shall be provided by The Bergren Associates, Inc. unless otherwise indicated.

2.3 REMOTE TERMINAL UNITS (RTUs)

- A. The RTUs and antennas shall be provided by The Bergren Associates, Inc., 6641 Sylvania Ave., Sylvania, Ohio 43560 to mount and interface with the new pump station equipment, and any other necessary equipment (water tower, etc.) in a NEMA 4X stainless steel enclosure with condensation prevention heaters.



- B. The RTUs shall have a total memory complement required for the operation and functions specified with spare capacity for future requirements.
- C. Power supply shall provide power for the RTU systems. Line voltage shall be 115 VAC and be rated for the voltage and current capacity as required for the RTU systems.
- D. Provide a battery back-up power supply for the RTUs. Voltage shall be 115VAC. Back-up power shall consist of a rechargeable sealed battery with a trickle charger, both sized to provide back-up power for all devices requiring power for operation of the RTUs and panel displays for a minimum of one hour. RTU supply shall be mounted in the enclosure.
- E. Operating programs, system setting, configuration, parameter set points required for RTU operations shall be stored on EEPROM.
- F. The RTUs shall employ a Siemens/Primex programmable controller with expansion capabilities for the addition of future I/O and pump station monitoring functions.

### PART 3 - EXECUTION

#### 3.1 TELEMETRY EQUIPMENT AND PROGRAMMING

- A. Contact Mr. Jim Schaffer at The Bergren Associates, Inc. at 419-843-2170 and jimschaffer@bergren.com to coordinate the furnishing of required equipment and service.
- B. The Contractor shall include in his contract price a total allowance of **\$50,000.00 per RTU** for The Bergren Associates, Inc. to provide the following equipment and services.
  - 1. City of Liberty Center – New Raw Sewage Pump Station
    - a. Furnish three 32) new RTUs.
    - b. RTUs to include equipment for I/O and radio communications.
    - c. Setting up the communication system from the RTUs to the user interface and coordinate with the **Village**.
    - d. Termination of all wiring inside the RTUs.
    - e. Reprogramming of the operator interface equipment to include new pump station equipment in the SCADA System including graphic, trends, logs, etc.
    - f. Check out and start up including verification of input signals from the control panels and equipment.
    - g. Install wireless device approved by the **Village**.
    - h. Furnish and install antenna, antenna cable, and surge arrester on RTUs.
- C. Work by Electrical Contractor (Not Included in Allowance)
  - 1. Installation of the RTUs in the pump stations.
  - 2. Furnish and install raceway and wiring between RTUs and equipment including power source.
  - 3. Termination of wiring outside the RTUs.
  - 4. Provision and installation of a 30' tall wooden utility pole for use as an antenna structure at each PS site. Provide minimum 1-1/4" conduit with sweep bends from each RTU to the top of the pole, terminated with a weatherhead. Conduit to have pull string left in place to facilitate installation of antenna cable at time of start-up (cable by Bergren)."

### 3.2 INSTALLATION

- A. The Electrical Contractor shall be responsible for the installation of the raceway, wiring, and wire terminations.
- B. Install in accordance with published manufacturer's instructions and standard trade practices.
- C. Do not install products until major construction is complete and building interior is enclosed and heated.
- D. Connect input and output devices as indicated.

### 3.3 FIELD QUALITY CONTROL

- A. Field inspection, commissioning, and testing will be performed under provisions of Section 26 6009 by the equipment suppliers.
- B. Perform operational testing on control systems to verify proper operation and field wiring connections.

### 3.4 TRAINING

- A. The Contractor shall include four (4) hours of training at the construction site for the Owner's personnel on the operation, maintenance and programming of the instrumentation control, telemetry and radio equipment.
- B. The Training personnel shall be qualified and certified to provide training for the equipment provided.
- C. All costs associated with the training including travel and living, training documents and presentation equipment, except Owner personnel time, shall be included.

## PART 4 - SPECIAL PROVISIONS

### 4.1 RTU SCHEDULE

- A. This subpart is intended to assist the Contractor with coordinating the locations of specific devices that are specified in this Section. Shown on the Input/Output (I/O) List are the I/O points to be wired to/from the RTUs.
- B. If an isolated signal is not available from the primary device to the RTU input structure or if interposing relays are required to properly interface to existing circuits, the necessary interfaces shall be provided at no additional cost. Relays shall be minimum DPDT, with coil voltages and contact ratings as required for the application.

- C. Conventional I/O addressing shall be used to identify the location of the I/O point to be incorporated into the I/O structure.
- D. All spare points shown on the Input/Output List or not used by the process shall be wired from the enclosure terminal blocks to the appropriate I/O modules.

#### 4.2 TELEMETRY FUNCTIONAL DESCRIPTION

- A. General Programming
  - 1. The telemetry system RTUs I/O, display functions and alarms are listed in the RTUs I/O listing.
- B. Raw Sewage Pump Stations
  - 1. The new RTUs shall be furnished with I/O equipment and programming for the total I/O listed.
  - 2. The RTUs shall include equipment to communicate with the server and other RTUs via radio connection.
  - 3. The RTUs shall include a battery backup system.
  - 4. The RTUs enclosure shall be a stainless steel NEMA 4X enclosure and be installed on a rack at the pump station.
- C. System User Interface
  - 1. Update software to incorporate the inputs into all appropriate displays, controls, trends, and reports for the new pump station.

#### 4.3 I/O LISTING

- A. The I/O Listing is as follows:
  - 1. The RTUs shall include chassis space and power supply capacity for the addition of future I/O modules.
  - 2. The following I/O shall be incorporated into the new pump station RTUs via hardwire connection: (\*)


(\*) Includes Station A – Damascus Street.

END OF SECTION 26 0553

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## SECTION 26 6009 – CONTROL SYSTEM TESTING

### PART 1 - GENERAL

#### 1.1 SCOPE OF WORK

- A. The work covered by this Section of the specifications consists of furnishing all labor, equipment, and materials in connection with the testing of the new Raw Sewage Pump Station RTUs, consisting of the PLC system, the operator interface system (if any), the primary devices, and all control enclosures and wire/cable.

#### 1.2 SUBMITTALS

- A. Submit under provisions of Section 01 and this paragraph.
- B. Test Procedure Submittal Schedule:
  - 1. Factory test: minimum thirty (30) days prior to scheduled test.
  - 2. Commissioning: minimum thirty (30) days prior to scheduled test.
- C. Submittal format:
  - 1. For all submittals, three (3) complete sets of hard print-out in binders of all proposed test procedures.

#### 1.3 SCHEDULING

- A. The Contractor shall formally schedule the commissioning or test with the Engineer a minimum of thirty (30) days prior to the proposed test date. Included with this notification shall be the proposed hardware commissioning or checkout test procedures for the Engineer to review. These procedures shall include all steps proposed by the Contractor to prove that the intent of the commissioning or test is accomplished.
- B. Test Suspension - If the Contractor schedules a test, and in the opinion of the Engineer and Owner after on-site inspection, the hardware is not ready to be tested, the Owner shall suspend the test until the Contractor corrects all deficiencies.

### PART 2 - PRODUCTS

- A. NONE

### PART 3 - EXECUTION

#### 3.1 FACTORY TEST REQUIREMENTS

- A. Factory tests are only required for systems with 10 or more RTUs or PLCs with 200 or more I/O points. Factory testing of the PLC and Operator Interface Systems shall be performed by the

Contractor in the presence of the Engineer and Owner prior to the software testing and installation of the plant control system. The purpose of the test is to demonstrate that all hardware and communications perform as intended by the specifications and Drawings.

1. Location - The factory test shall be held at the facilities of the Contractor or his subcontractor.
2. Costs - The Contractor shall be responsible for all costs associated with the factory test, except the direct costs of attendance by the Engineer and Owner.
  - a. Owner Reimbursed Costs - Should the factory test be suspended for reasons outlined in this Section, the Contractor shall reimburse the Owner for all costs incurred by the Owner associated with the Owner's and the Owner's Engineers' attendance at the factory test.
3. Personnel - The Contractor shall provide all personnel and equipment necessary to properly perform the hardware checkout at the factory test. The hardware checkout testing period shall continue until the Contractor and Engineer/Owner have mutually agreed that the test results are acceptable.
4. Factory Test Procedures - Shall include, but not be limited to, the following:
  - a. Hardware Checkout - The Contractor shall prove that all systems are constructed in accordance with all specifications and codes. The Contractor shall prove that each PLC input point is recognized from the terminal strip into the processor's memory, and each PLC output is energized at the terminal strip from the PLC's memory. All addressing and power settings shall be set prior to the commencement of the test and verified during the test. All necessary programming terminals, signal generators, and multimeters shall be provided by the Contractor at no additional cost to the Owner.
  - b. Communication Testing - The Contractor shall prove that all components shall communicate with all other components, to the extent that all hardware is proven to work and is reliable. All necessary multimeters, signal generators, communication testing specific software, and programming terminals used for the test shall be provided by the Contractor at no additional cost to the Owner.
  - c. Software Testing - All control software developed for the PLC and operator interface systems will be proven as part of the factory test by the Engineer and Owner. The Contractor shall permit the use of the equipment identified under the subparagraph Hardware Checkout.
5. Software testing will commence immediately upon the conclusion of the hardware checkout and communications testing.
6. Factory Test Duration - It is anticipated that the factory test will take five consecutive days (Monday through Friday) to complete. These five days are expected to consist of one day for hardware checkout and communications testing, and four days for software testing. In the event that deficiencies in the hardware checkout or communications testing are found that in the opinion of the Owner and Engineer cause the software testing to be delayed, the Owner reserves the right to invoke the provisions of the Test Suspension paragraph of this Section or extend the factory test beyond the scheduled five test days at no additional cost to the owner.
7. Scheduling shall be per Section 1.4 of this Specification.

### 3.2 COMMISSIONING

- A. Commissioning of the PLC/RTU system shall be performed by the Contractor in the presence of the Engineer and Owner. The purpose of the commissioning effort is to demonstrate that all

systems and components are installed and function as intended by the specifications and Drawings.

1. Scheduling shall be per Section 1.4 of this Specification.
2. Field inputs to each PLC/RTU shall be activated at the field device and the signal verified in the memory of the PLC or MTU. This function is the field equivalent to Factory Test Procedures - Hardware Checkout and Communications Testing. In addition, each wiring circuit shall be tested for continuity, short circuits, and ground faults.
3. Final calibration of all instrumentation shall be performed during the commissioning effort. All power supplies shall be adjusted to their final settings. The Contractor shall complete a calibration certificate for each instrument installed under this contract. The certificate shall be signed by the Contractor's field technician and indicate values tested, expected values, actual values obtained, and accuracy. Completed certificates shall be submitted to the Engineer for record purposes.
4. The Contractor shall supply all necessary personnel to perform the commissioning. The Owner and Engineer will only act as observers to verify the completeness of the commissioning.

### 3.3 FIELD TESTING

- A. Field testing of the control system will be performed by the Engineer and Owner after the installation and commissioning of the control system by the Contractor. The purpose of the test is to demonstrate that all hardware and software performs as intended by the design of the control system.
  1. Scheduling - The field test will begin after the acceptable conclusion of the installation and commissioning effort. The Engineer will notify the Contractor in writing of the actual field test commencement date. On small systems may immediately follow commissioning.
  2. Contractor Involvement - The Contractor shall provide the services of one field technician for a period of two consecutive weeks, beginning at the start of the field test. This field technician need not be on site, but must be available on site within 24 hours of notification of the Contractor's designated representative. The field technician's services during the field test shall be stated in the bid documents (maximum of four 8-hour days). The field technician shall report directly to the Engineer and be under his direction during this time. The duties of the field technician shall include, but not be limited to redirection of radio antennas, recalibration of field devices, monitoring process values, troubleshooting control circuits, and tracing field wiring. Any time spent by the Contractor resolving commissioning issues shall not be considered part of this involvement.
  3. Field Test Suspension - In the event the field test is suspended for any reason, the Owner reserves the right to notify the Contractor of such, and rescheduled the unused availability and field time of the Contractor's field technician.

### 3.4 TESTING ACCESSORIES

- A. The Contractor shall be responsible for supplying all required and necessary equipment to properly conduct the testing and commissioning required by this Section.

END OF SECTION 26 6009



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## SECTION 27 0528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Metal wireways and auxiliary gutters.
5. Nonmetallic wireways and auxiliary gutters.
6. Metallic surface pathways.
7. Nonmetallic surface pathways.
8. Hooks.
9. Boxes, enclosures, and cabinets.
10. Polymer-concrete handholes and boxes for exterior underground cabling.

#### 1.2 ACTION SUBMITTALS

- A. Product data for each type of product.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Pathway routing plans, drawn to scale and coordinated with each other, using input from installers of items involved.
- B. Qualification Data: For professional engineer.

### PART 2 - PRODUCTS

#### 2.1 METAL CONDUITS AND FITTINGS

- A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.
- B. General Requirements for Metal Conduits and Fittings:
1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
  2. Comply with TIA-569-D.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. ARC: Comply with ANSI C80.5 and UL 6A.

- E. IMC: Comply with ANSI C80.6 and UL 1242.
- F. PVC-Coated Steel Conduit: PVC-coated GRC.
  - 1. Comply with NEMA RN 1.
  - 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- G. EMT: Comply with ANSI C80.3 and UL 797.
- H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
  - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
  - 2. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
  - 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
- I. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

## 2.2 NONMETALLIC CONDUITS AND FITTINGS

- A. Description: Nonmetallic raceway of circular section with manufacturer-fabricated fittings.
- B. General Requirements for Nonmetallic Conduits and Fittings:
  - 1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
  - 2. Comply with TIA-569-D.
- C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- D. Rigid HDPE: Comply with UL 651A.
- E. Continuous HDPE: Comply with UL 651A.
- F. RTRC: Comply with UL 2515A and NEMA TC 14.
  - 1. Fittings: Comply with NEMA TC 3; match to conduit or tubing type and material.
- G. Solvents and Adhesives: As recommended by conduit manufacturer.

## 2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for general-use installation unless otherwise indicated.
  - 1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
  - 2. Comply with TIA-569-D.

## 2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.
- B. General Requirements for Metal Wireways and Auxiliary Gutters:
  - 1. Comply with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
  - 2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
  - 3. Comply with TIA-569-D.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

## 2.5 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.
- B. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.
- C. General Requirements for Nonmetallic Wireways and Auxiliary Gutters:
  - 1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
  - 2. Comply with TIA-569-D.
- D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.
- E. Solvents and Adhesives: As recommended by conduit manufacturer.

## 2.6 SURFACE METAL PATHWAYS

- A. Description: Galvanized steel with snap-on covers, complying with UL 5.
- B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- C. Comply with TIA-569-D.

## 2.7 SURFACE NONMETALLIC PATHWAYS:

- A. Description: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC.

- B. Finish: Texture and color selected by Architect from manufacturer's standard colors.
- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with TIA-569-D.

## 2.8 HOOKS

- A. Description: Prefabricated sheet metal cable supports for telecommunications cable.
- B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- C. Comply with TIA-569-D.
- D. Stainless steel.
- E. U shape.

## 2.9 BOXES, ENCLOSURES, AND CABINETS

- A. Description: Enclosures for communications.
- B. General Requirements for Boxes, Enclosures, and Cabinets:
  - 1. Comply with TIA-569-D.
  - 2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
  - 3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
  - 4. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep)
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, Type FD, with gasketed cover.
- E. Metal Floor Boxes:
  - 1. Shape: Rectangular.
  - 2. Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Nonmetallic Floor Boxes: Nonadjustable, rectangular.
  - 1. Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

- I. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- J. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, with continuous-hinge cover with flush latch unless otherwise indicated.
  - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2. Nonmetallic Enclosures:
    - a. Material: Plastic or Fiberglass.
    - b. Finished inside with radio-frequency-resistant paint.
  - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- K. Cabinets:
  - 1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
  - 2. Hinged door in front cover with flush latch and concealed hinge.
  - 3. Key latch to match panelboards.
  - 4. Metal barriers to separate wiring of different systems and voltage.
  - 5. Accessory feet where required for freestanding equipment.
  - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.10 POLYMER-CONCRETE HANDHOLES

- A. Description: Molded of sand and aggregate; bound together with polymer resin; and reinforced with steel, fiberglass, or a combination of the two.
- B. General Requirements for Polymer Concrete Handholes:
  - 1. Boxes and handholes for use in underground systems shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
  - 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
  - 3. Comply with TIA-569-D.
- C. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
- D. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
  - 1. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  - 2. Cover Legend: Molded lettering, "COMMUNICATIONS" -

## PART 3 - EXECUTION

### 3.1 PATHWAY APPLICATION

- A. Minimum Pathway Size: 3/4-inch (21-mm) trade size for copper and aluminum cables, and 1 inch (25 mm) for optical-fiber cables.

- B. Pathway Fittings: Compatible with pathways and suitable for use and location.
- C. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- D. Install surface pathways only where indicated on Drawings.
- E. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

### 3.2 INSTALLATION

- A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
  - 1. NECA 1.
  - 2. NECA/BICSI 568.
  - 3. TIA-569-D.
  - 4. NECA 101
  - 5. NECA 102.
  - 6. NECA 105.
  - 7. NECA 111.
- B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- C. Comply with requirements in Section 260529 "Hangers and Supports for Communications Systems" for hangers and supports.
- D. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.
- E. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- F. Complete pathway installation before starting conductor installation.
- G. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches (300 mm) of changes in direction. Utilize long radius ells for all optical-fiber cables.
- H. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- I. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- J. Pathways Embedded in Slabs:
  - 1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot (3-m) intervals.
  - 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
  - 3. Arrange pathways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.
  - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

5. Change from nonmetallic conduit and fittings to RNC, Type EPC-40-PVC, and fittings before rising above floor.
- K. Stub-ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for pathways.
  2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- L. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- M. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- N. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.
- O. Cut conduit perpendicular to the length. For conduits of 2-inch (50-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- P. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.
- Q. Surface Pathways:
1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
  2. Install surface pathway with a minimum 2-inch (50-mm) radius control at bend points.
  3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- R. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
1. 3/4-Inch (21-mm) Trade Size and Smaller: Install pathways in maximum lengths of 50 feet (15 m).
  2. 1-Inch (25-mm) Trade Size and Larger: Install pathways in maximum lengths of 75 feet (23 m).
  3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- S. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.



- T. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  2. Where an underground service pathway enters a building or structure.
  3. Where otherwise required by NFPA 70.
- U. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- V. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT that is located where environmental temperature change may exceed 100 deg F (55 deg C), and that has straight-run length that exceeds 100 feet (30 m).
  2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
    - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
    - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
    - d. Attics: 135 deg F (75 deg C) temperature change.
  3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
  4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
  5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- W. Hooks:
1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
  2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
  3. Hook spacing shall allow no more than 6 inches (150 mm) of slack. The lowest point of the cables shall be no less than 6 inches (150 mm) adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
  4. Space hooks no more than 5 feet (1.5 m) o.c.
  5. Provide a hook at each change in direction.

- X. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- Y. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
- Z. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- AA. Set metal floor boxes level and flush with finished floor surface.
- BB. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

### 3.3 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
  - 1. Excavate trench bottom to provide firm and uniform support for conduit. Install backfill.
  - 2. After installing conduit, backfill and compact.
  - 3. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
    - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete around conduit for a minimum of 12 inches (300 mm) on each side of the coupling.
    - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
  - 4. Underground Warning Tape: Comply with requirements in Section 270553 "Identification for Communications Systems."

### 3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.
- D. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 0544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in NFPA 70.

3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 27 0528

## SECTION 40 7213 – LEVEL MEASUREMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. General: Drawings and general provisions of Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to work of this section.

#### 1.2 DESCRIPTION OF WORK

- A. General: Provide the labor, tools, equipment, and materials necessary to install level measurement equipment in accordance with the contract drawings and as specified herein.
- B. Types: The types of equipment specified in this section include the following:
  - 1. Float switches.

#### 1.3 QUALITY ASSURANCE

- A. A. Codes and Standards: Perform all work associated with level measurement equipment in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.
  - 1. National Electrical Manufacturers Association (NEMA) Compliance.
  - 2. National Electrical Code (NEC) Compliance.
  - 3. Underwriters' Laboratories, Inc. (UL) Compliance and Labeling: Comply with provisions of UL safety standards pertaining to level measurement equipment. Provide products and components that have been UL listed and labeled.

#### 1.4 SUBMITTALS

- A. General: Furnish manufacturer's product data, test reports, and material certifications as required.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping: Deliver equipment properly packaged and mounted on pallets or skids to facilitate handling of heavy items. Utilize factory fabricated type containers or wrappings that protect components from damage.

## PART 2 - PRODUCTS

### 2.1 FLOAT SWITCHES

#### A. Features

1. Hermetically sealed non-metallic float housing.
2. Zinc plated cast iron split weight.
3. Mechanically activated SPDT micro switch.
4. Heavy duty, flexible, submersible cable connected to float with watertight seal.

#### B. Accessories

1. Enamel finished cast iron weight kit, bolt assembled to float cable.
2. Mounting bracket with cord grips for adjusting float elevation.

#### C. Materials

1. Float: Polypropylene.
2. Cable Jacket: Polyvinyl chloride (PVC).
3. Mounting bracket: Stainless steel.

#### D. Sizes and Ratings

1. Switch: 5 amperes minimum at 120 volts alternating current (Vac).
2. Length: 30 feet minimum.

#### E. Manufacturers: Conery Manufacturing, or equal.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verification of Conditions: Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
- B. Discrepancies: Immediately notify the Engineer in writing of any discrepancies discovered. Do not proceed with installation until all discrepancies have been fully resolved.

### 3.2 PREPARATION

#### A. Protection

1. All equipment and materials shall be packaged at the factory to protect each item from damage during shipment and storage.
2. Provide blocking and cushioning materials to prevent damage during shipment.
3. Provide temporary lifting lugs on shipping package as needed.
4. Include approximately 1 pint of touch-up paint for each finish color in shipment.

- B. Surface Preparation: Carefully lay out work in advance. Where cutting, drilling, etc., of floors, walls, ceilings, or other surfaces is necessary; this work shall be carefully done. Any damage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved, and at no additional cost to the Owner.

### 3.3 INSTALLATION

#### A. General

- 1. Install equipment as indicated in accordance with manufacturer's written instructions and in compliance with recognized industry practices.
- 2. Mount instruments so that they may be readily approached and easily serviced.
- 3. Install transmitters with local indicators in a position readily observable from the operating area.
- 4. Level Measurement Installation
  - a. Coordinate the installation of level sensing devices with the process equipment and contract drawings.
  - b. Install manufacturer's supplied cable between level element and transmitter. If flexible conduit is not provided or where conditions dictate, furnish and install rigid conduit sized according to manufacturer's recommendations.

#### B. Float Switches

- 1. Install as shown on the drawings.
- 2. Support with stainless steel cable.
- 3. Install cable connector and strain relief on cord.
- 4. Install conduit seal in accordance with NEC requirements.

### 3.4 FIELD QUALITY CONTROL

- A. Calibration: Provide for the service of a certified representative of the manufacturer to calibrate all level transmitters. Provide labor, materials, tools, and equipment required to calibrate the level transmitters.
- B. Inspection: Upon completion of this portion of the work, the Contractor shall provide for services of a qualified representative of the manufacturer to inspect and approve installation.
- C. Tests: Upon completion of all inspections, and prior to acceptance, perform field tests outlined in Division 40 Section "Instrumentation – General".

### 3.5 CLEANING

- A. Level Measurement: Each level device shall be kept clean and free of dust during the storage, start-up, demonstration, and warranty period.

### 3.6 EQUIPMENT SCHEDULE

- A. Provide a total of two (4) float switches per pump station.

END OF SECTION 40 7213

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