NWP NACIMIENTO WATER PROJECT

San Luis Obispo County Flood Control & Water Conservation District

SAN LUIS OBISPO COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

Technical Memorandum (TM) - 21
System Expansion and Modifications
Conceptual Details and Requirements

March 2011

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MEMORANDUM

SLO County Flood Control and Water Conservation District
Nacimiento Water Project
TM 21 – System Expansion and Modifications
Conceptual Details and Requirements

B&V Project 149789
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EXECUTIVE SUMMARY

This Technical Memorandum (TM) is meant to develop alternative methods for incorporating future turnouts into the Nacimiento Water Project (NWP) along the 45 miles of pipelines. Table ES-1 provides details of pipelines from Lake Nacimiento to the last turnout at San Luis Obispo.

Table ES-1: Details of Existing NWP Pipeline

Unit	Description	Pipe Material	Pipeline Diameter (inches)	Phase I		Ultimate	
				Flowrate (cfs)	Velocity (fps)	Flowrate (cfs)	Velocity (fps)
A	IPS to Camp Roberts West Property Line	Steel	36	23.49	3.32	32.79	4.64
A1	Camp Roberts West Property Line to CRT	Steel	36/30	23.49	3.32/4.79	32.79	4.64/ 6.68
C	CRT Discharge to Monterey Road / Wellsona	Steel	36	23.49	3.32	32.79	4.64
C1	Monterey Road / Wellsona to Sta. 829+50	Steel	36	23.49	3.32	32.79	4.64

Unit	Description	Pipe Material	Pipeline Diameter (inches)	Phase I		Ultimate	
				Flowrate (cfs)	Velocity (fps)	Flowrate (cfs)	Velocity (fps)
C1	From Sta. 829+50 to T2 Turnout Tee off (Paso Robles)	Steel	30	23.49	4.79	32.79	6.68
T2	Paso Robles Turnout	DI and Steel	24	9.03	2.87	12.90	4.10
B	Santa Ysabel Pump Station	Steel	24	14.46	4.60	19.89	6.33
D	Paso Robles Turnout Tee off to T4 (TCSD) Turnout Tee off (excluding Unit B)	DI and Steel	24	14.46	4.61	19.89	6.33
T4	TCSD Turnout	DI and Steel	8	1.03	2.98	1.27	3.64
E	T4 Turnout Tee off to T6 (AMWC) Turnout Tee off	DI	24	13.43	4.27	18.62	5.93
T6	AMWC Turnout	DI and Steel	18	8.28	4.69	10.22	5.78
F	T6 Turnout Tee off to RCT Inlet	DI	18	5.14	2.91	8.40	4.76
F1	RCT	DI	18	5.14	2.91	8.40	4.76
F2	RCPS	Steel	18	5.14	2.91	8.40	4.76
G	RCPS Discharge to Route 58/Maria Avenue	DI	18	5.14	2.91	8.40	4.76
G1	Route 58/Maria Avenue to CTT Inlet	DI	18	5.14	2.91	8.40	4.76
G2	CTT	DI	18	5.14	2.91	8.40	4.76
H	Cuesta Tunnel (existing)	Steel	24	5.14	1.64	8.40	2.67
H1	Cuesta Tunnel to T11 (SLO/CSA10A) Turnout	DI	12	5.14	6.54	8.40	10.70
T11	SLO/CSA10A Turnout	Steel	12	5.14	6.54	8.40	10.70

The main pipe sizes vary from 36 inch to12 inch, and two different materials have been used – steel and ductile iron. Some of the pipe sections are installed underground, and some are installed above ground.

Before deciding on a new turnout location, the hydraulics at the preferred location shall be given due consideration to ensure that adequate pressure is available for the required flowrate. Other considerations like easements, orientation of the air valves or pumpout when they are used, location of nearest pull box for fiber optic cable connection, space for installing the turnout structure, valves, controls, and piping and operational impact to the hydraulic transient control shall be adequately considered.

Electromagnetic flowmeters are recommended at turnouts. Flowmeters shall be sized to keep the velocity between 1 to 18 ft/s under all anticipated operating conditions.

Use globe type control valves (Cla Val or equal) for inlet pressures of up to 300 psi. The correct trim shall be selected in consultation with the valve manufacturer. For inlet pressures beyond 300 psi, use sleeve valves for flow control.

Based on the foregoing discussion, four alternatives for buried pipe and three alternatives for above grade pipe are recommended, for both steel and ductile iron pipes. Typical turnout configurations for above ground turnout and below grade turnout are also included.

The order of priority will be as below (most preferred to least preferred), if there are no capacity limitations:

- Air valve lines (can be incorporated without a shutdown, and the resulting turnout will not be too deep)
- Pumpout (can be incorporated without a shutdown, but the resulting turnout would be deep at the beginning)
- Tapping sleeves (a shutdown is required, but the damage to cement mortar lining is much less than a cut-in tee)
- Cut-in tee (a longer shut down than tapping sleeve alternative would be required)

Table ES-2 provides a summary of alternatives developed with recommended flowrates. Turnout designation with ‘U’ refers an underground turnout and with ‘A’ refers an above grade turnout.

Drawings TM21-TO-041 provides typical details of an Above Grade Turnout and drawings TM21-TO-051 and 052 provide typical details of an Underground Turnout.

Table ES-2: Recommended Turnout Configurations

Turnout Designation	Turnout Description	Existing Line Size, inch	Maximum Recommended Capacity, cfs	Drawing Number
TO-U-001	Underground Turnout from Air Valve Line – DI Pipe	3 (Regular Air Valve)	0.68	TM21-TO-001
		6 (Slow Closing Air Valve)	2.75	
TO-U-002	Underground Turnout from Pumpout – DI Pipe	6	2.75	TM21-TO-002
TO-U-003	Underground Turnout from Cut-in Tee – DI Pipe	Same as main pipeline	Limited by Main Pipeline Capacity	TM21-TO-003
TO-U-004	Underground Turnout with Tapping Sleeve – DI Pipe	Same as main pipeline	Limited by Main Pipeline Capacity	TM21-TO-004
TO-U-011	Underground Turnout from Air Valve Line – Steel Pipe	3 (Regular Air Valve)	0.68	TM21-TO-011
		6 (Slow Closing Air Valve)	2.75	
TO-U-012	Underground Turnout from Pumpout – Steel Pipe	6	2.75	TM21-TO-012
TO-U-013	Underground Turnout from Cut-in Tee – Steel Pipe	Same as main pipeline	Limited by Main Pipeline Capacity	TM21-TO-013
TO-U-014	Underground Turnout with Tapping Sleeve – Steel Pipe	Same as main pipeline	Limited by Main Pipeline Capacity	TM21-TO-014
TO-A-021	Above Grade Turnout from Air Valve Line – DI Pipe	3 (Regular Air Valve)	0.68	TM21-TO-021
		6 (Slow Closing	2.75	

Turnout Designation	Turnout Description	Existing Line Size, inch	Maximum Recommended Capacity, cfs	Drawing Number
		Air Valve)		
TO-A-023	Above Grade Turnout from Cut-in Tee – DI Pipe	Same as main pipeline	Limited by Main Pipeline Capacity	TM21-TO-023
TO-A-024	Above Grade Turnout with Tapping Sleeve – DI Pipe	Same as main pipeline	Limited by Main Pipeline Capacity	TM21-TO-024
TO-A-031	Above Grade Turnout from Air Valve Line – Steel Pipe	3 (Regular Air Valve)	0.68	TM21-TO-031
		6 (Slow Closing Air Valve)	2.75	
TO-A-033	Above Grade Turnout from Cut-in Tee – Steel Pipe	Same as main pipeline	Limited by Main Pipeline Capacity	TM21-TO-033
TO-A-034	Above Grade Turnout with Tapping Sleeve – Steel Pipe	Same as main pipeline	Limited by Main Pipeline Capacity	TM21-TO-034
TO-A	Above Grade Turnout Typical Layout	All Sizes	N/A	TO-A-041
TO-U	Underground Turnout Typical Layout Plans	All Sizes	N/A	TO-U-051
TO-U	Underground Turnout Typical Layout Sections	All Sizes	N/A	TO-U-052

Details of these recommended turnout configurations are included as Attachment TM21-2.

The order of priority for the new turnouts will be as listed below (most preferred to least preferred), if there are no capacity limitations:

- Air valve lines (can be incorporated without a shutdown, and the resulting turnout will not be too deep)
- Pumpout (can be incorporated without a shutdown, but the resulting turnout would be deep at the beginning)

- Tapping sleeves (a shutdown is required, but the damage to cement mortar lining is much less than a cut-in tee)
- Cut-in tee (a longer shut down than tapping sleeve alternative would be required)

On the existing pipelines, the corrosion monitoring measures are limited to the following:

- Insulating joints between dissimilar metal joints. This was followed for all buried joints between steel and ductile iron pipes, fittings and valves
- American Water Works Association (AWWA) C217 3 Part Wax Tape coating system for buried insulating flange joints
- Cathodic test stations consisting of test leads exothermally welded to the pipe and to a reference electrode at regular intervals (approximately every 1500 ft)
- At pipeline crossings, provide test leads from the existing pipe (in coordination with the owner of existing pipeline) and new pipelines terminated in a test station
- Bonding continuity between valves, pushon joints, flexible coupling, and non-insulated joints

For the turnouts, corrosion monitoring measures similar to these would be adequate, unless there is a drastic change in soil conditions.

There will be minor damages to the existing cement mortar lining (and coating) during these modifications, and they shall be repaired following procedures outlined in AWWA C104.

The existing pipelines are provided with surge control systems at the pump stations and transient pressure monitoring system (TP-1) at nine locations. Any expansion shall consider extending these measures. Details are included within this TM.

1.0 INTRODUCTION

This Technical Memorandum (TM) is developed to explore alternatives and provide guidelines for incorporating future expansion of the pipeline system, mainly through addition of new turnouts. Typical details provided herein are guidelines for the use by engineers performing detailed design of future facilities.

1.1 Purpose of Technical Memorandum

The TM will cover the following details for incorporating any future expansion of the Nacimiento Water Project Network.

- Possible connection details for future expansion
- Protection of pipe lining during expansion
- Corrosion monitoring requirements for the expanded network
- Surge protection and monitoring

Each of these aspects will be elaborated in this TM. Depending on the actual scenario, one of the alternatives could be selected for implementation during the expansion. Pipe laying, pipe pressure rating, fiber optic installation, electrical design etc. shall be determined on a case to case basis and are not covered in this TM.

1.2 List of Terms, Acronyms, and Abbreviations

AMWC	Atascadero Mutual Water Company
ANSI	American National Standards Institute
AR/AV	Air Release / Air Vacuum Valve
AWWA	American Water Works Association
B&V	Black & Veatch Corporation
cfs	cubic feet per second
CRT	Camp Roberts Tank
CSA10A	County Service Area 10, Benefit Zone A
CTT	Cuesta Tunnel Tank
DI	ductile iron
Dia	Diameter
DIPRA	Ductile Iron Pipe Research Association
ft	feet
ft/s	feet per second

HDD	Horizontal Directional Drilling
HGL	Hydraulic Grade Line
ID	inside diameter
in	inches
IPS	Intake Pump Station
NWP	Nacimiento Water Project
OD	Outside diameter
Phase I Flow	Flow entitlement per WDEC
Pressure Class	The pipe internal pressure rating based on the Project Basis of Design (psi)
Project	Nacimiento Water Project
psi	Pounds per square inch, gauge
RCPS	Rocky Canyon Pump Station
RCT	Rocky Canyon Tank
RFCA	Restrained Flange Coupling Adapter
SCADA	Supervisory Control and Data Acquisition
SLO	City of San Luis Obispo
SYPS	Santa Ysabel Pump Station
T2	City of Paso Robles Turnout
T4	TCSD Turnout
T6	AMWC Turnout
T11	SLO/CSA10A Turnout
TCSD	Templeton Community Services District
TM	Technical Memorandum
TP-1	Transient pressure monitoring system
Ultimate Flow	Maximum flow entitlement of NWP
WDEC	Water Delivery Entitlement Contract

2.0 DETAILS OF EXISTING PIPELINES

2.1 Overview

This section provides a summary of existing pipelines.

2.2 Existing Pipelines and Facilities

The existing Nacimiento Water Project (NWP) pipeline starts at Lake Nacimiento with an Intake and Pump Station (IPS). The pumps at IPS will pump water either to Camp Roberts Tank (CRT) or Rocky Canyon Tank (RCT). From the CRT, water flows by gravity to Santa Ysabel Pump Station (SYPS). Paso Robles Turnout (T2) is located between the CRT and the SYPS. Pumps at the SYPS will boost the pressure of incoming water and feed the RCT. Templeton Community Services (TCSD) Turnout (T4) and Atascadero Mutual Water Company (AMWC) Turnout (T6) are located between the SYPS and the RCT. Rocky Canyon Pump Station (RCPS) is located downstream of the RCT and draws water from the RCT and pumps to Cuesta Tunnel Tank (CTT). From the CTT, water flows by gravity to the City of San Luis Obispo/County Service Area 10, Benefit Zone A (SLO/CSA10A) Turnout (T11), which is connected to the San Luis Obispo Water Treatment Plant. The pipeline is designated as different units for easy identification. Table 2-1 provides a summary of all the pipelines, with unit designations, diameter, pipe material, flowrates and velocities. The NWP is built to meet the ultimate design capacity of 32.79 cubic per second (cfs) from Lake Nacimiento, but during initial operating periods (termed Phase 1), the demand would be low. Both steel and ductile iron (DI) pipes were allowed in the design. One of the three main pipeline contractors provided steel pipes, and the other two provided DI pipes. Turnouts T2, T4 and T6 are a combination of DI and steel pipes because all horizontal directional drilling (HDD) to cross rivers used steel pipes.

Table 2-1: Details of Existing NWP Pipeline

Unit	Description	Pipe Material	Pipeline Diameter (inches)	Phase I		Ultimate	
				Flowrate (cfs)	Velocity (fps)	Flowrate (cfs)	Velocity (fps)
A	IPS to Camp Roberts West Property Line	Steel	36	23.49	3.32	32.79	4.64
A1	Camp Roberts West Property Line to CRT	Steel	36/30	23.49	3.32/4.79	32.79	4.64/ 6.68

Unit	Description	Pipe Material	Pipeline Diameter (inches)	Phase I		Ultimate	
				Flowrate (cfs)	Velocity (fps)	Flowrate (cfs)	Velocity (fps)
C	CRT Discharge to Monterey Road / Wellsona	Steel	36	23.49	3.32	32.79	4.64
C1	Monterey Road / Wellsona to Sta. 829+50	Steel	36	23.49	3.32	32.79	4.64
C1	From Sta. 829+50 to T2 Turnout Tee off (Paso Robles)	Steel	30	23.49	4.79	32.79	6.68
T2	Paso Robles Turnout	DI and Steel	24	9.03	2.87	12.90	4.10
B	Santa Ysabel Pump Station	Steel	24	14.46	4.60	19.89	6.33
D	Paso Robles Turnout Tee off to T4 (TCSD) Turnout Tee off (excluding Unit B)	DI and Steel	24	14.46	4.61	19.89	6.33
T4	TCSD Turnout	DI and Steel	8	1.03	2.98	1.27	3.64
E	T4 Turnout Tee off to T6 (AMWC) Turnout Tee off	DI	24	13.43	4.27	18.62	5.93
T6	AMWC Turnout	DI and Steel	18	8.28	4.69	10.22	5.78
F	T6 Turnout Tee off to RCT Inlet	DI	18	5.14	2.91	8.40	4.76
F1	RCT	DI	18	5.14	2.91	8.40	4.76
F2	RCPS	Steel	18	5.14	2.91	8.40	4.76
G	RCPS Discharge to Route 58/Maria Avenue	DI	18	5.14	2.91	8.40	4.76
G1	Route 58/Maria Avenue to CTT Inlet	DI	18	5.14	2.91	8.40	4.76
G2	CTT	DI	18	5.14	2.91	8.40	4.76
H	Cuesta Tunnel (existing)	Steel	24	5.14	1.64	8.40	2.67

Unit	Description	Pipe Material	Pipeline Diameter (inches)	Phase I		Ultimate	
				Flowrate (cfs)	Velocity (fps)	Flowrate (cfs)	Velocity (fps)
H1	Cuesta Tunnel to T11 (SLO/CSA10A) Turnout	DI	12	5.14	6.54	8.40	10.70
T11	SLO/CSA10A Turnout	Steel	12	5.14	6.54	8.40	10.70

Table 2-2 provides details of materials and pressure ratings of different segments of the pipelines:

Table 2-2: Materials and Pressure Ratings of Pipeline Segments

Unit	Pipe Diameter, Inch	Station		Pipe Material	Pressure Class	Min. Cylinder Wall Thickness, inch
		From	To			
A	36	IPS (0+00)	4+00	Steel	150	0.188
A	36	4+00	12+00	Steel	150	0.188
A	36	12+00	26+00	Steel	200	0.234
A	36	26+00	82+00	Steel	250	0.284
A	36	82+00	88+24	Steel	200	0.234
A1	36	88+24	98+06	Steel	200	0.234
A1 (HDD)	30	98+06	114+65	Steel	-	0.500
A1	36	114+65	155+00	Steel	200	0.234
A1	36	155+00	180+00	Steel	250	0.284
A1	36	180+00	222+00	Steel	200	0.234
A1	36	222+00	263+50	Steel	250	0.284
A1	36	263+50	348+00	Steel	200	0.234
A1	36	348+00	529+28	Steel	150	0.188
CRT	36	529+28	536+57	Steel	150	0.188
C	36	536+57	787+00	Steel	150	0.188
C1	36	787+00	829+50	Steel	150	0.188
C1	30	829+50	901+86	Steel	150	0.154
C1 (HDD)	30	901+86	904+30	Steel	150	0.154

Unit	Pipe Diameter, Inch	Station		Pipe Material	Pressure Class	Min. Cylinder Wall Thickness, inch
		From	To			
C1 (HDD)	30	904+30	911+62	Steel	200	0.190
C1	30	911+62	940+00	Steel	200	0.190
C1	30	940+00	1157+50	Steel	150	0.154
C1	30	1157+50	1176+10	Steel	250	0.240
D	24	1176+10	1223+77	DI	250	-
D (HDD)	24	1223+77	1252+91	Steel	-	0.50
D	24	1252+91	1410+00	DI	250	-
D	24	1401+00	1414+00	DI	200	-
E	24	1414+00	1490+00	DI	200	-
F	24	1490+00	1495+95	DI	200	-
F	18	1495+95	1772+61	DI	250	-
F1 & F2	RCT/RCPS	1772+61	1785+50	Mix	-	-
G	18	1785+50	1886+00	DI	350	-
G	18	1886+00	2016+00	DI	300	-
G	18	2016+00	2151+57	DI	250	-
G1	18	2151+57	2308+08	DI	250	-
G2	CTT	-	-	Mix	-	-
H1	12	2370+00	2510+28	DI	350	-

2.3 Pipeline Route, System Schematic and HGL

Figure 2-1 is the System Schematic and Figure 2-2 is the Hydraulic Profile. Figures 2-3 to 2-24 are unit maps of the NWP and provide details of the pipeline route. Figures 2-3 to 2-24 are included as Attachment TM21-3.

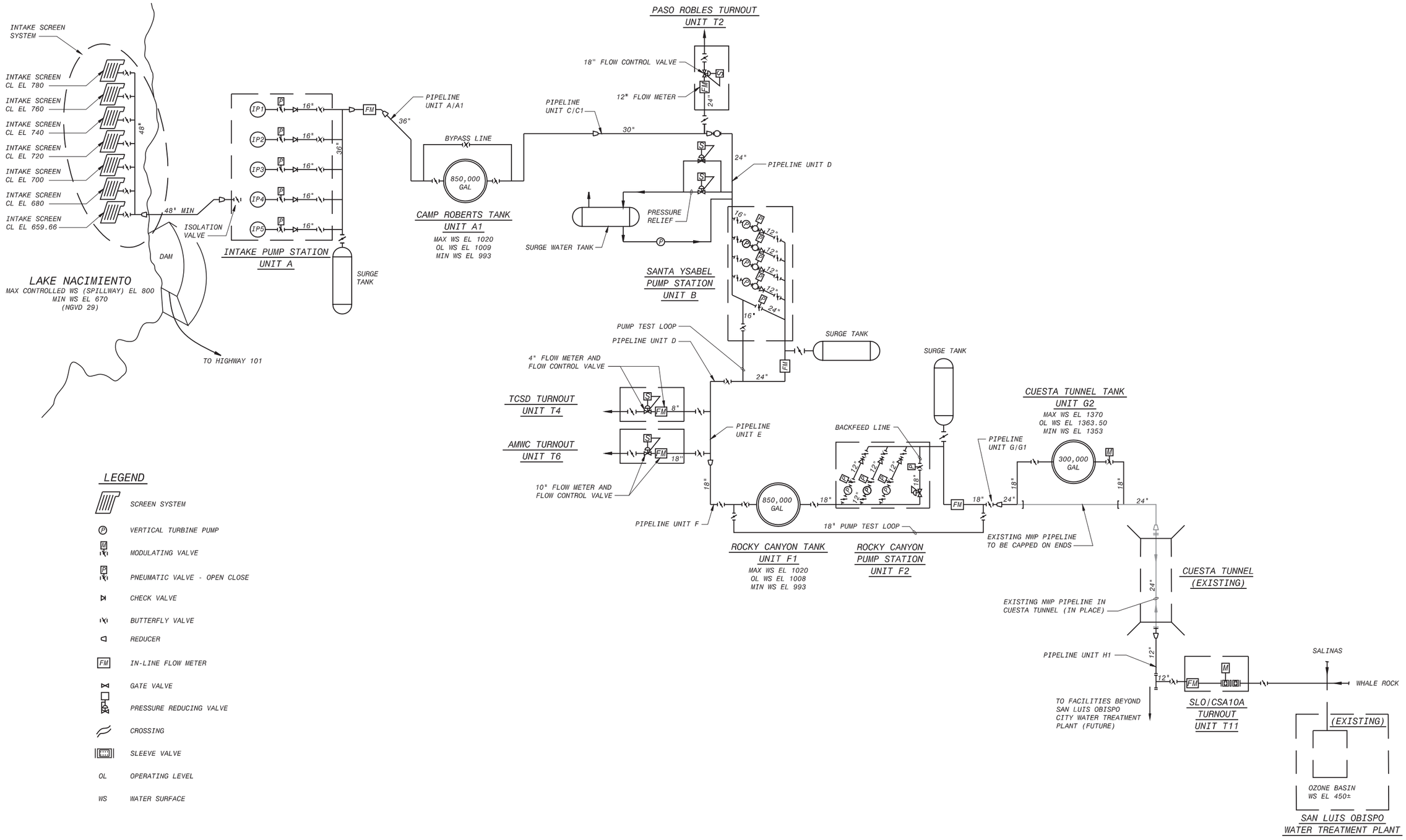
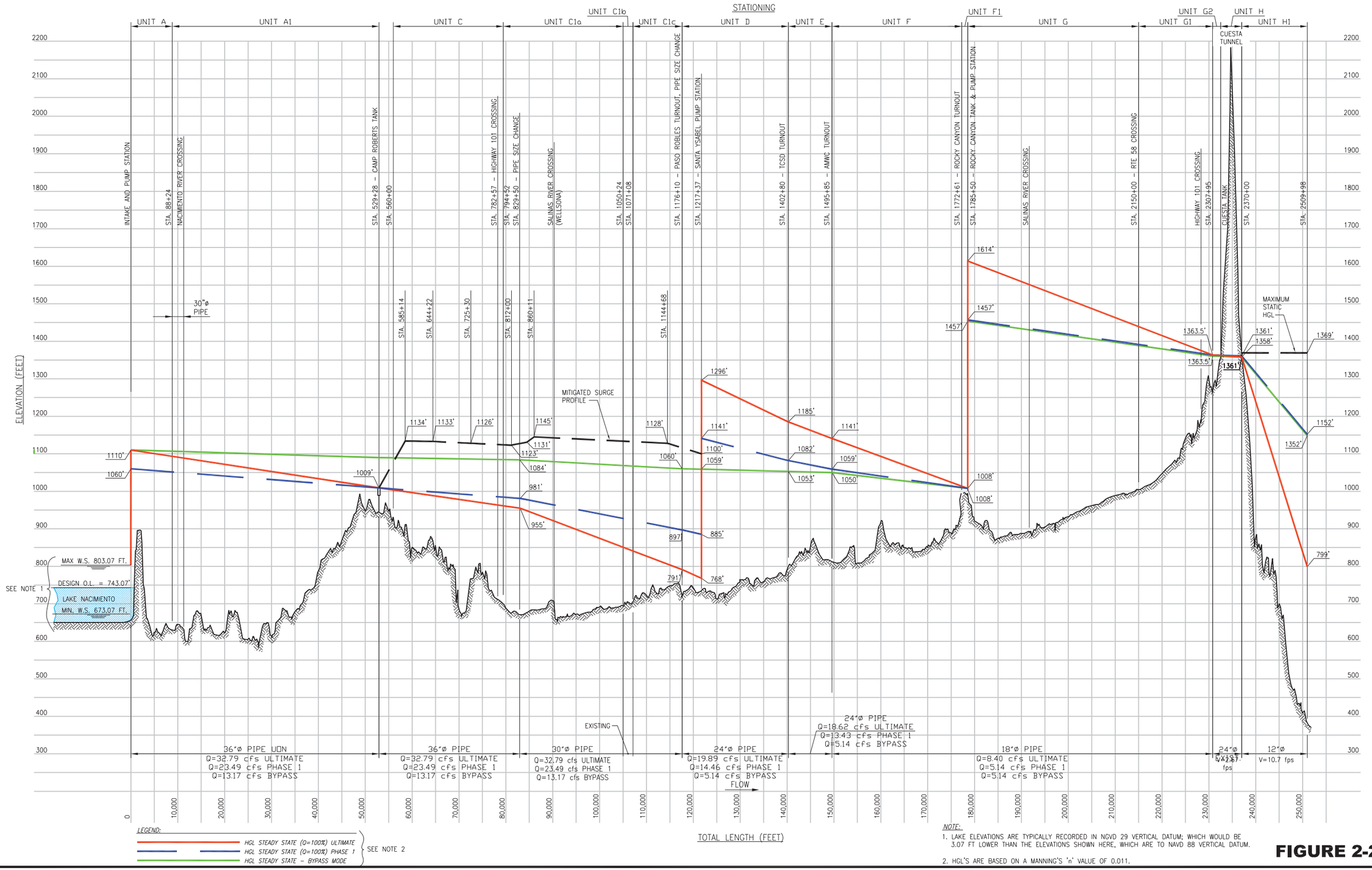


FIGURE 2-1

FB137522-MOP
B137522-MOP



FB137522-MOP
B137522-MOP

FIGURE 2-2

2.4 Existing Pipeline Appurtenances

The existing pipelines have the following appurtenances located at different sections:

- Air/vacuum valves
- Pumpouts
- Instruments

Table 2-3 provides a summary of appurtenances along the pipeline.

Table 2-3: Details of Appurtenances along the Pipeline

Unit	Labeled Station	Actual Location, if different	Main Pipe Diameter, Inch	Appurtenance	Branch Connection Size, Inch	Branch Material
A	7+01	-	36	Slow Closing AR/AV	6	Steel
A	22+19	-	36	AR/AV	3	Steel
A	32+62	-	36	Pump Out	6/12	Steel
A	40+92	-	36	AR/AV	3	Steel
A	50+39	-	36	Pump Out	6/12	Steel
A	60+79	-	36	AR/AV	3	Steel
A	79+28	-	36	Pump Out	6/12	Steel
A	83+41	-	36	AR/AV	3	Steel
A1	98+00	97+35	36	AR/AV	3	Steel
A1	127+64	-	36	AR/AV	3	Steel
A1	142+27	-	36	Pump Out	6/12	Steel
A1	144+80	-	36	AR/AV	3	Steel
A1	147+16	-	36	Pump Out	6/12	Steel
A1	155+70	-	36	AR/AV	3	Steel
A1	170+70	-	36	AR/AV	3	Steel
A1	175+58	-	36	Pump Out	6/12	Steel
A1	182+91	-	36	AR/AV	3	Steel
A1	186+53	-	36	Pump Out	6/12	Steel
A1	195+15	-	36	AR/AV	3	Steel
A1	197+20	-	36	Pump Out	6/12	Steel
A1	199+97	-	36	AR/AV	3	Steel

Unit	Labeled Station	Actual Location, if different	Main Pipe Diameter, Inch	Appurtenance	Branch Connection Size, Inch	Branch Material
A1	204+64	-	36	Pump Out	6/12	Steel
A1	208+07	-	36	AR/AV	3	Steel
A1	224+00	-	36	AR/AV	3	Steel
A1	234+12	-	36	Pump Out	6/12	Steel
A1	238+12	-	36	AR/AV	3	Steel
A1	243+70	-	36	Pump Out	6/12	Steel
A1	247+45	-	36	AR/AV	3	Steel
A1	251+38	-	36	Pump Out	6/12	Steel
A1	254+23	-	36	AR/AV	3	Steel
A1	258+30	-	36	Pump Out	6/12	Steel
A1	268+97	-	36	AR/AV	3	Steel
A1	279+20	-	36	AR/AV	3	Steel
A1	286+74	-	36	Pump Out	6/12	Steel
A1	296+38	-	36	AR/AV	3	Steel
A1	310+78	-	36	AR/AV	3	Steel
A1	328+96	-	36	AR/AV	3	Steel
A1	330+40	-	36	Pump Out	6/12	Steel
A1	343+31	-	36	AR/AV	3	Steel
A1	345+00	-	36	Pump Out	6/12	Steel
A1	360+12	-	36	AR/AV	3	Steel
A1	368+75	-	36	Pump Out	6/12	Steel
A1	373+40	-	36	AR/AV	3	Steel
A1	388+36	-	36	AR/AV	3	Steel
A1	403+40	-	36	AR/AV	3	Steel
A1	412+40	-	36	AR/AV	3	Steel
A1	415+28	-	36	Pump Out	6/12	Steel
A1	418+59	-	36	AR/AV	3	Steel
A1	420+75	-	36	Pump Out	6/12	Steel
A1	426+99	-	36	AR/AV	3	Steel

Unit	Labeled Station	Actual Location, if different	Main Pipe Diameter, Inch	Appurtenance	Branch Connection Size, Inch	Branch Material
A1	431+60	-	36	Pump Out	6/12	Steel
A1	444+54	-	36	Slow Closing AR/AV	6	Steel
A1	446+65	-	36	Pump Out	6/12	Steel
A1	459+50	-	36	Slow Closing AR/AV	6	Steel
A1	474+45	-	36	Slow Closing AR/AV	6	Steel
A1	486+14	-	36	Pump Out	6/12	Steel
A1	495+46	-	36	Slow Closing AR/AV	6	Steel
A1	510+84	-	36	Pump Out	6/12	Steel
A1	513+97	-	36	AR/AV	3	Steel
A1	524+19	-	36	Pump Out	6/12	Steel
C	537+95	-	36	AR/AV	3	Steel
C	543+20	-	36	Pump Out	6/12	Steel
C	545+40	-	36	AR/AV	3	Steel
C	563+58	-	36	Pump Out	6/12	Steel
C	567+72	567+79	36	Slow Closing AR/AV	6	Steel
C	579+44	-	36	Pump Out	6/12	Steel
C	582+30	-	36	Slow Closing AR/AV	6	Steel
C	593+94	-	36	Pump Out	6/12	Steel
C	597+01	-	36	AR/AV	3	Steel
C	615+95	-	36	Pump Out	6/12	Steel
C	620+56	-	36	AR/AV	3	Steel
C	624+81	-	36	Pump Out	6/12	Steel
C	636+25	-	36	AR/AV	3	Steel
C	644+45	-	36	Pump Out	6/12	Steel
C	646+68	-	36	AR/AV	3	Steel
C	650+70	650+77	36	Pump Out	6/12	Steel
C	655+00	-	36	AR/AV	3	Steel

Unit	Labeled Station	Actual Location, if different	Main Pipe Diameter, Inch	Appurtenance	Branch Connection Size, Inch	Branch Material
C	665+40	-	36	Pump Out	6/12	Steel
C	668+56	-	36	AR/AV	3	Steel
C	674+18	-	36	Pump Out	6/12	Steel
C	675+34	-	36	AR/AV	3	Steel
C	677+99	-	36	Pump Out	6/12	Steel
C	679+68	-	36	AR/AV	3	Steel
C	681+57	-	36	Pump Out	6/12	Steel
C	683+87	-	36	AR/AV	3	Steel
C	691+54	-	36	Pump Out	6/12	Steel
C	693+87	-	36	AR/AV	3	Steel
C	700+87	-	36	Pump Out	6/12	Steel
C	721+75	-	36	AR/AV	3	Steel
C	733+17	-	36	AR/AV	3	Steel
C	737+24	-	36	Pump Out	6/12	Steel
C	741+46	-	36	AR/AV	3	Steel
C	744+38	-	36	Pump Out	6/12	Steel
C	746+07	-	36	AR/AV	3	Steel
C	751+10	-	36	Pump Out	6/12	Steel
C	753+98	-	36	AR/AV	3	Steel
C	763+00	-	36	Pump Out	6/12	Steel
C	766+15	-	36	AR/AV	3	Steel
C1	788+81	-	36	Pump Out	6/12	Steel
C1	788+86	-	36	AR/AV	3	Steel
C1	807+56	-	36	Pump Out	6/12	Steel
C1	813+95	-	36	AR/AV	3	Steel
C1	826+42	-	36	Pump Out	6/12	Steel
C1	846+36	-	30	AR/AV	3	Steel
C1	846+42	-	30	Pump Out	6/12	Steel
C1	849+05	-	30	AR/AV	3	Steel

Unit	Labeled Station	Actual Location, if different	Main Pipe Diameter, Inch	Appurtenance	Branch Connection Size, Inch	Branch Material
C1	849+09	-	30	Pump Out	6/12	Steel
C1	853+43	-	30	AR/AV	3	Steel
C1	854+42	-	30	Pump Out	6/12	Steel
C1	854+47	-	30	AR/AV	3	Steel
C1	861+61	-	30	Pump Out	6/12	Steel
C1	871+99	-	30	AR/AV	3	Steel
C1	896+22	-	30	AR/AV	3	Steel
C1	902+05	901+84	30	AR/AV	3	Steel
C1	916+10	-	30	AR/AV	3	Steel
C1	930+12	-	30	AR/AV	3	Steel
C1	932+02	-	30	Pump Out	6/12	Steel
C1	950+34	-	30	AR/AV	3	Steel
C1	956+08	-	30	Pump Out	6/12	Steel
C1	986+00	-	30	AR/AV	3	Steel
C1	993+20	-	30	AR/AV	3	Steel
C1	1000+70	-	30	AR/AV	3	Steel
C1	1001+31	1001+52	30	Pump Out	6/12	Steel
C1	1002+68	-	30	AR/AV	3	Steel
C1	1005+27	1005+40	30	AR/AV	3	Steel
C1	1008+50	-	30	Pump Out	6/12	Steel
C1	1020+59	-	30	AR/AV	3	Steel
C1	1025+05	-	30	Pump Out	6/12	Steel
C1	1028+79	-	30	AR/AV	3	Steel
C1	1032+26	-	30	Pump Out	6/12	Steel
C1	1034+52	-	30	AR/AV	3	Steel
C1	1040+90	-	30	AR/AV	3	Steel
C1	1041+01	-	30	Pump Out	6/12	Steel
C1	1043+84	1043+80	30	AR/AV	3	Steel
C1	1047+82	-	30	AR/AV	3	Steel

Unit	Labeled Station	Actual Location, if different	Main Pipe Diameter, Inch	Appurtenance	Branch Connection Size, Inch	Branch Material
C1	1050+06	-	30	Pump Out	6/12	Steel
C1	1050+11	-	30	AR/AV	3	Steel
C1	1071+29	-	30	Pump Out	6/12	Steel
C1	1077+44	-	30	AR/AV	3	Steel
C1	1085+43	-	30	Pump Out	6/12	Steel
C1	1093+30	-	30	AR/AV	3	Steel
C1	1097+56	-	30	Pump Out	6/12	Steel
C1	1097+64	-	30	AR/AV	3	Steel
C1	1104+16	-	30	Pump Out	6/12	Steel
C1	1109+37	-	30	AR/AV	3	Steel
C1	1115+71	-	30	Pump Out	6/12	Steel
C1	1118+13	-	30	AR/AV	3	Steel
C1	1119+26	-	30	Pump Out	6/12	Steel
C1	1119+52	-	30	AR/AV	3	Steel
C1	1119+61	-	30	Pump Out	6/12	Steel
C1	1128+00	-	30	AR/AV	3	Steel
C1	1129+00	-	30	AR/AV	3	Steel
C1	1133+05	-	30	AR/AV	3	Steel
C1	1135+86	1135+91	30	Pump Out	6/12	Steel
C1	1145+00	-	30	AR/AV	3	Steel
C1	1149+25	-	30	AR/AV	3	Steel
C1	1157+23	-	30	Pump Out	6/12	Steel
C1	1168+74	-	30	AR/AV	3	Steel
C1	1175+38	-	30	Pump Out	6/12	Steel
C1	1176+00	-	30	AR/AV	3	Steel
D	1185+44	-	24	Pump Out	6/12	DI
D	1205+29	-	24	AR/AV	3	DI
D	1209+75	-	24	Pump Out	6/12	DI
D	1212+85	-	24	AR/AV	3	DI

Unit	Labeled Station	Actual Location, if different	Main Pipe Diameter, Inch	Appurtenance	Branch Connection Size, Inch	Branch Material
D	1239+83	1240+39	24	AR/AV	3	DI
D	1262+75	-	24	Pump Out	6/12	DI
D	1280+50	-	24	AR/AV	3	DI
D	1286+75	-	24	Pump Out	6/12	DI
D	1295+25	-	24	AR/AV	3	DI
D	1307+91	-	24	Pump Out	6/12	DI
D	1316+25	1315+80	24	AR/AV	3	DI
D	1326+97	-	24	Pump Out	6/12	DI
D	1338-97	-	24	AR/AV	3	DI
D	1344+85	-	24	Pump Out	6/12	DI
D	1365+95	-	24	AR/AV	3	DI
D	1374+15	-	24	Pump Out	6/12	DI
D	1385+72	-	24	AR/AV	3	DI
D	1388+85	1388+65	24	Pump Out	6/12	DI
D	1410+75	1409+10	24	AR/AV	3	DI
E	1414+25	-	24	Pump Out	6/12	DI
E	1418+75	-	24	AR/AV	3	DI
E	1425+60	-	24	Pump Out	6/12	DI
E	1436+20	-	24	Slow Closing AR/AV	6	DI
E	1457+30	-	24	Pump Out	6/12	DI
E	1464+65	-	24	AR/AV	3	DI
E	1485+00	-	24	Pump Out	6/12	DI
F	1522+00	-	18	AR/AV	3	DI
F	1532+00	-	18	Pump Out	6/12	DI
F	1581+50	-	18	Slow Closing AR/AV	6	DI
F	1600+65	-	18	Pump Out	6/12	DI
F	1606+00	-	18	AR/AV	3	DI
F	1609+50	-	18	Pump Out	6/12	DI

Unit	Labeled Station	Actual Location, if different	Main Pipe Diameter, Inch	Appurtenance	Branch Connection Size, Inch	Branch Material
F	1616+50	-	18	AR/AV	3	DI
F	1622+82	-	18	Pump Out	6/12	DI
F	1625+20	1625+40	18	AR/AV	3	DI
F	1636+50	-	18	Pump Out	6/12	DI
F	1646+10	-	18	AR/AV	3	DI
F	1649+56	-	18	Pump Out	6/12	DI
F	1677+60	-	18	AR/AV	3	DI
F	1685+15	-	18	Pump Out	6/12	DI
F	1694+10	-	18	AR/AV	3	DI
F	1703+10	-	18	Pump Out	6/12	DI
F	1717+67	-	18	AR/AV	3	DI
F	1731+84	-	18	Pump Out	6/12	DI
F	1741+92	-	18	AR/AV	3	DI
F	1744+26	1744+15	18	Pump Out	6/12	DI
F	1759+03	1758+35	18	Slow Closing AR/AV	6	DI
F	1766+01	-	18	Slow Closing AR/AV	6	DI
G	1789+12	-	18	Pump Out	6/12	DI
G	1789+50	-	12	AR/AV	3	DI
G	1812+00	-	18	Pump Out	6/12	DI
G	1817+00	-	18	AR/AV	3	DI
G	1836+38	-	18	Pump Out	6/12	DI
G	1846+50	-	18	AR/AV	3	DI
G	1847+70	-	18	Pump Out	6/12	DI
G	1872+00	-	18	AR/AV	3	DI
G	1875+00	-	18	Pump Out	6/12	DI
G	1911+00	-	18	AR/AV	3	DI
G	1914+15	-	18	AR/AV	3	DI
G	1914+19		18	Pump Out	6/12	DI

Unit	Labeled Station	Actual Location, if different	Main Pipe Diameter, Inch	Appurtenance	Branch Connection Size, Inch	Branch Material
G	1918+67	-	18	AR/AV	3	DI
G	1927+85	-	18	AR/AV	3	DI
G	1933+50	-	18	Pump Out	6/12	DI
G	1982+00	-	18	AR/AV	3	DI
G	1990+68	-	18	AR/AV	3	DI
G	1991+91	-	18	Pump Out	6/12	DI
G	2047+10	-	18	AR/AV	3	DI
G	2068+50	-	18	AR/AV	3	DI
G	2068+70	-	18	Pump Out	6/12	DI
G	2080+87	-	18	AR/AV	3	DI
G	2080+95	-	18	Pump Out	6/12	DI
G	2089+10	-	18	Pump Out	6/12	DI
G	2094+00	-	18	AR/AV	3	DI
G	2094+50	-	18	Pump Out	6/12	DI
G	2099+50	-	18	AR/AV	3	DI
G	2099+95	-	18	Pump Out	6/12	DI
G	2104+50	-	18	AR/AV	3	DI
G	2105+90	-	18	Pump Out	6/12	DI
G	2107+50	-	18	AR/AV	3	DI
G	2113+45	-	18	Pump Out	6/12	DI
G	2140+19	-	18	AR/AV	3	DI
G	2146+00	-	18	Pump Out	6/12	DI
G1	2166+50	-	18	AR/AV	3	DI
G1	2166+60	-	18	Pump Out	6/12	DI
G1	2170+10	-	18	AR/AV	3	DI
G1	2170+50	-	18	Pump Out	6/12	DI
G1	2182+70	-	18	AR/AV	3	DI
G1	2183+00	-	18	Pump Out	6/12	DI
G1	2219+62	-	18	AR/AV	3	DI

Unit	Labeled Station	Actual Location, if different	Main Pipe Diameter, Inch	Appurtenance	Branch Connection Size, Inch	Branch Material
G1	2222+00	-	18	Pump Out	6/12	DI
G1	2232+97	-	18	AR/AV	3	DI
G1	2236+00	-	18	Pump Out	6/12	DI
G1	2249+75	-	18	AR/AV	3	DI
G1	2252+55	-	18	AR/AV	3	DI
G1	2256+72	-	18	Pump Out	6/12	DI
G1	2256+72	-	18	AR/AV	3	DI
G1	2258+10	-	18	AR/AV	3	DI
G1	2259+85	-	18	Pump Out	6/12	DI
G1	2268+76	-	18	AR/AV	3	DI
G1	2271+00	-	18	Pump Out	6/12	DI
G1	2274+40	-	18	AR/AV	3	DI
G1	2290+84	-	18	AR/AV	3	DI
G1	2300+02	-	18	Pump Out	6/12	DI
G1	2304+95	-	18	AR/AV	3	DI
H1	2377+15	-	12	Pump Out	6/12	DI
H1	2378+80	-	12	AR/AV	3	DI
H1	2390+04	-	12	AR/AV	3	DI
H1	2391+00	-	12	Pump Out	6/12	DI
H1	2393+94	-	12	AR/AV	3	DI
H1	2396+00	-	12	Pump Out	6/12	DI
H1	2396+63	-	12	AR/AV	3	DI
H1	2397+87	-	12	Service Drain	3	DI
H1	2399+40	-	12	AR/AV	3	DI
H1	2403+00	-	12	Pump Out	6/12	DI
H1	2405+00	-	12	AR/AV	3	DI
H1	2410+60	-	12	Pump Out	6/12	DI
H1	2414+90	-	12	AR/AV	3	DI
H1	2422+00	-	12	Pump Out	6/12	DI

Unit	Labeled Station	Actual Location, if different	Main Pipe Diameter, Inch	Appurtenance	Branch Connection Size, Inch	Branch Material
H1	2427+80	-	12	AR/AV	3	DI
H1	2432+00	-	12	Pump Out	6/12	DI
H1	2433+00	-	12	AR/AV	3	DI
H1	2440+00	-	12	Pump Out	6/12	DI
H1	2442+00	-	12	AR/AV	3	DI
H1	2445+20	-	12	AR/AV	3	DI
H1	2448+00	-	12	Pump Out	6/12	DI
H1	2450+00	-	12	AR/AV	3	DI
H1	2462+88	-	12	AR/AV	3	DI
H1	2481+50	-	12	AR/AV	1	DI
H1	2487+32	-	12	AR/AV	3	DI

The pipeline diameters of the NWP vary between 36 inches (in) to 12 in for the main pipelines, and existing appurtenance connections are either 3 in(for air valves) or 6 in (slow closing air/vacuum valves and pumpouts). The 36 in and 30 in pipeline are steel pipes, and all other sizes are DI, except some localized sections, which are steel (eg. river crossings using HDD, T11 Turnout). All pipes are cement mortar lined, except the river crossings using HDD, which used a paint coating system. All buried pipes are cement mortar coated, and above grade pipes are epoxy coated.

Any of these appurtenances would be a source for expansion, as long as the new expansion capacity at that location could be adequately handled by the branch and there is adequate pressure at the location of the appurtenance to feed the new turnout.

Before deciding on a new turnout location, the hydraulics at the preferred location shall be given due consideration to ensure that adequate pressure is available for the required flowrate. Other considerations like easements, orientation of the air valves or pumpout when they are used, location of nearest pull box for fiber optic cable connection, space for installing the turnout structure, valves, controls and piping shall be adequately considered. The operational impact of the new turnout on the hydraulic transient control system shall also be considered. If the air valve

or pumpout is on the same side of the proposed turnout, that would help in easy routing of the turnout pipe. If the new turnout is closer to an existing fiber optic pull box, connection of new fiber optic cable for the new turnout could be completed without much excavation. Easements (both temporary during construction and permanent) shall be given adequate consideration.

There are two major sizes on which these appurtenances are installed: 3 in for normal air valves, 6 in for slow closing air valves and pumpouts (pumpouts are 6 in at the main pipeline and expands to 12 in). The Ductile Iron Pipe Research Association (DIPRA) recommends a maximum velocity of 14 feet per second (ft/s) through cement mortar lined pipes for fluids without too much abrasive particles. Also, American Water Works Association (AWWA) standard limits the flow velocity through resilient seated gate valves and butterfly valves to 16 ft/s. Considering these recommendations, a maximum velocity of 14 ft/s is recommended through the existing branch lines (like air valves lines, pumpouts and drain lines). This higher velocity is recommended only for the existing pipe. The new pipe to be installed shall be designed for a much lower velocity, compatible with velocities through the existing main pipelines.

Assuming a normal velocity of 14 ft/s through the existing branch lines, the maximum capacity of branch lines would be as listed in Table 2-4:

Table 2-4: Maximum Capacities for Turnouts from Existing Appurtenances

Appurtenance	Turnout size, inch	Flowrate, cfs
Air Valve	3	0.68
Slow Closing Air Valve / Pumpout	6	2.75

3.0 EXPANSION/MODIFICATION TECHNIQUES

3.1 Overview

Future expansion and modifications to the existing pipeline system may become necessary for a variety of reasons. Major reasons are temporary modifications, permanent expansion, and addition of appurtenances.

Temporary modifications include work in response to a pipe break or leak, improving efficiency of the system, or providing a bypass system while the permanent system is being installed. Temporary modification might include temporary bypass system, pressure relief system, line plugging, air release facilities etc. Fig. 3-1 shows a typical bypass system using hot taps.

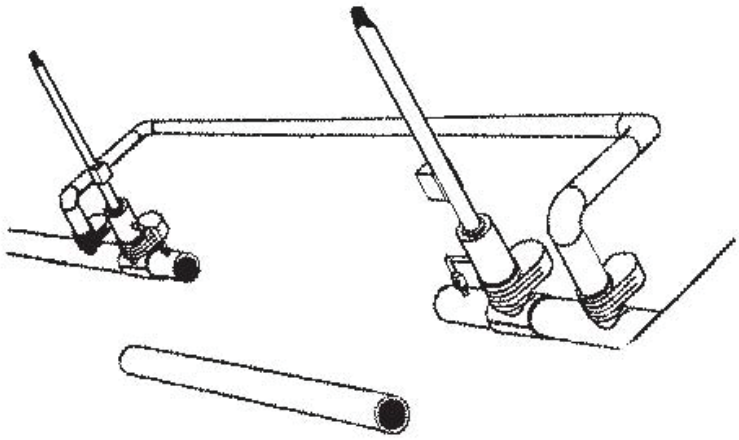


Fig. 3-1 - Typical Bypass System Using Hot Tap

Permanent modifications would become necessary when work is done to provide permanent facilities to maintain system functionality. Permanent modifications include work to incorporate additional turnouts to new customers, replace temporary modifications, replace deteriorated section of pipe, and/or improve efficiency and functionality of the system.

Additional appurtenances refer to the incorporation of new appurtenances such as air valves, pumpouts, instruments etc. to improve the functionality of the existing system.

The following expansion/modification techniques are covered in this TM.

- Hot tapping
- Tapping saddles
- Cut-in tee
- Use of existing pumpouts
- Use of existing air valve connection
- Use of existing blind flanges

The following sections describe each of these modification techniques.

3.2 Hot Tapping

Hot tapping is a procedure of tie-in, into a pressurized system under normal operating conditions, without a shut down. Typically, hot taps require the use of a tapping fitting, isolation valve, and hot tapping machine. A typical hot tapping procedure is described below:

- Remove the cement mortar coating for buried pipe, after exposing the pipe or clean off epoxy coating for above grade pipes.
- Attach tapping fitting securely to the system pipe to be cut.
- Position the isolation valve (which allows the hole saw or cutter to advance into the pipe without allowing pipe contents to escape) and hot tapping machine in place.
- Pressure test the valve assembly to check for any leakage.
- Move the hole cutter past the open valve to the pipe. The cut begins, and the cutter advances through the pipe wall.
- Upon completion of the cut, withdraw the cutter to just past the gate of the valve, close the valve securely, and remove the cutter.
- The coupon (chunk of pipe that is cut loose) will be retained by the use of a pilot drill to which a wire is attached. The wire is designed so that, once through the coupon, the wire toggles. In this way, the coupon can be easily removed.
- Repair the cement mortar coating or epoxy coating to original condition.
- If this connection is to be retained permanently, repair the lining during the next shutdown of the system.

Fig. 3-2 shows a typical hot tapping assembly.

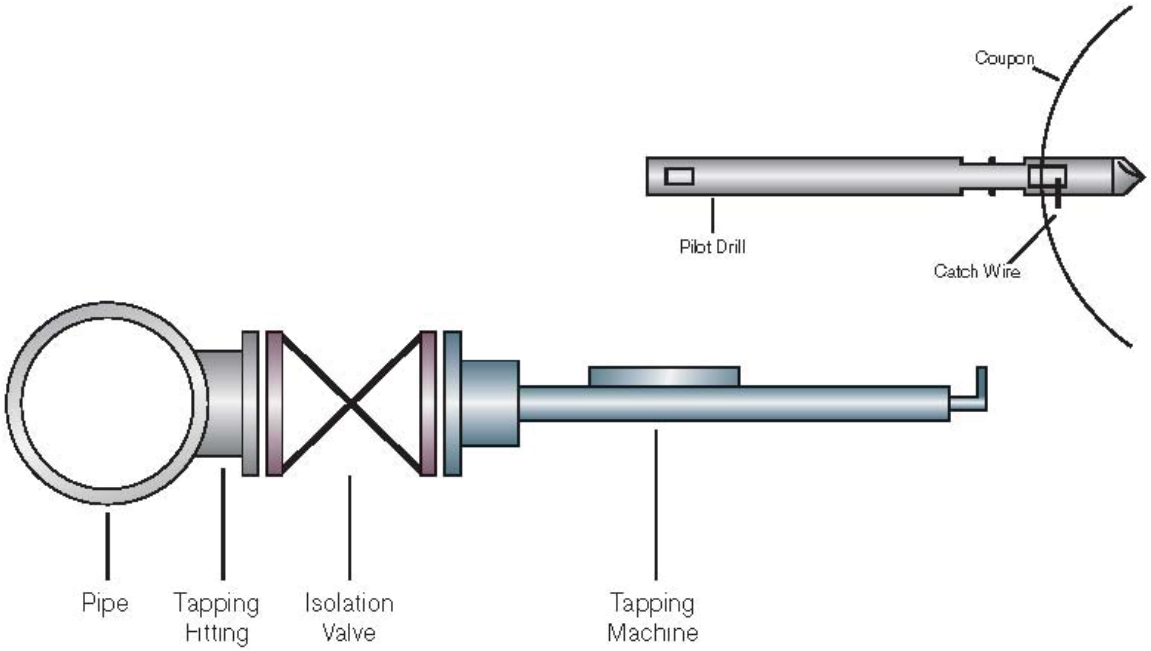


Fig. 3-2 - Typical Hot Tapping Assembly

Since hot tapping is done while the pipe is still under normal operation, it would not be possible to repair cement lining of the existing pipe damaged during hot tapping. Hot tapping should only be considered for temporary expansion and modification such as for emergency repair. Alternately, hot tapping should be immediately followed by a shutdown of the system to repair the cement mortar lining.

Although hot tapping is a relatively simple procedure, it requires equipment specifically designed for this application, proper fittings for the piping system, and qualified technicians to perform the operation. To safely and successfully perform a hot tap operation, the following critical information needs to be obtained prior to the operation.

- Pipe size, material, outside diameter (OD) and inside diameter (ID) or wall thickness, and type of lining for the selection of appropriate tapping machine
- Design pressure and temperature for selection of tapping sleeve and tapping machine
- Operating pressure, temperature, and flowrate during tapping process

Tapping sleeves would be used for this application and must be properly sized to accommodate

the hot tapping machine and to allow for full depth of cutter penetration, and to allow uninterrupted tapping valve closure when the cutter and cut out coupon are retrieved.

- Choose hot tap location and orientation to ensure the connection is positioned to allow for the installation, operation, and removal of the tapping machine.
- Allow clearance at tapping location for staging of equipment.

Attachment TM21-1 includes details of common tapping sleeves available for steel and ductile iron pipes. For both steel and DI pipes, standard tapping sleeves are available up to the required maximum 36 in pipe with maximum branch connection of 24 in. For steel pipes, weld on or strap on tapping sleeves could be used. For DI pipe, strap on tapping sleeves would be used.

Prior to installing tapping sleeves on buried pipelines, the cement mortar coating shall be chipped off locally and the pipe surface cleaned. After installing the tapping sleeve and completing the tapping, the damaged cement mortar lining and coating shall be repaired.

On exposed lines, the coating shall be removed prior to installing a tapping sleeve. The cement mortar lining shall be repaired prior to putting the system back into operation. To accomplish cement mortar lining, a minimum branch line size of 6 in is recommended, even if the turnout size is smaller. The turnout shall be reduced to the required diameter downstream of the branch.

3.3 Tapping Sleeves

Use of tapping sleeves would be similar to hot tapping, except that this would be done when the pipeline is shut down and drained. All the details, precautions, and procedures for hot tapping are relevant to installation of tapping sleeves.

3.4 Cut-in Tee

A cut-in tee is a procedure of inserting a tee into the main service line after a section of existing pipe is removed. The procedure involves cutting a section of the main line, inserting a tee, making the connection with either couplings (on DI Pipes) or by welding (on steel pipes) on both sides of the tee, and repairing lining and coating. This procedure will involve shutting down the service at the section of pipe where the tee is planned to be inserted. To be consistent with existing materials, provide steel tees on steel pipes and DI tees on DI pipes. Steel tees can either be welded to the existing pipe or connected by using restrained couplings. DI tees shall be connected to the existing pipes using restrained couplings.

The cut-in tee procedure allows branch size up to the size of the main pipe. This modification technique can be done at almost any section along the pipeline system. Fig. 3-3 shows a typical cut-in tee installation.

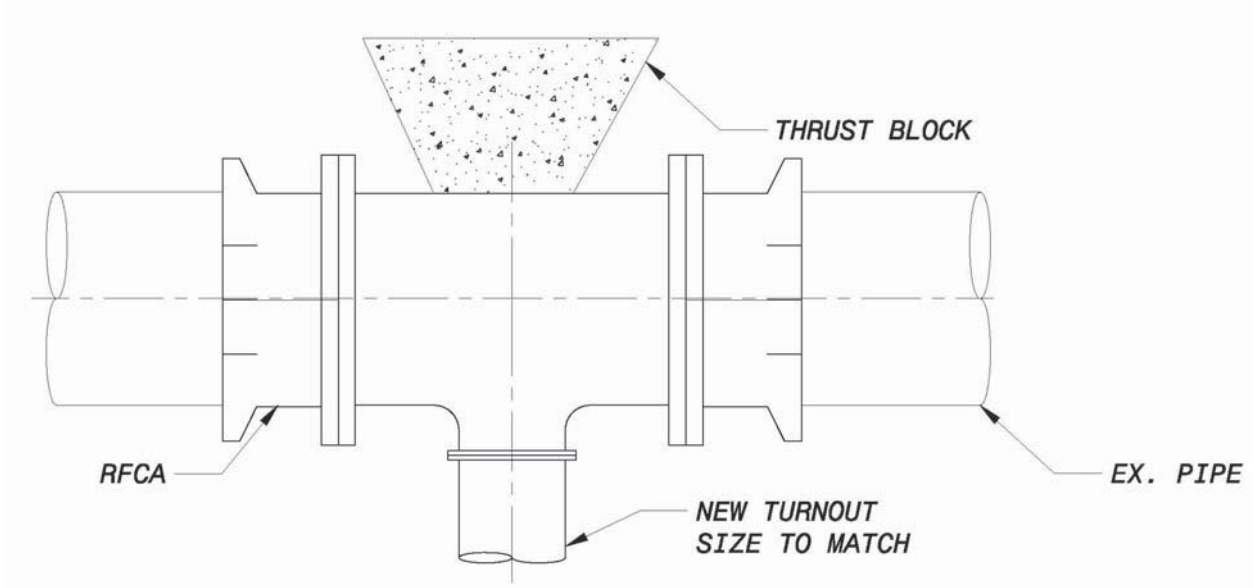


Fig. 3-3 - Typical Cut-In Tee

RFCA – Restrained Flange Coupling Adapter; Ex. - Existing

3.5 Use of Existing Pumpouts

The entire pipeline is provided with pumpouts at regular intervals as shown on Table 2-3. The pumpouts start at 6 in at the main line, and expand to 10 in downstream, and are provided with 6 in isolation valves. The pumpout line will not be under pressure downstream of the isolation valve. Thus, when an expansion or modification of branch is required closer to an existing pumpout, the branch could be easily installed on the pumpout line without a shutdown of the main line.

Steps for making a new branch connection on an existing pumpout/drain line are listed below:

- Make sure that the existing pumpout isolation valve is closed
- Cut the existing pumpout pipe downstream of the isolation valve
- Install a new tee with two new isolation valves – one on pumpout line downstream of the new tee and one on the branch of the tee

- Repair cement mortar coating and lining
- Close new isolation valves
- Open old isolation valve on the pumpout

Fig. 3-4 shows a typical expansion/modification using an existing pumpout.

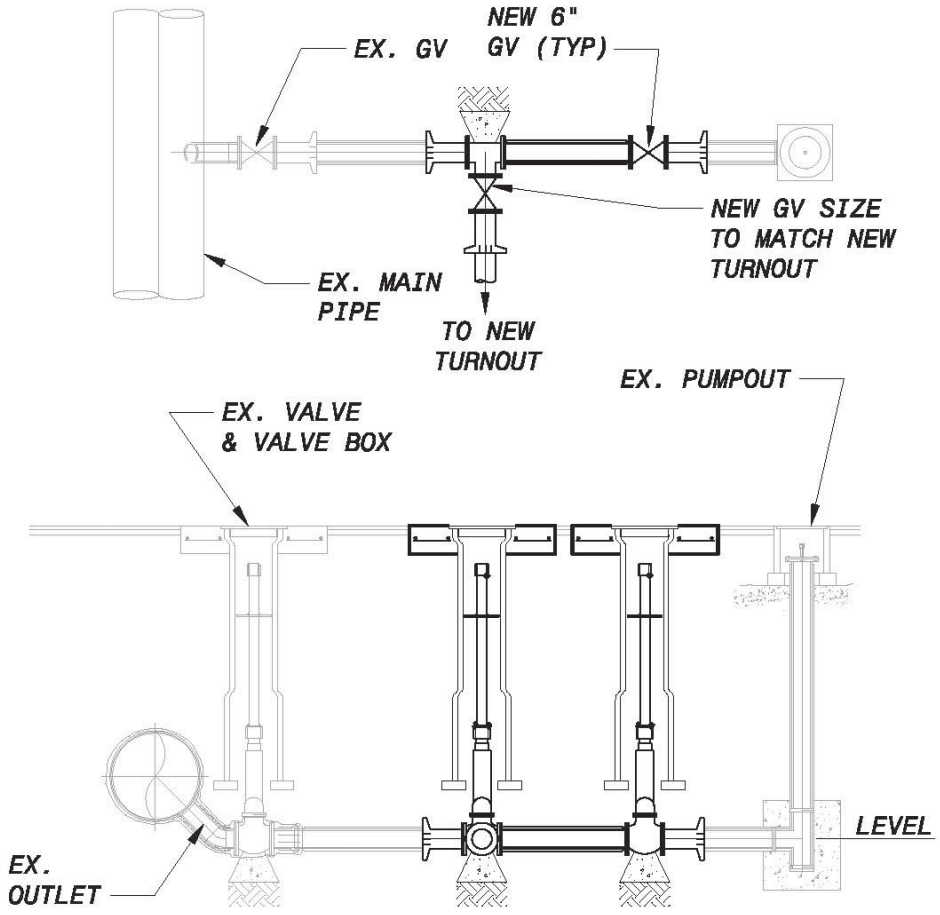


Fig. 3-4 - Typical Branch Line from Pumpout

Use of an existing pumpout for expansion/modification is limited by the maximum capacity through the existing pumpout. Since the pumpouts are located lower than the main pipelines, the new branch connection would be deeper at the beginning.

3.6 Use of Existing Air Valve Connection

Two sizes of air valves are installed along the pipelines – 3 in valves for air/vacuum release and 6 in slow closing air valves for avoiding surges. Where an expansion or modification is required at a location closer to one of these air valves, an existing air valve connection can be used for creating a new branch line. Figure 3-5 shows a typical expansion/modification using an existing air valve line.

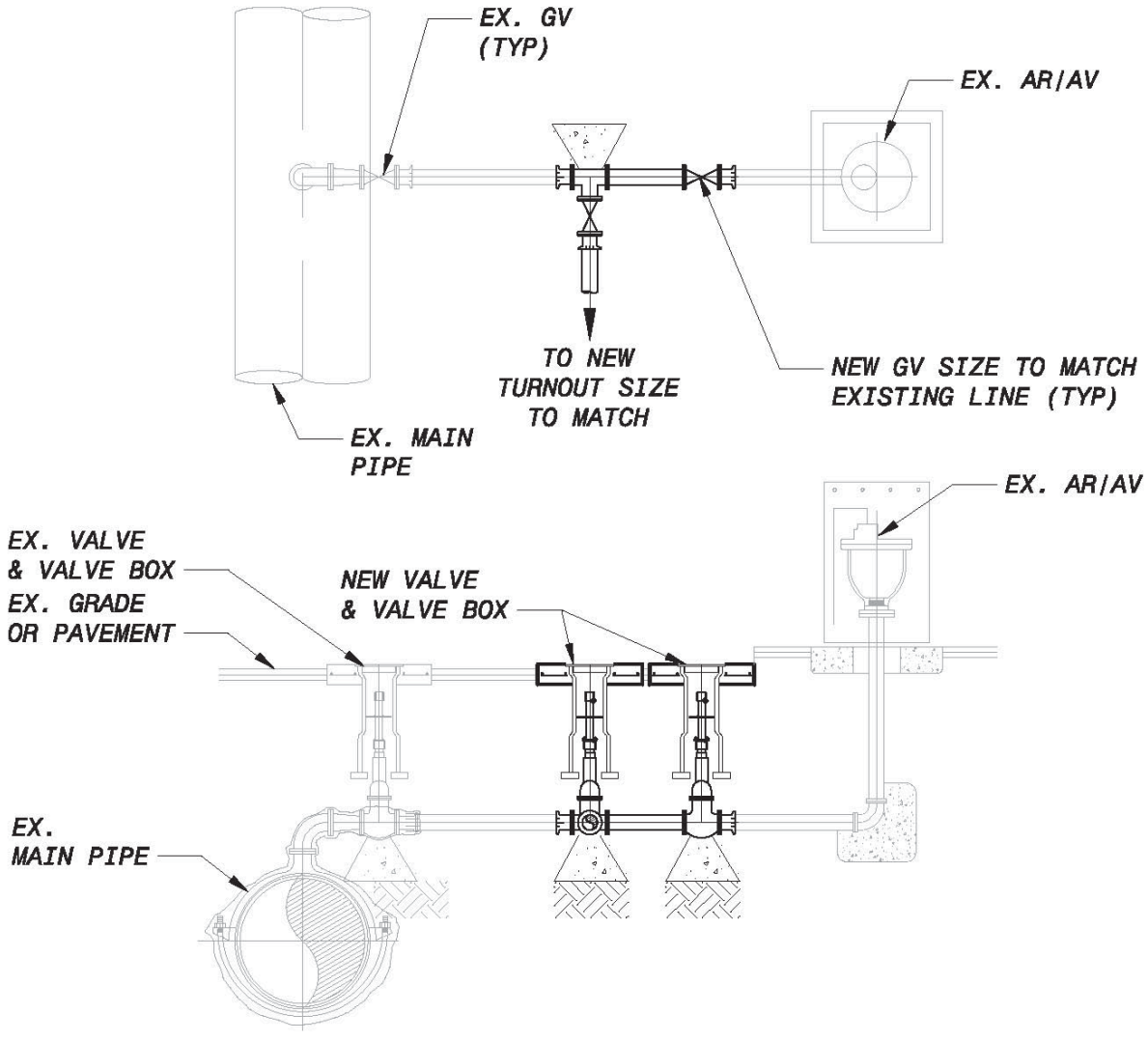


Fig. 3-5: Typical Branch Line from Air Valve Connection

Steps for making a new branch connection on an existing air valve line are listed below:

- Make sure that the existing air line isolation valve is closed (on lines to slow closing air valves, these modifications shall be carried out during low flow conditions)
- Cut the existing air valve connection downstream of the isolation valve
- Install a new tee with two new isolation valves – one of air valve line downstream of the new tee and one on the branch of the tee
- Repair cement mortar coating and lining
- Close new isolation valve on the branch line
- Open old isolation valve for the air valve connection

Use of an existing air valve for expansion/modification is limited to the capacity of the existing air valve line. This technique can be done while the system is on normal operation.

3.7 Use of Existing Blind Flanges

There are a small number of pipe ends along the pipeline system where blind flanges are installed. Expansion and modifications can be done at these locations by removing the blind flanges and installing the new branch lines, up to the size of the existing blind flange. A total shutdown of the system would be required for making this connection.

3.8 Relative Advantages and Disadvantages of Techniques

Prior to selecting a technique for expansion and modification, advantages and disadvantages of each technique should be reviewed. The following table presents the advantages and disadvantages of each technique.

Table 3-1: Advantages and Disadvantages of Modification Techniques

Techniques	Advantages	Disadvantages
Hot Tap	• Can be done while the pipe is pressurized and system is in operation • Quick installation • Can be installed at almost any section along the pipeline system	• Lining of existing pipe cannot be repaired, without a shutdown.
Tapping Sleeve	• Can install up to any branch size • Lining of existing pipe can be repaired	• Requires shutdown of section for a branch to be installed

Techniques	Advantages	Disadvantages
	• Can be installed at almost any section along the pipeline system	• Require longer time compared to hot tapping
Cut-in Tee	• Can install up to any branch size • Lining of existing pipe can be repaired • Can be installed at almost any section along the pipeline system	• Requires shutdown of section where the cut-in tee is to be installed • Require longer time to install than other techniques
Use of Existing Pumpout	• Can be done without interruption of system operation • Lining of existing pipe can be repaired • Quick installation • Can be a permanent installation	• Size of expansion branch is limited to size of existing pumpout (6 inches maximum) • Location is limited to location of existing pumpout • Some locations can be very deep
Use of Existing Air Valve	• Can be done without interruption of system operation • Lining of existing pipe can be repaired • Quick installation • Can be a permanent installation	• Size of expansion branch is limited to size of existing air valve connection line • Location is limited to location of existing air valves • Air release valves would be off line during installation
Use of Existing Blind flanges	• Lining of existing pipe does not require any repair	• Requires shutdown of existing system • There are not many blind flange locations along the pipeline

3.9 Selection Criteria for Turnout Connections

Prior to making a decision on the type of connection, several aspects should be considered.

- Based on the design flowrate through the new line, determine the diameter of the pipe.
- Calculate head required at the beginning of the branch to feed the new destination.
- From the hydraulic profile, determine an approximate location where the required pressure is available for the new turnout.
- Establish the availability and feasibility of using any of the existing appurtenance connections.
- Other considerations like easements, orientation of the air valves or pumpout when they are used, location of nearest pull box for fiber optic cable connection, space for installing the turnout structure, valves, controls, and piping and operation impact to the hydraulic transient control shall be adequately considered.
- Based on the following criteria, select an appropriate technique:
    - Impact to system operation. Some techniques require system shut down several hours or up to days for completing the modifications.
    - Some of the techniques allow only limited size of connecting branch. The use of existing pumpout and air valves are limited to the size of these appurtenances. Connection sizes up to the main line size are feasible with cut-in tee and through the use of tapping sleeves.
    - Some of the techniques like use of pumpouts, air valve connections etc. are limited to locations of these lines.
    - Temporary or permanent modification is an important selection criteria. Some techniques such as a hot tap can only be used in a temporary modification since lining of existing pipes cannot be repaired using this technique.

3.10 Selection Criteria for Flowmeters

All of the existing turnouts have electromagnetic flowmeters for flow measurement. To be consistent with this approach, all future turnouts shall also be provided with magnetic flowmeters. The flowmeters shall be sized to have a velocity in the range of 1 to 18 ft/s over the expected operating flowrate range. The body pressure rating shall be consistent with the connected piping.

3.11 Selection Criteria for Control Valves

Two types of control valves were used in the existing turnouts – self actuating globe valve and sleeve valve with electric actuator. Two major considerations for selecting control valves are the valve inlet pressure and pressure drop across the valve. Globe valves are available up to an inlet pressure of 300 psi and sleeve valves are suitable for much higher inlet pressures. Normal globe valves can handle a pressure drop of approximately 60% of inlet pressure, beyond which special valves with anti-cavitation trim would be required. Globe valves are available from the CLA-VAL Company. Consult CLA-VAL Company for proper selection in such cases. CLA-VAL Cavitation Guide under the following link provides a rough guide for determining the need for anti-cavitation trims.
http://www.cla-val.com/pdfs/E-Cavitation_Guide.pdf

Globe valves are less expensive compared to sleeve valves and should be the first choice, if they can handle the inlet pressure and pressure drop. If either the inlet pressure or the pressure drop across the globe valve is beyond its capabilities, sleeve type valves shall be used.

3.12 Recommended Alternatives and Configurations

Based on the foregoing discussion, four alternatives for buried pipe and three alternatives for above grade pipe are recommended, for both steel and ductile iron pipes. Typical turnout configuration for a above ground turnout and below grade turnout are also included.

The order of priority will be as below (most preferred to least preferred), if there are no capacity limitations:

- Air valve lines (can be incorporated without a shutdown, and the resulting turnout will not be too deep)
- Pumpout (can be incorporated without a shutdown, but the resulting turnout would be deep at the beginning)
- Tapping sleeves (a shutdown is required, but the damage to cement mortar lining is much less than a cut-in tee)
- Cut-in tee (a longer shut down than tapping sleeve alternative would be required)

Table 3-2 provides a summary of alternatives developed with recommended flowrates through each size. Turnout designation with ‘U’ refers an underground turnout and with ‘A’ refers an above grade turnout. Drawings TM21-TO-041 provides typical details of an Above Grade

Turnout and drawings TM21-TO-051 and 052 provide typical details of an Underground Turnout.

Table 3-2: Recommended Turnout Configurations

Turnout Designation	Turnout Description	Existing Line Size, inch	Maximum Recommended Capacity, cfs	Drawing Number
TO-U-001	Underground Turnout from Air Valve Line – DI Pipe	3 (Regular Air Valve)	0.68	TM21-TO-001
		6 (Slow Closing Air Valve)	2.75	
TO-U-002	Underground Turnout from Pumpout – DI Pipe	6	2.75	TM21-TO-002
TO-U-003	Underground Turnout from Cut-in Tee – DI Pipe	Same as main pipeline	Limited by Main Pipeline Capacity	TM21-TO-003
TO-U-004	Underground Turnout with Tapping Sleeve – DI Pipe	Same as main pipeline	Limited by Main Pipeline Capacity	TM21-TO-004
TO-U-011	Underground Turnout from Air Valve Line – Steel Pipe	3 (Regular Air Valve)	0.68	TM21-TO-011
		6 (Slow Closing Air Valve)	2.75	
TO-U-012	Underground Turnout from Pumpout – Steel Pipe	6	2.75	TM21-TO-012
TO-U-013	Underground Turnout from Cut-in Tee – Steel Pipe	Same as main pipeline	Limited by Main Pipeline Capacity	TM21-TO-013
TO-U-014	Underground Turnout with Tapping Sleeve – Steel Pipe	Same as main pipeline	Limited by Main Pipeline Capacity	TM21-TO-014
TO-A-021	Above Grade Turnout from Air Valve Line – DI Pipe	3 (Regular Air Valve)	0.68	TM21-TO-021
		6 (Slow Closing Air Valve)	2.75	
TO-A-023	Above Grade Turnout from	Same as main	Limited by Main Pipeline	TM21-TO-023

Turnout Designation	Turnout Description	Existing Line Size, inch	Maximum Recommended Capacity, cfs	Drawing Number
	Cut-in Tee – DI Pipe	pipeline	Capacity	
TO-A-024	Above Grade Turnout with Tapping Sleeve – DI Pipe	Same as main pipeline	Limited by Main Pipeline Capacity	TM21-TO-024
TO-A-031	Above Grade Turnout from Air Valve Line – Steel Pipe	3 (Regular Air Valve)	0.68	TM21-TO-031
		6 (Slow Closing Air Valve)	2.75	
TO-A-033	Above Grade Turnout from Cut-in Tee – Steel Pipe	Same as main pipeline	Limited by Main Pipeline Capacity	TM21-TO-033
TO-A-034	Above Grade Turnout with Tapping Sleeve – Steel Pipe	Same as main pipeline	Limited by Main Pipeline Capacity	TM21-TO-034
TO-A	Above Grade Turnout Typical Layout	All Sizes	N/A	TO-A-041
TO-U	Underground Turnout Typical Layout Plans	All Sizes	N/A	TO-U-051
TO-U	Underground Turnout Typical Layout Sections	All Sizes	N/A	TO-U-052

Details of these connections are included as Attachment TM21-2.

4.0 CORROSION MONITORING

4.1 Overview

This section provides a brief summary of corrosion monitoring measures on the existing pipelines and ways to protect them during expansion. Corrosion monitoring methods for the new pipelines are also described.

4.2 Existing Pipeline Corrosion Monitoring Methods

On the existing pipelines, the corrosion monitoring measures are limited to the following:

- Insulating joints between dissimilar metal joints. This was followed for all buried joints between steel and ductile iron pipes, fittings and valves, aimed at corrosion prevention.
- AWWA C217 3 Part Wax Tape coating system for buried insulating flange joints.
- Cathodic test stations consisting of test leads exothermally welded to the pipe and to a reference electrode at regular intervals (approximately every 1500 ft).
- At pipeline crossings, provide test leads from the existing pipe (in coordination with the owner of existing pipeline) and new pipelines terminated in a test station.
- Bonding continuity between valves, pushon joints, flexible coupling, and non-insulated joints.

4.3 Suggested Corrosion Monitoring Methods for New Pipelines

For the new pipelines, corrosion monitoring similar to the existing pipelines would be adequate, as long the new pipelines are passing through soil of similar nature.

5.0 PROTECTION OF CEMENT MORTAR LINING

5.1 Overview

Lining of the existing pipe will likely be damaged by any of the techniques described above. Protection of the existing lining is required during these modifications. The following sections describe the existing cement mortar lining and methods to protect the lining during the expansion and modifications of the pipeline system.

5.2 Existing Cement Mortar Lining

Lining of the existing steel pipe is per AWWA C205 Table 1, with a minimum thickness of 3/8 in. cement mortar lining. The existing ductile iron pipes are cement mortar lined according to AWWA C104/A21.4.

5.3 Suggested Cement Mortar Lining Protection Methods

Cement lining will withstand normal handling; however, care should be taken during cutting of the existing pipe or making connection for expansion. AWWA C104 provides that damaged lining may be repaired, and the following repair procedure is recommended:

- Cut out the damaged lining to the metal. Square the edges.
- Thoroughly wet the cut-out area and adjoining lining.
- With the damaged area cleaned and the adjoining lining wet, spread the mortar evenly over the area to be patched. After the lining has become firm and adheres well to the surface, finish it with a wet paint brush or similar soft bristle brush.
- The repaired lining should be kept moist by tying canvas, wet burlap, or other wrap over the ends of the pipe or fitting for at least 24 hours. As an alternative, the repaired lining may be seal coated with a cut back type of asphaltic seal coating. This must be sprayed or brushed on within five to 30 minutes after lining.

6.0 SURGE PROTECTION AND MONITORING

6.1 Overview

This section provides a brief summary of surge control and surge monitoring systems for the existing pipelines and ways to extend these measures for the new pipelines to be added; details of the Surge Protection and Monitoring Systems are provided in the Manual of Procedures.

6.2 Existing Surge Control and Monitoring Measures

Following are the surge control measures implemented on the project:

- An air/water surge vessel, 8 ft diameter (dia) x 57 ft long is installed at the IPS and connected to the common pump discharge header.
- An air/water surge vessel, 8 ft dia x 44 ft long is installed at the SYPS and connected to the common pump discharge header.
- An air/water surge vessel, 6 ft dia x 12 ft long is installed at the RCPS and connected to the common pump discharge header.
- Slow closing air release/air vacuum valves are installed at selected high points as shown on Table 2-3.
- All the turnout control valves are provided with actuators with a minimum operating time from full open to full close of three minutes.

For surge monitoring, sophisticated TP-1 has been installed at the following locations:

- IPS pump common discharge header
- On main pipeline high point upstream of CRT (Sta. 474+45.92)
- Paso Robles Turnout (T2)
- SYPS pump common suction header
- SYPS pump common discharge header
- AMWC Turnout (T6)
- RCPS pump common suction header
- RCPS pump common discharge header
- SLO/CSA10A Turnout (T11)

The TP-1 system will record surge pressures on a real time basis at very small increments and would be a useful tool for analyzing the surge event and taking corrective actions as required.

6.3 Suggested Surge Control and Monitoring Measures

The surge control measures already incorporated in the design would be adequate as long as the pumps are not modified and the following aspects are taken care of in the design of the new turnouts:

- Provide slow closing AR/AVs at all high points higher than the existing pipelines.
- Turnout control valves shall be selected to have a minimum operating time of three minutes, as has been followed for the existing turnout control valves.
- Keep the velocity through the new pipelines within comparable limits of existing pipelines (4 to 6.5 ft/s).
- Design the new pipelines with a wall thickness sized for factor of safety of at least 3.5 (related to tensile strength) for normal operating pressures.

If any of the above could not be met, a detailed surge analysis is recommended.

For monitoring surge pressures, PipeTech International (supplier of existing TP-1 system) recommends that a TP-1 be installed on the new turnout when the turnout diameter is at least 25% of the main pipeline to which the turnout is connected (any turnout larger than 6 in on a 24 in main line shall be provided with a TP-1 system). Consultation with the PipeTech International is recommended.

ATTACHMENT TM21-1

TYPICAL TAPPING SLEEVES

ROMAC INDUSTRIES, INC.
1-800-426-9341
MADE IN U.S.A

"FTS445" Steel Fabricated Tapping Sleeve

Material Specifications

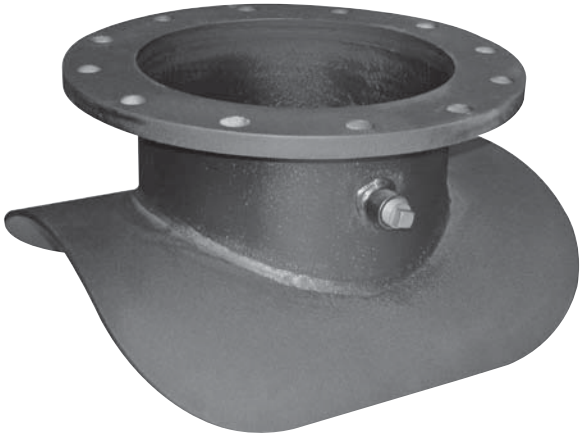
Body and Outlet Nozzle: Carbon steel, A-36 or equal. Also available with type 304 stainless steel (style STS445)

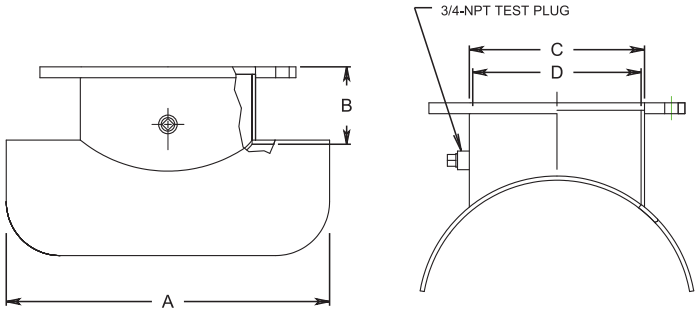
Flange: Carbon steel, A-36 or equal. AWWA Class "D" plate flange, ANSI CLS 150 drilling, proper recessing for tapping valves. Will accommodate tapping flanges per MSS SP-60.

Test Plug: 3/4" NPT type 304 stainless steel test plug.

Coatings: Romac shopcoat for corrosion protection in transit. Optional fusion epoxy 8-12 mil. lined and coated. Edges and ID masked where weld is required. Romac packages sleeves to protect coating.

Fabricated Tapping Sleeve for Weld-on Outlets

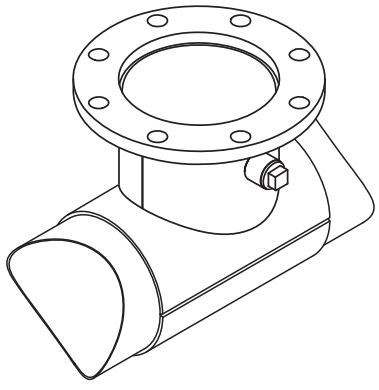




FLANGE SIZE	DIMENSIONS				MIN. PIPE DIAMETER
	A	B	C	D	
4"	9.0	5.18	5.03	4.73	6.00
6"	12.0	5.18	7.03	6.73	8.00
8"	16.0	5.18	9.03	8.73	10.00
10"	20.0	5.50	11.03	10.73	12.00
12"	22.0	5.75	13.03	12.73	14.00
14" *	24.0	6.00	15.03	14.73	16.00
16" *	29.0	6.00	17.03	16.73	20.00
18" *	32.0	6.00	19.03	18.73	22.00
20" *	35.0	6.00	21.03	20.73	24.00
24" *	42.0	6.63	25.03	24.73	36.00

Sleeves designed for a minimum pipe wall thickness of 0.25" and a minumum pipe material yield strength of 36 ksi will be collar style.

Size on size sleeves, and sleeves for thinner or lower strength pipe will require full wrap style sleeve (see illustration below).



* Please specify tapping valve manufacturer, and flange dimensions for flange sizes larger than 12 inches.

Larger sizes and outlets available.

All prices POA

No Cancel, No Return Item.

662 - Carbon Flange Tapping Sleeve
663 - Stainless Steel Flange Tapping Sleeve

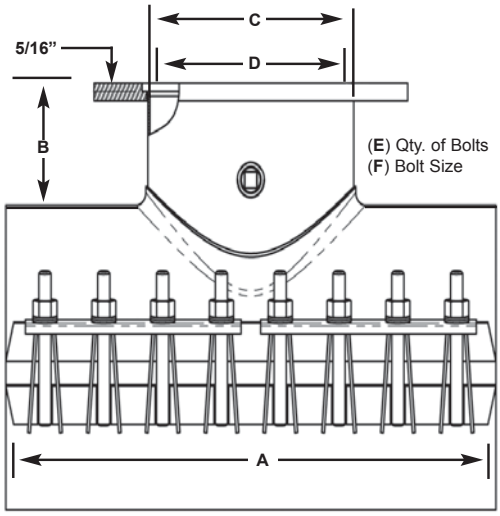
Stainless Steel Body and Neck

ANSI/NSF® 61 Listed

Material Specifications

Body:	Full circumference band. 18-8 type 304 Stainless Steel.
Flanges:	AWWA C207 Class D, ANSI 150# drilling. Recessed for Tapping Valve Per MSS-SP 60. Fusion bonded, Flexi-Coat® epoxy coated carbon steel on 662. 18-8 type 304 stainless steel flange on 663. Optional: Other types of Flanges, threaded outlets, MJ Outlets.
Gasket:	Nitrile (Buna-N) NSF® 61 compounded to resist water, oil, acids, alkalies, most (aliphatic) hydrocarbon fluids and many chemicals. Temperatures up to 180ºF.
Bolts, Nuts & Washers:	18-8 type 304 stainless steel heavy hex nuts, stud bolts & washers. Nuts and studs are coated to prevent galling.

Material specifications are subject to change.



662-663 Tapping Sleeve Specifications

Outlet Size	Nominal Body Size	A (in.)	B (in.)	C (in.)	D (in.)	E	F (in.)
4	4	15	5	5 1/16	4 3/16	8	5/8
	6-18	15	5	5 1/16	4 3/4	8	5/8
	20-24	20	5	5 1/16	4 3/4	15	5/8
6	6	15	5	7 1/16	6 5/16	8	5/8
	8-18	15	5	7 1/16	6 3/4	8	5/8
	20-24	20	5	7 1/16	6 3/4	15	5/8
8	8	20	5	9 1/16	8 3/8	10	5/8
	10-18	20	5	9 1/16	8 3/4	10	5/8
	20-24	25	5	9 1/16	8 3/4	24	5/8
10	10	25	5	11 3/32	10 1/4	16	5/8
	12-18	25	5	11 3/32	10 3/4	16	5/8
	20-24	25	5	11 3/32	10 3/4	24	5/8
12	12	25	5	13 3/32	12 1/4	16	5/8
	14-18	25	5	13 3/32	12 3/4	16	5/8
	20-24	25	5	13 3/32	12 3/4	24	5/8

Optional 316 Stainless Steel.
For MJ Outlets, replace the last 2 “00”s in the middle eight digits with “MJ”. Example: 622-127504MJ-003.

662 - Carbon Flange Tapping Sleeve
663 - Stainless Steel Flange Tapping Sleeve
Stainless Steel Body and Neck
ANSI/NSF® 61 Listed

Nominal Size of Pipe x Flanged Outlet	O. D. Range (Inches)	662 Flexi-Coat® Epoxy Coated Carbon Steel Flange	663 Stainless Steel Flange	Approx. Weight Each Pounds
		Catalog Number	Catalog Number	
4 x 4	4.46-4.86	662-04800400-200	663-04800400-200	32
4 x 4	4.80-5.10	662-05000400-200	663-05000400-200	34
4 x 4	4.90-5.35	662-05100400-200	663-05100400-200	40
6 x 4	6.59-6.99	662-06630400-000	663-06630400-000	38
6 x 6		662-06630600-200	663-06630600-200	42
6 x 4	6.84-7.30	662-06900400-000	663-06900400-000	38
6 x 6		662-06900600-200	663-06900600-200	42
6 x 4	7.10-7.50	662-07200400-000	663-07200400-000	38
6 x 6		662-07200600-200	663-07200600-200	42
6 x 4	7.40-7.80	662-07450400-000	663-07450400-000	38
6 x 6		662-07450600-200	663-07450600-200	42
8 x 4	7.90-8.30	662-08000400-000	663-08000400-000	43
8 x 6		662-08000600-000	663-08000600-000	63
8 x 4	8.62-9.06	662-08630400-000	663-08630400-000	43
8 x 6		662-08630600-000	663-08630600-000	47
8 x 8		662-08630800-200	663-08630800-200	63
8 x 4	8.99-9.45	662-09050400-000	663-09050400-000	43
8 x 6		662-09050600-000	663-09050600-000	47
8 x 8		662-09050800-200	663-09050800-200	63
8 x 4	9.20-9.60	662-09450400-000	663-09450400-000	43
8 x 6		662-09450600-000	663-09450600-000	47
8 x 8		662-09450800-200	663-09450800-200	63
8 x 4	9.60-10.00	662-09650400-000	663-09650400-000	43
8 x 6		662-09650600-000	663-09650600-000	47
8 x 8		662-09650800-200	663-09650800-200	63
10 x 4	9.90-10.30	662-10000400-000	663-10000400-000	47
10 x 6		662-10000600-000	663-10000600-000	51
10 x 8		662-10000800-000	663-10000800-000	70
10 x 4	10.73-11.13	662-10750400-000	663-10750400-000	47
10 x 6		662-10750600-000	663-10750600-000	51
10 x 8		662-10750800-000	663-10750800-000	70
10 x 10		662-10751000-200	663-10751000-200	75
10 x 4	11.05-11.45	662-11100400-000	663-11100400-000	47
10 x 6		662-11100600-000	663-11100600-000	51
10 x 8		662-11100800-000	663-11100800-000	70
10 x 10		662-11101000-200	663-11101000-200	75
10 x 4	11.70-12.10	662-11750400-000	663-11750400-000	47
10 x 6		662-11750600-000	663-11750600-000	51
10 x 8		662-11750800-000	663-11750800-000	70
10 x 10		662-11751000-200	663-11751000-200	75
10 x 4	12.00-12.40	662-12000400-000	663-12000400-000	47
10 x 6		662-12000600-000	663-12000600-000	51
10 x 8		662-12000800-000	663-12000800-000	70
10 x 10		662-12001000-200	663-12001000-200	75

For MJ Outlets, replace the last 2 “00”s in the middle eight digits with “MJ”. Example: 622-127504MJ-003.

662 - Carbon Flange Tapping Sleeve
663 - Stainless Steel Flange Tapping Sleeve
Stainless Steel Body and Neck
ANSI/NSF® 61 Listed

Nominal Size of Pipe x Flanged Outlet	O. D. Range (Inches)	662 Flexi-Coat® Epoxy Coated Carbon Steel Flange	663 Stainless Steel Flange	Approx. Weight Each Pounds
		Catalog Number	Catalog Number	
12 x 4	12.50-12.90	662-12750400-000	663-12750400-000	51
12 x 6		662-12750600-000	663-12750600-000	55
12 x 8		662-12750800-000	663-12750800-000	75
12 x 10		662-12751000-000	663-12751000-000	80
12 x 12		662-12751200-200	663-12751200-200	110
12 x 4	13.16-13.56	662-13200400-000	663-13200400-000	51
12 x 6		662-13200600-000	663-13200600-000	55
12 x 8		662-13200800-000	663-13200800-000	75
12 x 10		662-13201000-000	663-13201000-000	80
12 x 12		662-13201200-200	663-13201200-200	110
12 x 4	13.60-14.09	662-13820400-000	663-13820400-000	51
12 x 6		662-13820600-000	663-13820600-000	55
12 x 8		662-13820800-000	663-13820800-000	75
12 x 10		662-13821000-000	663-13821000-000	80
12 x 12		662-13821200-200	663-13821200-200	110
12 x 4	14.10-14.58	662-14250400-000	663-14250400-000	51
12 x 6		662-14250600-000	663-14250600-000	55
12 x 8		662-14250800-000	663-14250800-000	75
12 x 10		662-14251000-000	663-14251000-000	80
12 x 12		662-14251200-200	663-14251200-200	110
14 x 4	15.30-15.80	662-15300400-000	663-15300400-000	72
14 x 6		662-15300600-000	663-15300600-000	76
14 x 8		662-15300800-000	663-15300800-000	95
14 x 10		662-15301000-000	663-15301000-000	102
14 x 12		662-15301200-000	663-15301200-000	135
14 x 4	15.80-16.30	662-16000400-000	663-16000400-000	72
14 x 6		662-16000600-000	663-16000600-000	76
14 x 8		662-16000800-000	663-16000800-000	95
14 x 10		662-16001000-000	663-16001000-000	102
14 x 12		662-16001200-000	663-16001200-000	135
14 x 4	16.40-16.80	662-16400400-000	663-16400400-000	72
14 x 6		662-16400600-000	663-16400600-000	76
14 x 8		662-16400800-000	663-16400800-000	95
14 x 10		662-16401000-000	663-16401000-000	102
14 x 12		662-16401200-000	663-16401200-000	135
16 x 4	17.40-17.80	662-17400400-000	663-17400400-000	77
16 x 6		662-17400600-000	663-17400600-000	82
16 x 8		662-17400800-000	663-17400800-000	103
16 x 10		662-17401000-000	663-17401000-000	108
16 x 12		662-17401200-000	663-17401200-000	145
16-18 x 4	18.60-19.20	662-18700400-000	663-18700400-000	77
16-18 x 6		662-18700600-000	663-18700600-000	82
16-18 x 8		662-18700800-000	663-18700800-000	103
16-18 x 10		662-18701000-000	663-18701000-000	108
16-18 x 12		662-18701200-000	663-18701200-000	145
18-20 x 4	19.50-20.10	662-19500400-000	663-19500400-000	78
18-20 x 6		662-19500600-000	663-19500600-000	82
18-20 x 8		662-19500800-000	663-19500800-000	105
18-20 x 10		662-19501000-000	663-19501000-000	111
18-20 x 12		662-19501200-000	663-19501200-000	147
18-20 x 4	20.90-21.59	662-20900400-000	663-20900400-000	78
18-20 x 6		662-20900600-000	663-20900600-000	82
18-20 x 8		662-20900800-000	663-20900800-000	105
18-20 x 10		662-20901000-000	663-20901000-000	111
18-20 x 12		662-20901200-000	663-20901200-000	147

For MJ Outlets, replace the last 2 “00”s in the middle eight digits with “MJ”. Example: 622-127504MJ-003.

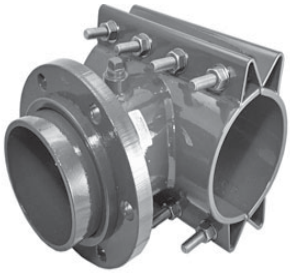
662 - Carbon Flange Tapping Sleeve
663 - Stainless Steel Flange Tapping Sleeve
Stainless Steel Body and Neck
ANSI/NSF® 61 Listed

Nominal Size of Pipe x Flanged Outlet	O. D. Range (Inches)	662 Flexi-Coat® Epoxy Coated Carbon Steel Flange	663 Stainless Steel Flange	Approx. Weight Each Pounds
		Catalog Number	Catalog Number	
20 x 4	21.60-22.40	662-21600400-000	663-21600400-000	88
20 x 6		662-21600600-000	663-21600600-000	94
20 x 8		662-21600800-000	663-21600800-000	118
20 x 10		662-21601000-000	663-21601000-000	124
20 x 12		662-21601200-000	663-21601200-000	160
20-24 x 4	23.50-24.20	662-23500400-000	663-23500400-000	95
20-24 x 6		662-23500600-000	663-23500600-000	100
20-24 x 8		662-23500800-000	663-23500800-000	122
20-24 x 10		662-23501000-000	663-23501000-000	130
20-24 x 12		662-23501200-000	663-23501200-000	169
24 x 4	25.80-26.60	662-25800400-000	663-25800400-000	95
24 x 6		662-25800600-000	663-25800600-000	100
24 x 8		662-25800800-000	663-25800800-000	122
24 x 10		662-25801000-000	663-25801000-000	130
24 x 12		662-25801200-000	663-25801200-000	170
24 x 4	28.30-29.00	662-28300400-000	663-28300400-000	103
24 x 6		662-28300600-000	663-28300600-000	109
24 x 8		662-28300800-000	663-28300800-000	133
24 x 10		662-28301000-000	663-28301000-000	141
24 x 12		662-28301200-000	663-28301200-000	185

For MJ Outlets, replace the last 2 “00”s in the middle eight digits with “MJ”. Example: 622-127504MJ-003.

MJ Series
Tapping Sleeves
with Mechanical Joint Outlets

665 Tapping Sleeve



622 Tapping Sleeve

623 Fabricated Mechanical Joint

Smith-Blair, Inc. Mechanical Joint Outlet is available on all Smith-Blair® Carbon Steel and Stainless Steel Tapping Sleeve product lines.

The MJ Outlet allows the user to tap pipe, utilizing a standard MJ x MJ valve in lieu of a specialty tapping valve. This outlet allows the user to combine valve inventory to a single valve, reduce installation time and save money.

The heavy mechanical joint flange is fixed in place to make installation easier, while reducing the chance of injuries during the tapping operation.

The Smith-Blair® Mechanical Joint Outlet product extension has all the quality features expected in our full line of Tapping Sleeve Products.

To order, modify the standard Smith-Blair® Tapping Sleeve catalog number as shown below

Example:

622 6" x 4" Tapping Sleeve w/alloy bolts and nuts

Standard Catalog Number	MJ Outlet Number
622-069004**00**-003	622-069004**MJ**-003

For information on sizes and prices, please contact Smith-Blair, Inc.
Ph: (870)773-5127 or (800)643-9705

Note: For the flange dimension, please see the specific tapping sleeve specification.

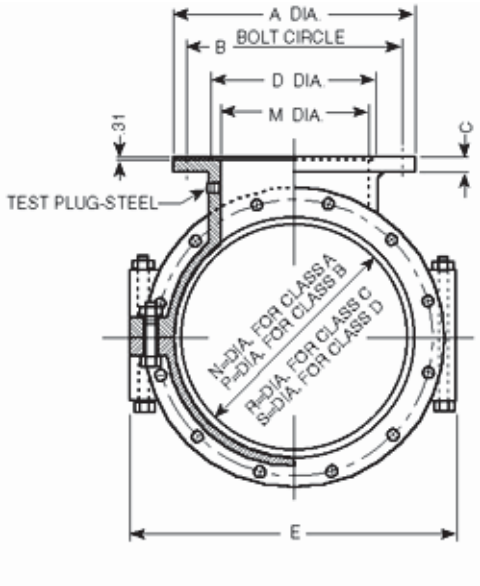
626 Weld-On Outlet

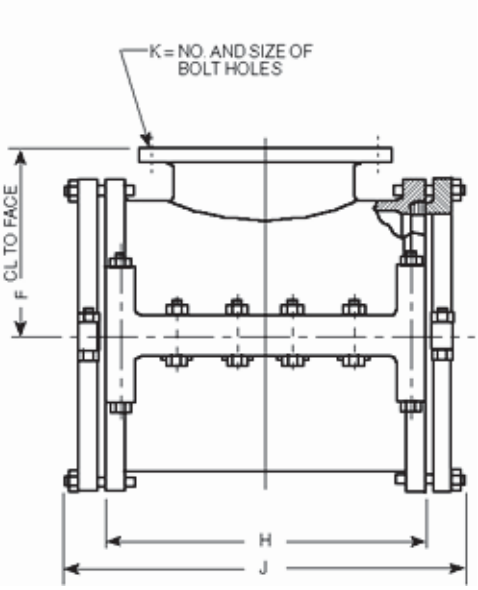
626 Carbon Steel "Weld-On" fittings are provided with several configurations of outlets for use on steel pipe. The 626 is available in stainless steel.

American Flow Control

MENU CATEGORIES

Series 1004 Sectional Drawing





> Tapping Sleeves Features
> Tapping Sleeves Specifications
> Series 1004 Sectional Drawing
> Series 2800 Sectional Drawing

Parts	
Part Name	**Material**
Sleeve Outlet Half	Ductile Iron
Sleeve Plain Half	Ductile Iron
Split Gland	Ductile Iron
Side Flange Gasket	Rubber
End Flange Gasket	Rubber
Bolts and Nuts	High-Strength, Low-Alloy Steel Per AWWA C111

AFC-sleeves-sectional-1004-d1436

Size	A	E	C	F	D (outside Pipe Dia.)	
					Class A	Class B
14 x 4	5.02	23	13.75	18	15.3	15.3
14 x 6	7.02	23	13.75	18	15.3	15.3
14 x 8	9.02	23	13.75	18	15.3	15.3
14 x 10	11.02	23	14.25	24	15.3	15.3
14 x 12	13.02	23	14.25	24	15.3	15.3
14 x 14	15	23	15	24	15.3	15.3
16 x 14	15	25.74	15.5	24	17.4	17.4
16 x 16	17.02	25.74	15.5	30	17.4	17.4

18 x 4	5.02	28	16.25	18	19.5	19.5
18 x 6	7.02	28	16.25	18	19.5	19.5
18 x 8	9.02	28	16.25	18	19.5	19.5
18 x 10	11.02	28	16.25	24	19.5	19.5
18 x 12	13.02	28	16.75	24	19.5	19.5
18 x 14	15	28	16.75	24	19.5	19.5
18 x 16	17	28	16.75	30	19.5	19.5
18 x 18	19.13	28	16.75	30	19.5	19.5
20 x 4	5.02	30.24	16.5	18	21.6	21.6
20 x 6	7.02	30.24	16.5	18	21.6	21.6
20 x 8	9.02	30.24	16.5	18	21.6	21.6
20 x 10	11.02	30.24	16.5	24	21.6	21.6
20 x 12	13.02	30.24	16.5	24	21.6	21.6
20 x 14	15	30.24	16.5	24	21.6	21.6
20 x 16	17	30.24	16.5	30	21.6	21.6
20 x 20	21	30.24	18	30	21.6	21.6
24 x 4	5.02	35.5	19.5	18	25.8	25.8
24 x 6	7.02	35.5	19.5	18	25.8	25.8
24 x 8	9.02	35.5	19.5	18	25.8	25.8
24 x 10	11.02	35.5	19.5	24	25.8	25.8
24 x 12	13.02	35.5	19.5	24	25.8	25.8
24 x 14	15	35.5	19.5	24	25.8	25.8
24 x 16	17	35.5	20.5	30	25.8	25.8
24 x 18	19.12	35.5	20.5	30	25.8	25.8
24 x 20	21	35.5	20.5	30	25.8	25.8
24 x 24	25	35.5	20.5	36	25.8	25.8
30 x 6	7.02	43.37	23.25	24	31.74	32
30 x 8	9.02	43.37	23.25	24	31.74	32
30 x 10	11.02	43.37	23.25	24	31.74	32
30 x 12	13.02	43.37	23.35	24	31.74	32
30 x 16	17	43.37	23.75	36	31.74	32
30 x 18	19.12	43.37	23.75	36	31.74	32
30 x 20	21	43.37	23.75	36	31.74	32
30 x 24	25	43.37	23.75	36	31.74	32
36 x 6	7.02	49.75	26.5	24	37.96	38.3
36 x 8	9.02	49.75	26.5	24	37.96	38.3
36 x 10	11.02	49.75	26.5	24	37.96	38.3
36 x 12	13.02	49.75	27.25	24	37.96	38.3
36 x 16	17	49.75	27.25	30	37.96	38.3
36 x 20	21	49.75	27.25	36	37.96	38.3
36 x 24	25	49.75	27.25	36	37.96	38.3

Notes:
DIMENSION D IS OUTSIDE PIPE DIAMETERS SLEEVE WILL FIT.
PIPE SIZE (CLASS A ON 24" AND SMALLER AND CLASS B ON LARGER THAN 24").
SLEEVE IS NOT A COMBINATION SLEEVE. YOU MUST MEASURE PIPE PRIOR TO PLACING ORDER.

250 P.S.I.G. RATED WORKING PRESSURE.

AFC-sleeves-sectional-1004-dinches

Size	A	B	C	D	E	F	H	J	K		M	N	P	Wt.-lbs.
									No.	Size				
20 x 4	9	7.5	0.94	5.02	30.24	16.5	18	24.62	8	3/4	4.5	21.6	21.6	760
20 x 6	11	9.5	1	7.02	30.24	16.5	18	24.62	8	7/8	6.5	21.6	21.6	765
20 x 8	13.5	11.75	1.13	9.02	30.24	16.5	18	24.62	8	7/8	8.5	21.6	21.6	775
20 x 10	16	14.25	1.19	11.02	30.24	16.5	24	30.62	12	1	10.5	21.6	21.6	930
20 x 12	19	17	1.25	13.02	30.24	16.5	24	30.62	12	1	12.5	21.6	21.6	950
20 x 14	21	18.75	1.38	15	30.24	16.5	24	30.62	12	1 1/8	13.5	21.6	21.6	965
20 x 16	23.5	21.25	1.44	17	30.24	16.5	30	36.62	16	1 1/8	16.5	21.6	21.6	1130
20 x 20	27.5	25	1.69	21	30.24	18	30	36.62	20	1 1/4	20.25	21.6	21.6	1175
24 x 4	9	7.5	0.94	5.02	35.5	19.5	18	24.37	8	3/4	4.5	25.8	25.8	985
24 x 6	11	9.5	1	7.02	35.5	19.5	18	24.37	8	7/8	6.5	25.8	25.8	990
24 x 8	13.5	11.75	1.13	9.02	35.5	19.5	18	24.37	8	7/8	8.5	25.8	25.8	995
24 x 10	16	14.25	1.19	11.02	35.5	19.5	24	30.37	12	1	10.5	25.8	25.8	1300
24 x 12	19	17	1.25	13.02	35.5	19.5	24	30.37	12	1	12.5	25.8	25.8	1410
24 x 14	21	18.75	1.38	15	35.5	19.5	24	30.37	12	1 1/8	14.5	25.8	25.8	1415
24 x 16	23.5	21.25	1.44	17	35.5	20.5	30	36.37	16	1 1/8	16.5	25.8	25.8	1420
24 x 18	25	22.75	1.56	19.12	35.5	20.5	30	36.37	16	1 1/4	18.25	25.8	25.8	1440
24 x 20	27.5	25	1.69	21	35.5	20.5	30	36.37	20	1 1/4	20.25	25.8	25.8	1470
24 x 24	32	29.5	1.88	25	35.5	20.5	36	42.37	20	1 3/8	24.25	25.8	25.8	1730
30 x 6	11	9.5	1	7.02	43.37	23.25	24	32.12	8	7/8	6.5	31.74	32	1895
30 x 8	13.5	11.75	1.13	9.02	43.37	23.25	24	32.12	8	7/8	8.5	31.74	32	1910
30 x 10	16	14.25	1.19	11.02	43.37	23.25	24	32.12	12	1	10.5	31.74	32	2210
30 x 12	19	17	1.25	13.02	43.37	23.35	24	32.12	12	1	12.5	31.74	32	2225

30 x 16	23.5	21.25	1.44	17	43.37	23.75	36	44.12	16	1 1/8	16.5	31.74	32	2600
30 x 18	25	22.75	1.56	19.12	43.37	23.75	36	44.12	16	1 1/4	18.25	31.74	32	--
30 x 20	27.5	25	1.69	21	43.37	23.75	36	44.12	20	1 1/4	20.25	31.74	32	--
30 x 24	32	29.5	1.88	25	43.37	23.75	36	44.12	20	1 3/8	24.25	31.74	32	2890
36 x 6	11	9.5	1	7.02	49.75	26.5	24	32	8	7/8	6.5	37.96	38.3	2222
36 x 8	13.5	11.75	1.13	9.02	49.75	26.5	24	32	8	7/8	8.5	37.96	38.3	2232
36 x 10	16	14.25	1.19	11.02	49.75	26.5	24	32	12	1	10.5	37.96	38.3	--
36 x 12	19	17	1.25	13.02	49.75	26.5	24	32	12	1	12.5	37.96	38.3	--
36 x 16	23.5	21.25	1.44	17	49.75	27.25	30	38	16	1 1/8	16.5	37.96	38.3	--
36 x 20	27.5	25	1.69	21	49.75	27.25	36	44	20	1 1/4	20.25	37.96	38.3	3055
36 x 24	32	29.5	1.88	25	49.75	27.25	36	44	20	1 3/8	24.25	37.96	38.3	3075

Notes:
N AND P DIMENSIONS ARE PIPE OUTSIDE DIAMETERS SLEEVE WILL FIT.
SLEEVE IS NOT A COMBINATION SLEEVE.
PIPE SIZE IS REQUIRED FOR EACH SLEEVE.
RATED FOR 250 P.S.I.G. WORKING PRESSURE.

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Customer Service: 1-800-326-8051 (Birmingham) 1-888-266-3686 (Waterous)
Contact Us

ATTACHMENT TM21-2
TYPICAL TURNOUT CONFIGURATIONS

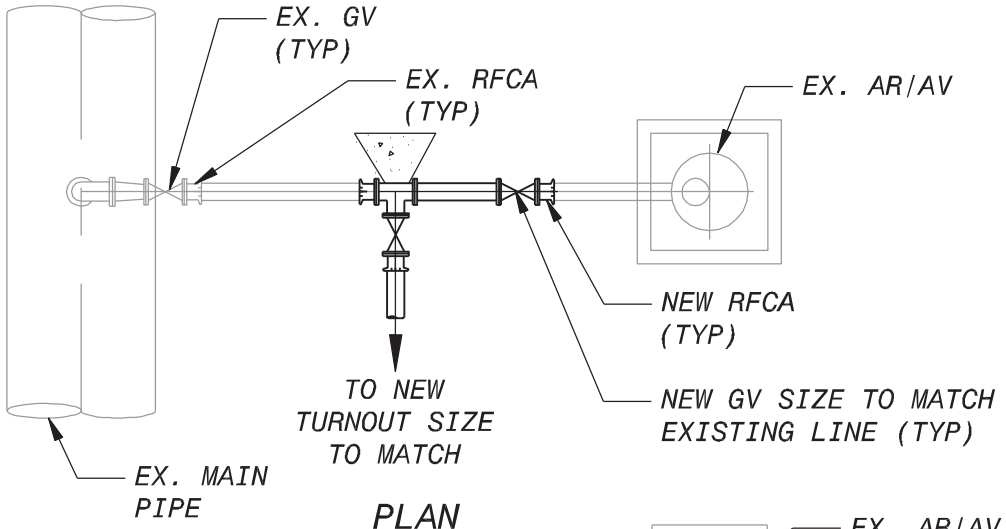
List of Turnout Configurations and Drawings

Turnout Designation	Turnout Description	Drawing Number
TO-U-001	Underground Turnout from Air Valve Line – DI Pipe	TM21-TO-001
TO-U-002	Underground Turnout from Pumpout – DI Pipe	TM21-TO-002
TO-U-003	Underground Turnout from Cut-in Tee – DI Pipe	TM21-TO-003
TO-U-004	Underground Turnout from Tapping Sleeve – DI Pipe	TM21-TO-004
TO-U-011	Underground Turnout from Air Valve Line – Steel Pipe	TM21-TO-011
TO-U-012	Underground Turnout from Pumpout – Steel Pipe	TM21-TO-012
TO-U-013	Underground Turnout from Cut-in Tee – Steel Pipe	TM21-TO-013
TO-U-014	Underground Turnout from Tapping Sleeve – Steel Pipe	TM21-TO-014
TO-A-021	Above Grade Turnout from Air Valve Lines – DI Pipe	TM21-TO-021
TO-A-023	Above Grade Turnout from Cut-in Tee – DI Pipe	TM21-TO-023
TO-A-024	Above Grade Turnout from Tapping Sleeve – DI Pipe	TM21-TO-024
TO-A-031	Above Grade Turnout from Air Valve Lines – Steel Pipe	TM21-TO-031
TO-A-033	Above Grade Turnout from Cut-in Tee – Steel Pipe	TM21-TO-033
TO-A-034	Above Grade Turnout from Tapping Sleeve – Steel Pipe	TM21-TO-034
TO-A	Above Grade Turnout – Typical Layout	TM21-TO-041
TO-U	Underground Turnout – Typical Layout Plans	TM21-TO-051
TO-U	Underground Turnout – Typical Layout Sections	TM21-TO-052
-	Trench Bedding	STD-C005
-	Buried Valve Operator	STD-C033
-	Extension Stem	STD-C034
-	Rubber Gasket Joint for Steel Pipe	STD-M052
-	Jumper Rod for Steel Pipe (Alternative to Bonding Clips)	STD-M052A
-	Exothermal Weld Procedure	STD-CP003
-	Test Lead to Steel Pipe	STD-CP004
-	Test Lead to DI Pipe	STD-CP005
-	Joint Bonding	STD-CP026
-	DI Pipe Joint Bonding	STD-CP027

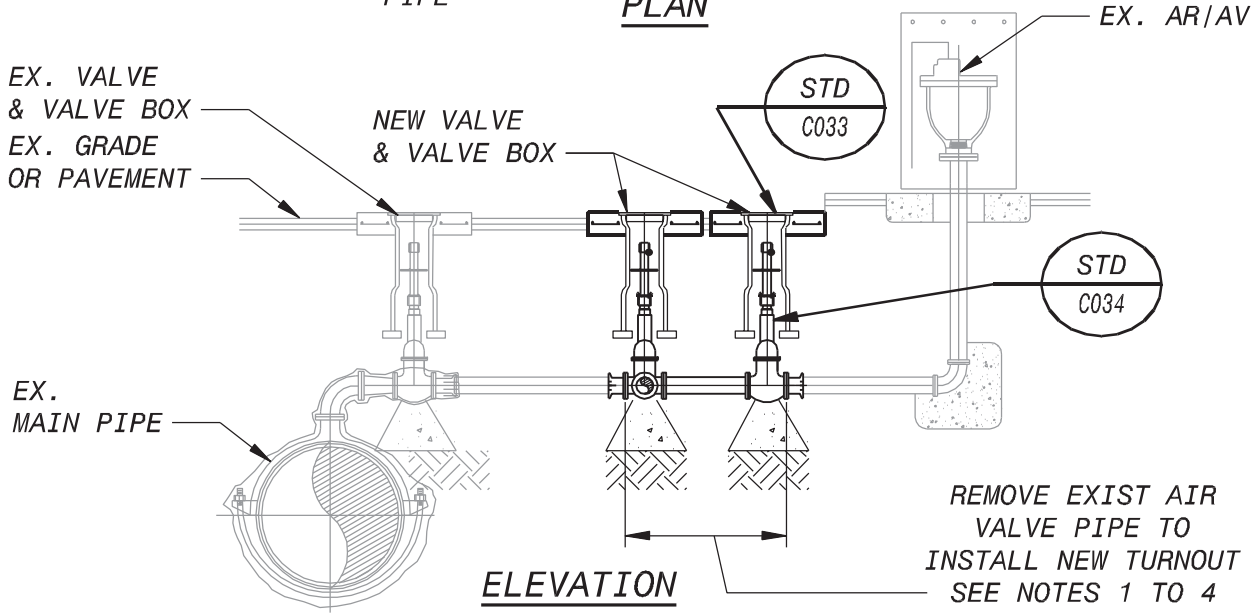
PLOTTED: VIZ28550, 10/13/2010 7:19:14 AM
SAVED: VIZ28550, 10/13/2010 7:37:18 AM
CYGNET ID:
FAL137522_TM
AL137522_TM

NOTES:

1. WAX TAPE COAT ALL FLANGES, NUTS, AND BOLTS. APPLY POLYETHYLENE SHEET ENCASEMENT PER SPECIFICATIONS.
2. WRAP ALL DUCTILE IRON PIPE WITH POLYETHYLENE ENCASEMENT PER SEPECIFICATIONS.
3. SEE STD C005 FOR TRENCH EXCAVATION AND BACKFILL.
4. SEE STD CP026 & CP027 FOR BONDING DETAILS.



PLAN



ELEVATION

BLACK & VEATCH
137522

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District
3000187.08

DATE	REVISION OR ISSUE	NO	BY

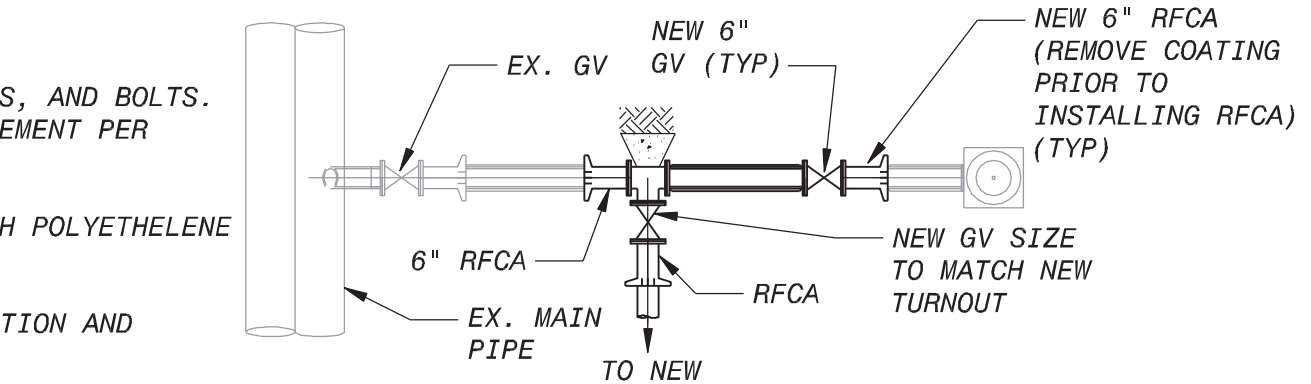
TYPE TO-U-001
UNDERGROUND TURNOUT FROM
AIR VALVE LINE - DI PIPE

TM21
TO-001
SCALE
NO SCALE

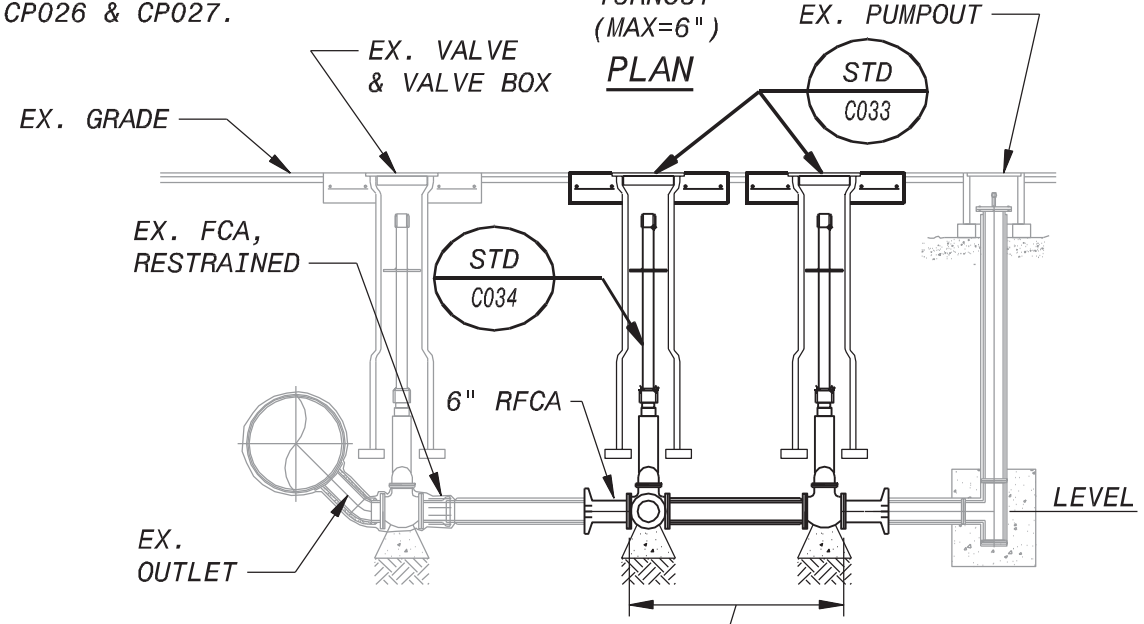
PLOTTED: VIZ28550, 10/12/2010 3:33:58 PM
SAVED: VIZ28550, 10/13/2010 10:11:56 AM
CYGNET ID:
FAL137522_TM
AL137522_TM

NOTES:

1. WAX TAPE COAT ALL FLANGES, NUTS, AND BOLTS. APPLY POLYETHYLENE SHEET ENCASEMENT PER SPECIFICATIONS.
2. WRAP ALL DUCTILE IRON PIPE WITH POLYETHELENE ENCASEMENT PER SPECIFICATIONS.
3. SEE STD C005 FOR TRENCH EXCAVATION AND BACKFILL.
4. PROVIDE JOINT BONDING PER STD CP026 & CP027.



PLAN



ELEVATION

BLACK & VEATCH
137522

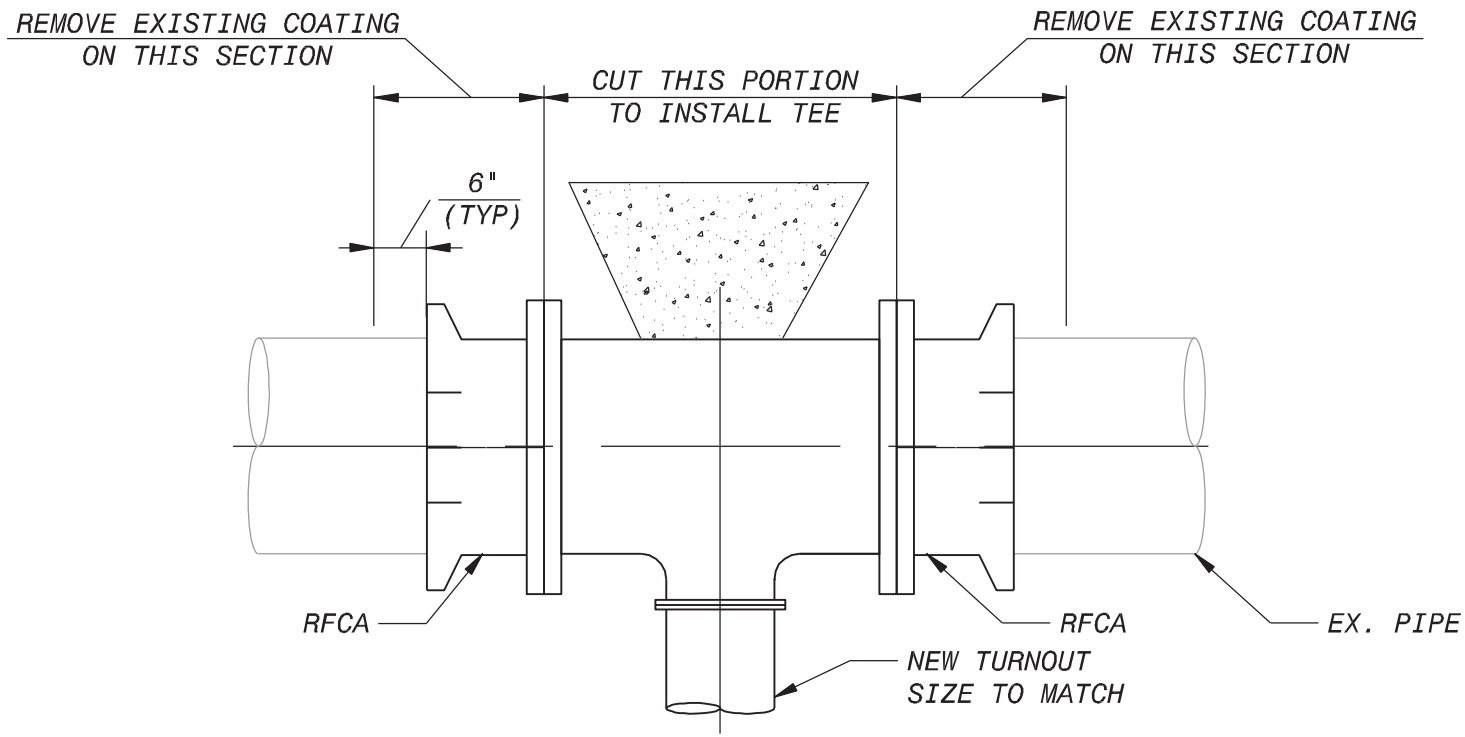
NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District
3000187.08

DATE	REVISION OR ISSUE	NO	BY

TYPE TO-U-002
UNDERGROUND TURNOUT FROM PUMPOUT - DI PIPE

TM21
TO-002
SCALE
NO SCALE

PLOTTED: VIZ28550, 10/12/2010 1:41:59 PM
SAVED: VIZ28550, 10/13/2010 10:17:17 AM
CYGNET ID:
FAL137522_TM
AL137522_TM



NOTES:

1. INSTALL CUT-IN TEE ONLY AFTER THE MAIN PIPELINE IS SHUTDOWN AND DRAINED.
2. WAX TAPE COAT ALL FLANGES, NUTS, AND BOLTS. APPLY POLYETHYLENE SHEET ENCASEMENT PER SPECIFICATION.
3. SEE STD C005 FOR TRENCH EXCAVATION AND BACKFILL.
4. SEE STD CP026 & CP027 FOR JOINT BONDING.

BLACK & VEATCH
137522

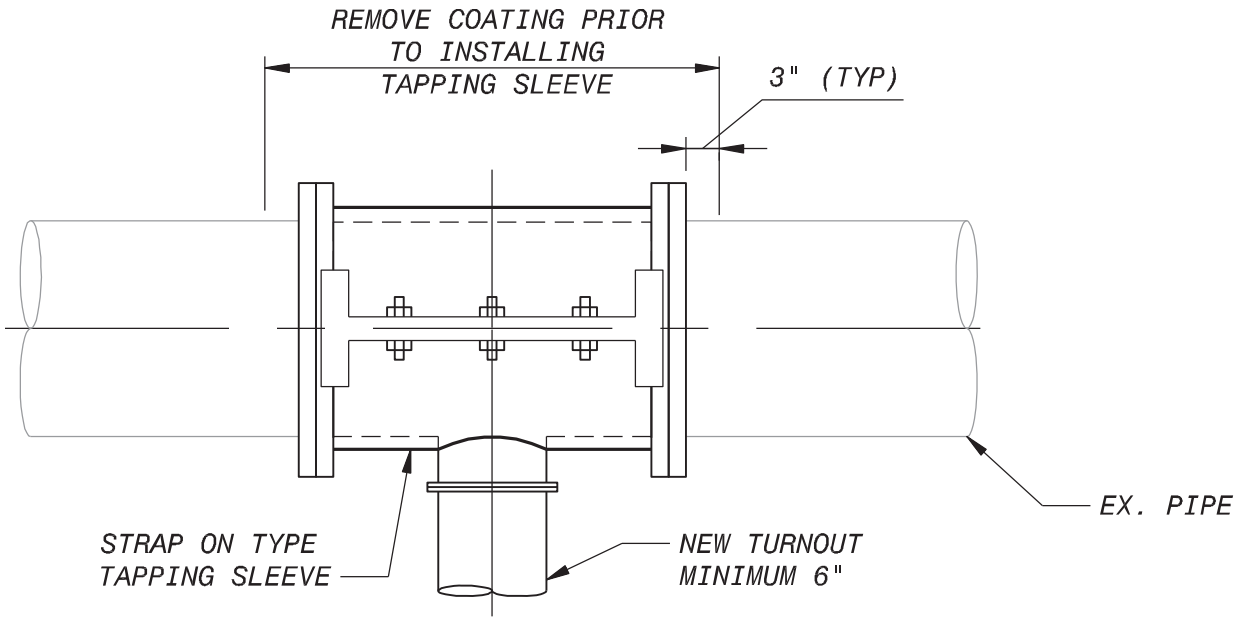
NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District
3000187.08

DATE	REVISION OR ISSUE	NO	BY

TYPE TO-U-003
UNDERGROUND TURNOUT FROM
CUT-IN TEE - DI PIPE

TM21
TO-003
SCALE
NO SCALE

PLOTTED: VIZ28550, 10/13/2010 7:43:25 AM
SAVED: VIZ28550, 10/13/2010 10:22:29 AM
CYGNET ID:
FAL137522_TM
AL137522_TM



NOTES:

1. WAX TAPE COAT ALL FLANGES, NUTS, AND BOLTS. APPLY POLYETHYLENE SHEET ENCASEMENT PER SPECIFICATIONS.
2. WRAP ALL PIPE WITH POLYETHELENE ENCASEMENT PER SPECIFICATIONS.
3. SEE STD C005 FOR TRENCH EXCAVATION AND BACKFILL.
4. AFTER TAPPING SLEEVE IS INSTALLED, DRILL THROUGH MAIN PIPE AND REPAIR CEMENT MORTAR LINING PRIOR TO INSTALLING TURNOUT PIPING.
5. SEE STD CP026 & CP027 FOR BONDING DETAILS.

BLACK & VEATCH
137522

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District
3000187.08

DATE	REVISION OR ISSUE	NO	BY

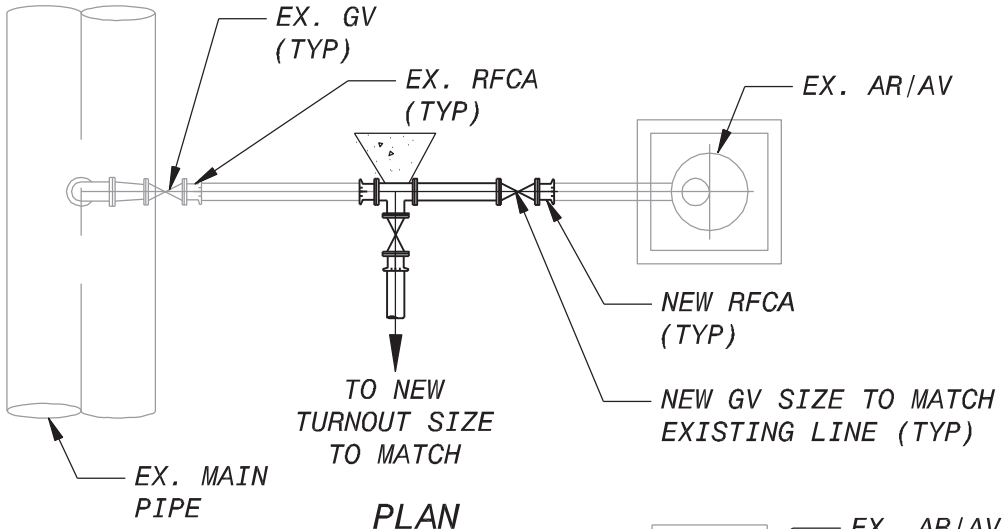
TYPE TO-U-004
UNDERGROUND TURNOUT WITH
TAPPING SLEEVE - DI PIPE

TM21
TO-004
SCALE
NO SCALE

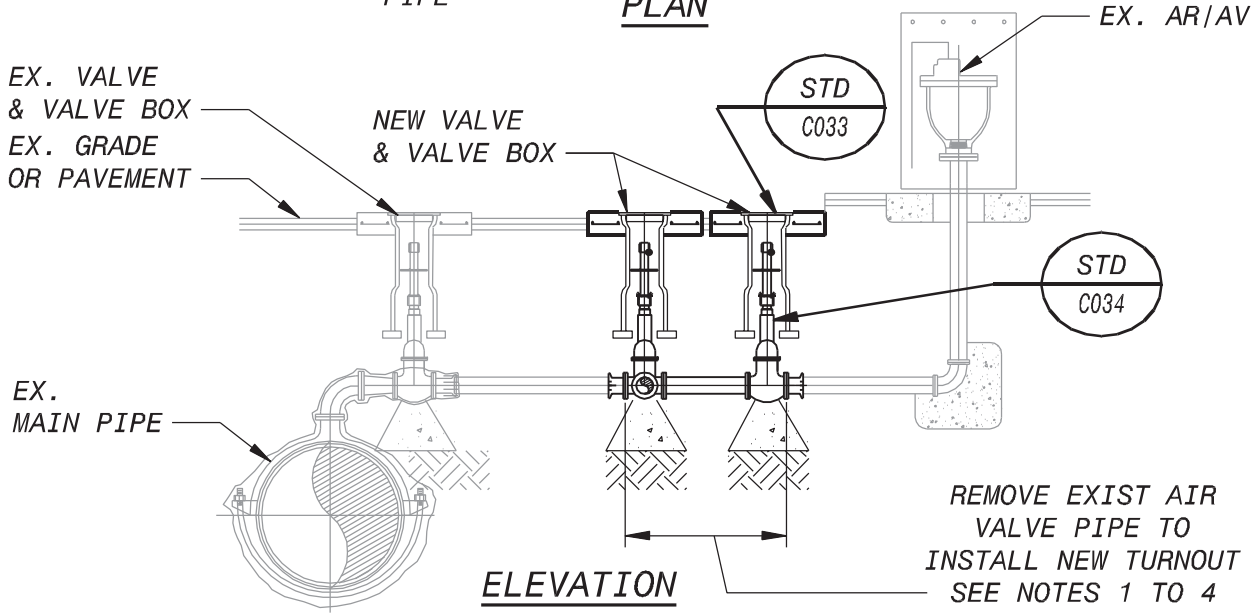
PLOTTED: VIZ28550, 10/13/2010 7:45:39 AM
SAVED: VIZ28550, 10/13/2010 7:45:59 AM
CYGNET ID:
FAL137522_TM
AL137522_TM

NOTES:

1. WAX TAPE COAT ALL FLANGES, NUTS, AND BOLTS PER SPECIFICATIONS.
2. COAT ALL STEEL PIPE WITH CEMENT MORTAR PER SPECIFICATIONS.
3. SEE STD C005 FOR TRENCH EXCAVATION AND BACKFILL.
4. PROVIDE JOINT BONDING PER STD CP026.



PLAN



ELEVATION

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137522

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District
3000187.08

DATE	REVISION OR ISSUE	NO	BY

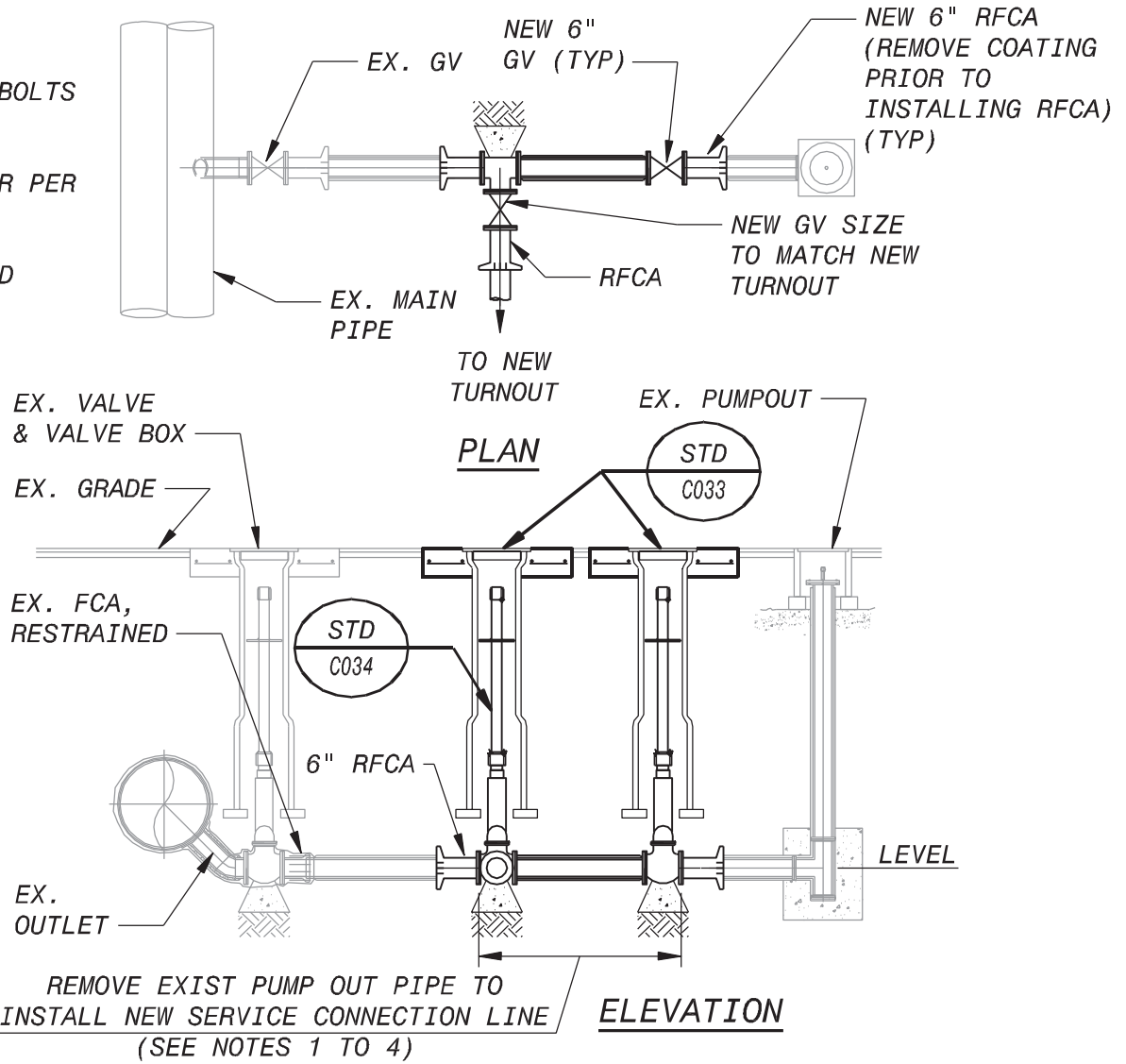
TYPE TO-U-011
UNDERGROUND TURNOUT FROM
AIR VALVE LINE - STEEL PIPE

TM21
TO-011
SCALE
NO SCALE

PLOTTED: VIZ28550, 10/12/2010 3:33:58 PM
SAVED: VIZ28550, 10/13/2010 10:23:34 AM
CYGNET ID:
FAL137522_TM
AL137522_TM

NOTES:

1. WAX TAPE COAT ALL FLANGES, NUTS, AND BOLTS PER SPECIFICATIONS.
2. COAT ALL STEEL PIPE WITH CEMENT MORTAR PER SPECIFICATIONS.
3. SEE STD C005 FOR TRENCH EXCAVATION AND BACKFILL.
4. PROVIDE JOINT BONDING PER STD CP026.



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NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District
3000187.08

DATE	REVISION OR ISSUE	NO	BY

TYPE TO-U-012
UNDERGROUND TURNOUT FROM PUMPOUT - STEEL PIPE

TM21
TO-012
SCALE
NO SCALE

PLOTTED: VIZ28550, 10/13/2010 7:47:23 AM
SAVED: VIZ28550, 10/13/2010 10:25:15 AM
CYGNET ID:
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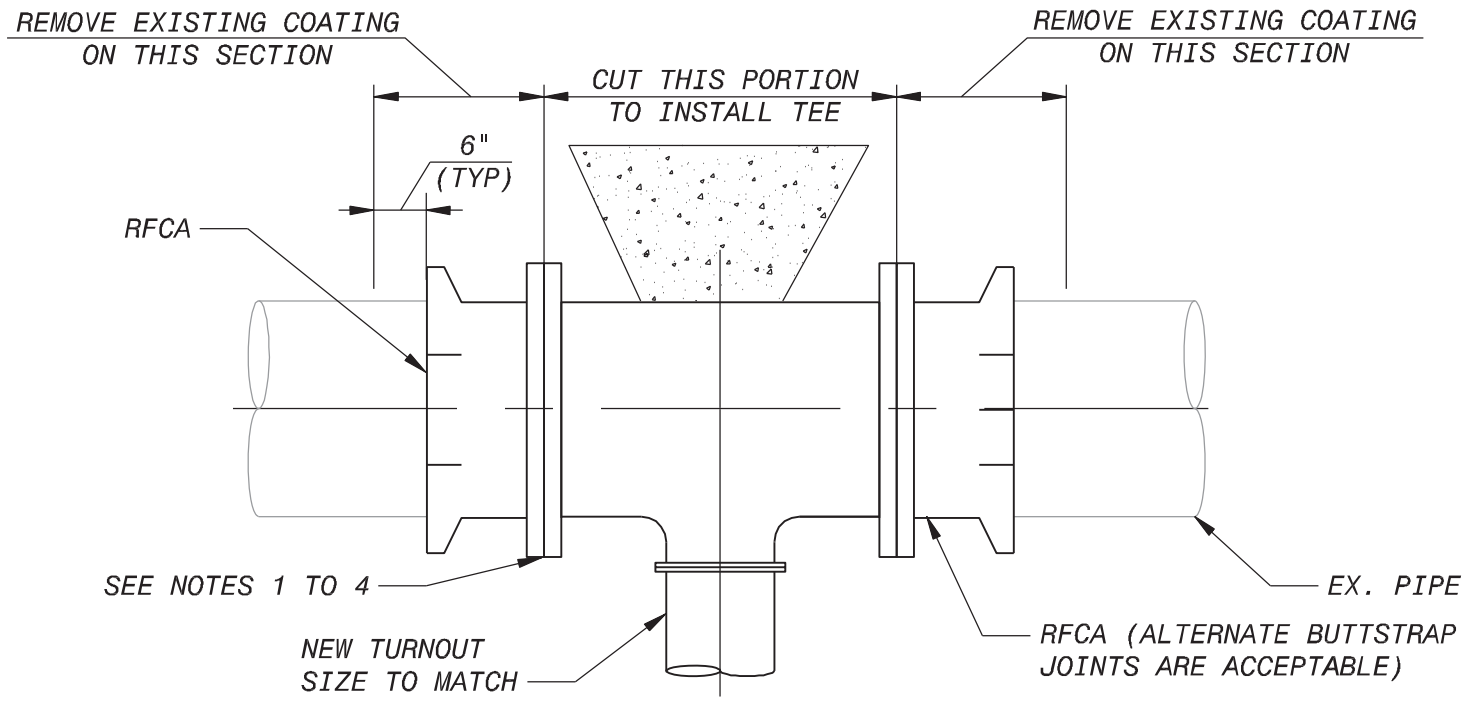
AL137522_TM



NOTES:

1. WAX TAPE COAT ALL FLANGES, NUTS, AND BOLTS PER SPECIFICATIONS.
2. COAT ALL STEEL PIPE WITH CEMENT MORTAR PER SPECIFICATIONS.
3. SEE STD C005 FOR TRENCH EXCAVATION AND BACKFILL.
4. SEE STD CP026 FOR BONDING DETAILS.

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NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District
3000187.08

DATE	REVISION OR ISSUE	NO	BY

TYPE TO-U-013
UNDERGROUND TURNOUT FROM
CUT-IN TEE - STEEL PIPE

TM21
TO-013
SCALE
NO SCALE

PLOTTED: VIZ28550, 10/13/2010 7:51:36 AM
SAVED: VIZ28550, 10/13/2010 10:26:54 AM
CYGNET ID:
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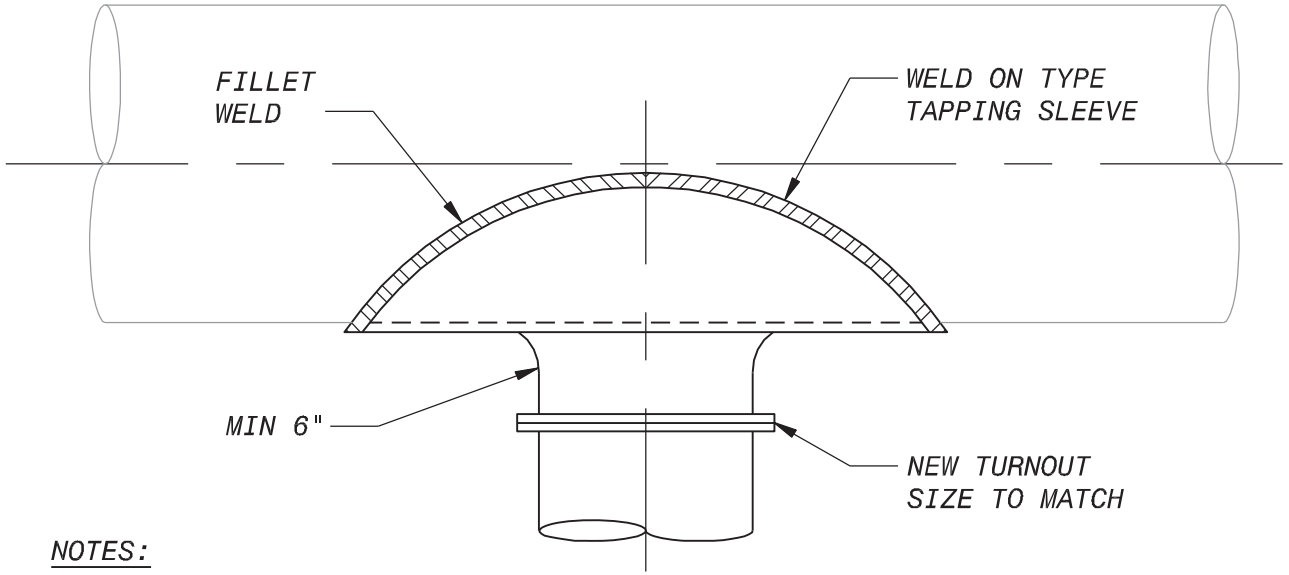
AL137522_TM



NOTES:

1. WAX TAPE COAT ALL FLANGES, NUTS, AND BOLTS PER SPECIFICATIONS.
2. COAT ALL STEEL PIPE WITH CEMENT MORTAR PER SPECIFICATIONS.
3. SEE STD C005 FOR TRENCH EXCAVATION AND BACKFILL.
4. PRIOR TO WELDING TAPPING SLEEVE, REMOVE COATING FROM THE INTERFACING AREA BETWEEN TAPPING SLEEVE AND PIPE.
5. AFTER WELDING TAPPING SLEEVE, DRILL THROUGH THE MAIN PIPE AND REPAIR CEMENT MORTAR PRIOR LINING TO INSTALLING TURNOUT PIPING.
6. SEE STD CP026 FOR BONDING DEATILS.
7. BOLT-ON TYPE TAPPING SADDLE IS ACCEPTABLE IN LIEU OF WELD-ON TYPE.

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San Luis Obispo County Flood Control & Water Conservation District
3000187.08

DATE	REVISION OR ISSUE	NO	BY

TYPE TO-U-014
UNDERGROUND TURNOUT WITH
TAPPING SLEEVE - STEEL PIPE

TM21
TO-014
SCALE
NO SCALE

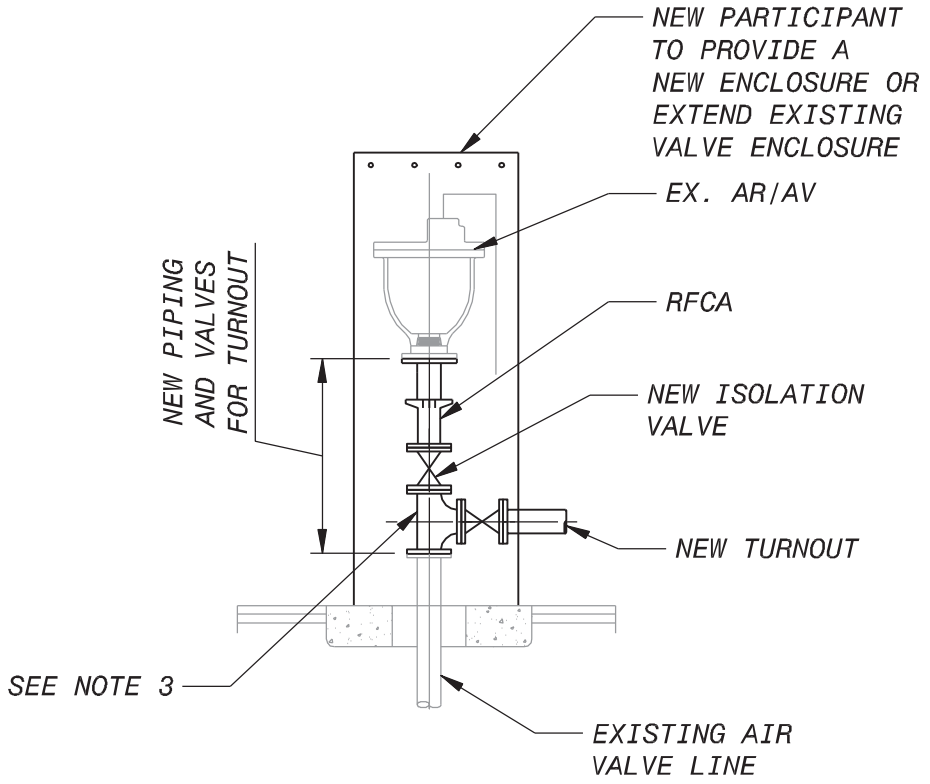
PLOTTED: SAN43843, 3/7/2011 2:40:08 PM
SAVED: JAY37537, 3/8/2011 10:37:23 AM
CYGNET ID:
FAL137522_TM
AL137522_TM

NOTES:

1. COAT ALL PIPES AND VALVES PER SPECIFICATION.

2. SEE STD CP026 & CP027 FOR BONDING DETAILS.

3. SUPPORT THE NEWLY INSTALLED TURNOUT PIPING TO RESIST THRUST FORCES.



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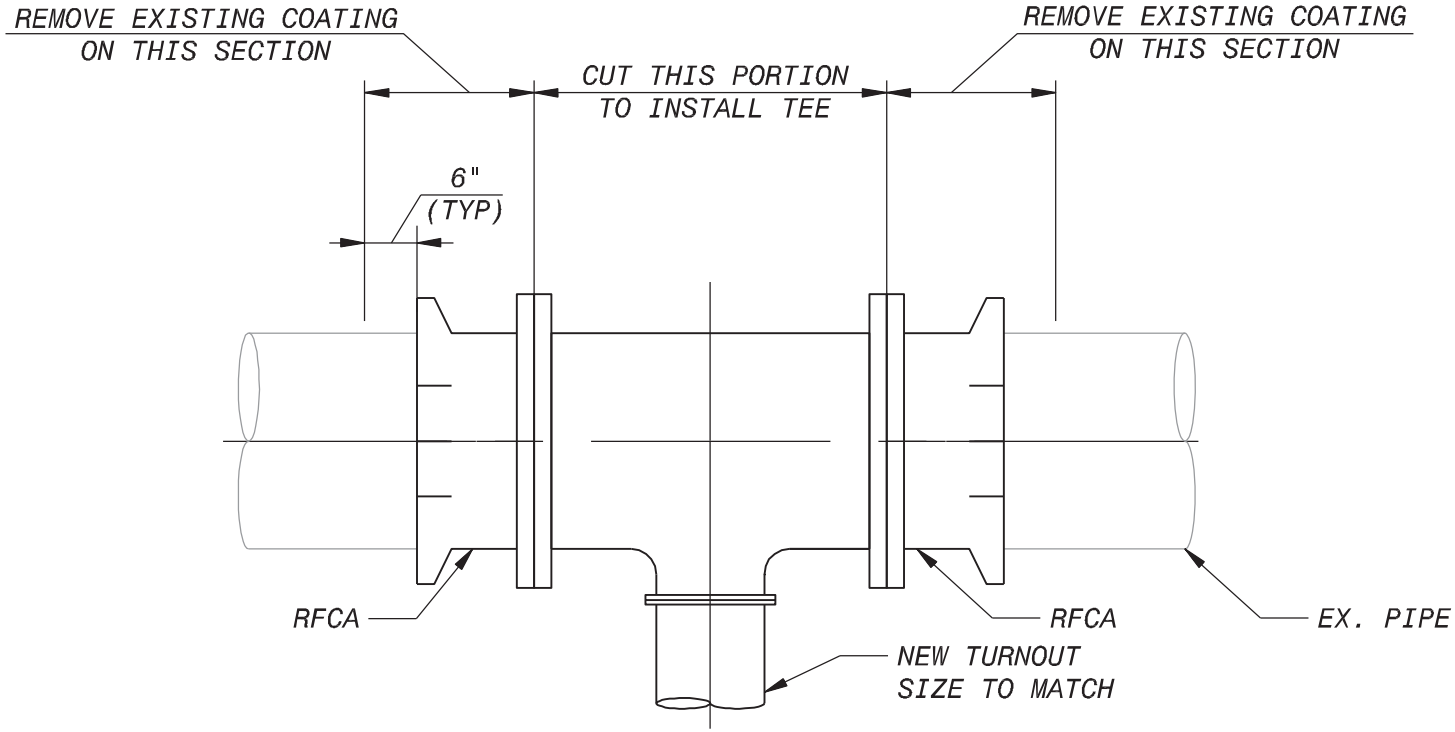
NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District
3000187.08

DATE	REVISION OR ISSUE	NO	BY

TYPE TO-A-021
ABOVE GRADE TURNOUT FROM AIR VALVE LINE - DI PIPE

TM21
TO-021
SCALE
NO SCALE

PLOTTED: VIZ28550, 10/12/2010 2:13:03 PM
SAVED: VIZ28550, 10/13/2010 11:12:11 AM
CYGNET ID:
FAL137522_TM
AL137522_TM



NOTES:

1. INSTALL CUT-IN TEE ONLY AFTER THE MAIN PIPELINE IS SHUTDOWN AND DRAINED.
2 SEE STD CP026 & CP027 FOR JOINT BONDING.
3. COAT PIPE PER SPECIFICATIONS.
4. PROVIDE SUPPORTS ON EITHER SIDE OF THE PIPE AS CLOSE TO THE NEW TEE AS POSSIBLE.

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San Luis Obispo County Flood Control & Water Conservation District
3000187.08

DATE	REVISION OR ISSUE	NO	BY

TYPE TO-A-023
ABOVE GRADE TURNOUT FROM
CUT-IN TEE - DI PIPE

TM21
TO-023
SCALE
NO SCALE

PLOTTED: VIZ28550, 10/13/2010 8:15:04 AM
SAVED: VIZ28550, 10/13/2010 11:15:31 AM
CYGNET ID:
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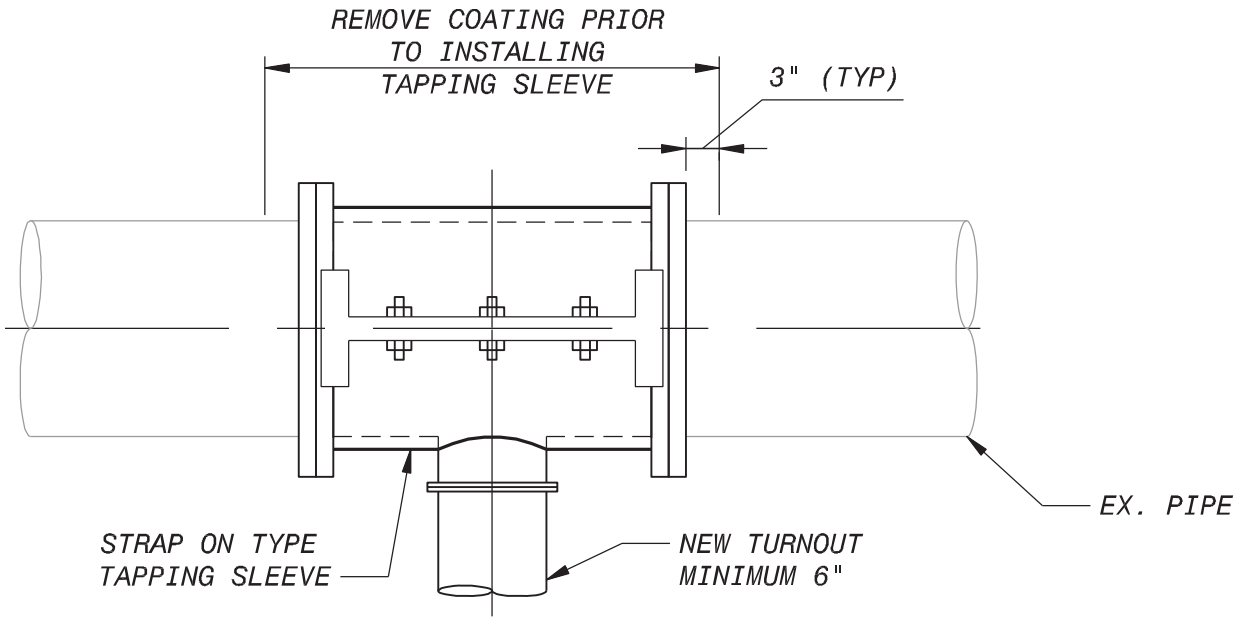
AL137522_TM



NOTES:

1. AFTER TAPPING SLEEVE IS INSTALLED, DRILL THROUGH MAIN PIPE AND REPAIR CEMENT MORTAR LINING PRIOR TO INSTALLING TURNOUT PIPING.
2. SEE STD CP026 & CP027 FOR BONDING DETAILS.
3. COAT NEW INSTALLATION PER SPECIFICATION.

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San Luis Obispo County Flood Control & Water Conservation District
3000187.08

DATE	REVISION OR ISSUE	NO	BY

TYPE TO-A-024
ABOVE GRADE TURNOUT WITH
TAPPING SLEEVE - DI PIPE

TM21
TO-024
SCALE
NO SCALE

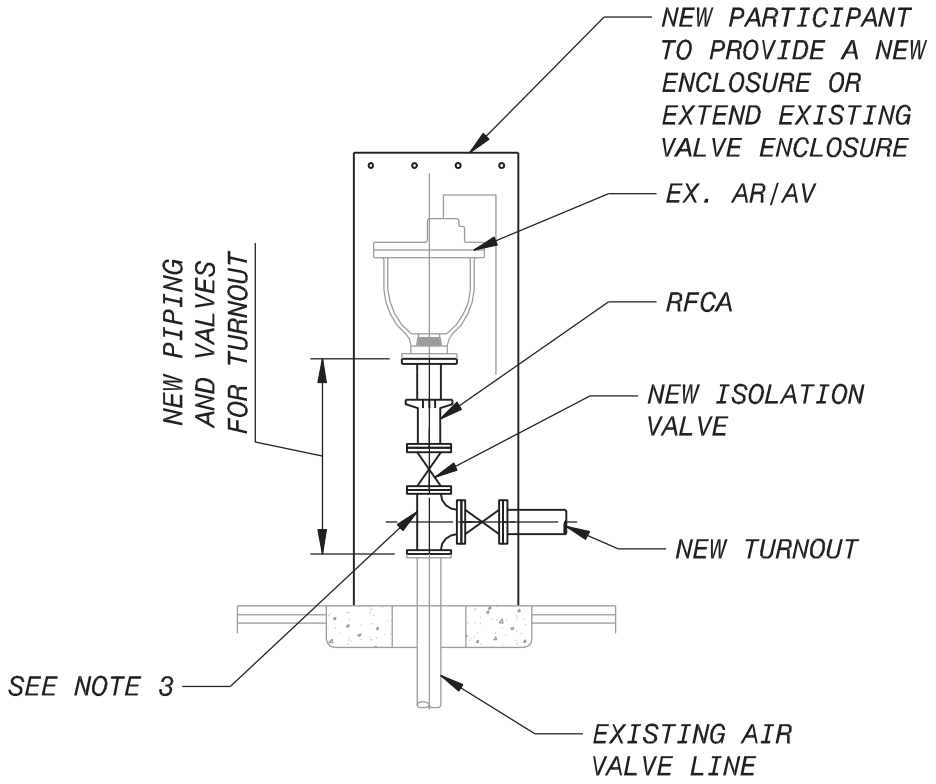
PLOTTED: SAN43843, 3/7/2011 2:43:46 PM
SAVED: JAY37537, 3/8/2011 10:35:33 AM
CYGNET ID:
FAL137522_TM
AL137522_TM

NOTES:

1. COAT ALL PIPES AND VALVES PER SPECIFICATION.

2. SEE STD CP026 FOR BONDING DETAILS.

3. SUPPORT THE NEWLY INSTALLED TURNOUT PIPING TO RESIST THRUST FORCES.



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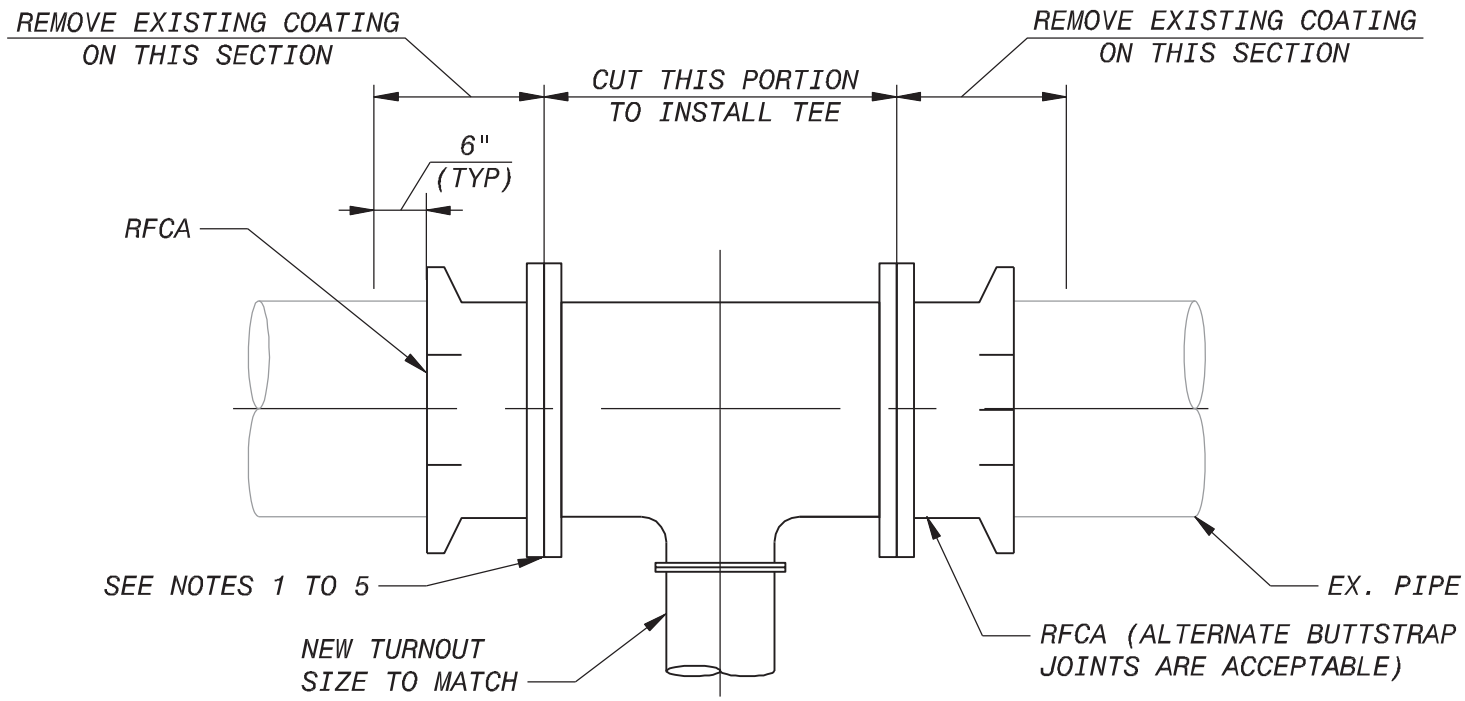
NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District
3000187.08

DATE	REVISION OR ISSUE	NO	BY

TYPE TO-A-031
ABOVE GRADE TURNOUT FROM
AIR VALVE LINE - STEEL PIPE

TM21
TO-031
SCALE
NO SCALE

PLOTTED: VIZ28550, 10/13/2010 11:21:33 AM
SAVED: VIZ28550, 10/13/2010 11:21:38 AM
CYGNET ID:
FAL137522_TM
AL137522_TM



NOTES:

1. COAT ALL STEEL PIPE PER SPECIFICATION.
2. SEE STD CP026 FOR BONDING DETAILS.
3. SUPPORT THE NEWLY INSTALLED TEE ON EITHER SIDE TO RESIST THRUST FORCES.

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San Luis Obispo County Flood Control & Water Conservation District
3000187.08

DATE	REVISION OR ISSUE	NO	BY

TYPE TO-A-033
ABOVE GRADE TURNOUT FROM
CUT-IN TEE - STEEL PIPE

TM21
TO-033
SCALE
NO SCALE

PLOTTED: VIZ28550, 10/13/2010 8:24:09 AM
SAVED: VIZ28550, 10/13/2010 11:22:48 AM
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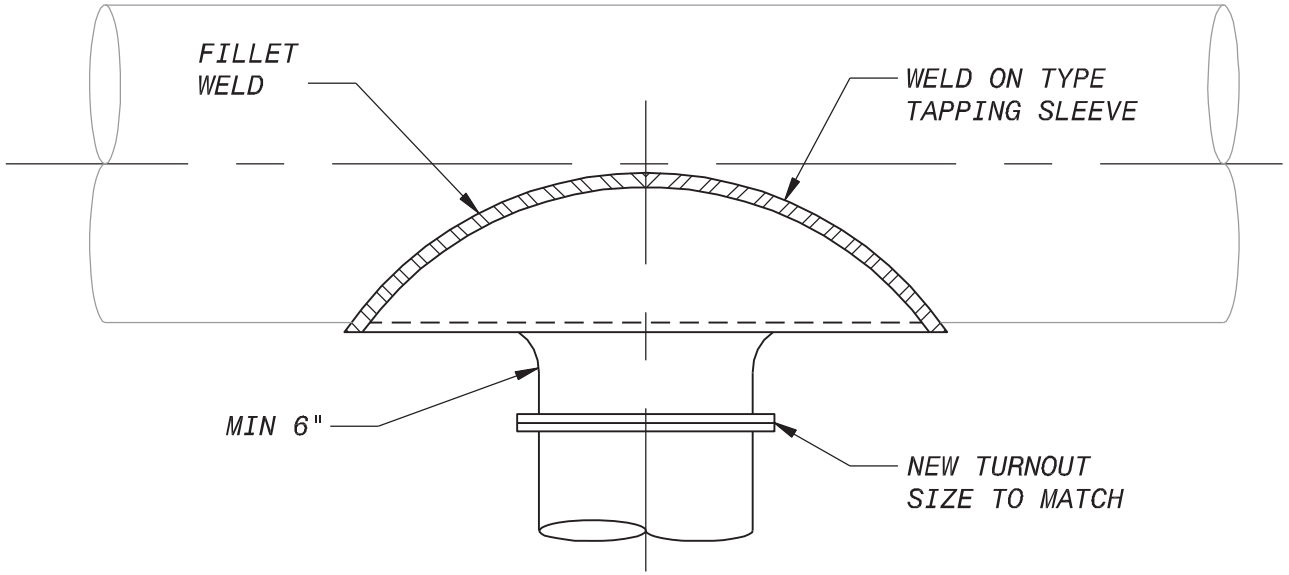
AL137522_TM



NOTES:

1. COAT ALL STEEL PIPE PER SPECIFICATION.
2. PRIOR TO WELDING TAPPING SLEEVE, REMOVE COATING FROM THE INTERFACING AREA BETWEEN TAPPING SLEEVE AND PIPE.
3. AFTER WELDING TAPPING SLEEVE, DRILL THROUGH THE MAIN PIPE AND REPAIR CEMENT MORTAR PRIOR LINING TO INSTALLING TURNOUT PIPING.
4. SEE STD CP026 FOR BONDING DEATILS.
5. BOLT-ON TYPE TAPPING SADDLE IS ACCEPTABLE IN LIEU OF WELD-ON TYPE.

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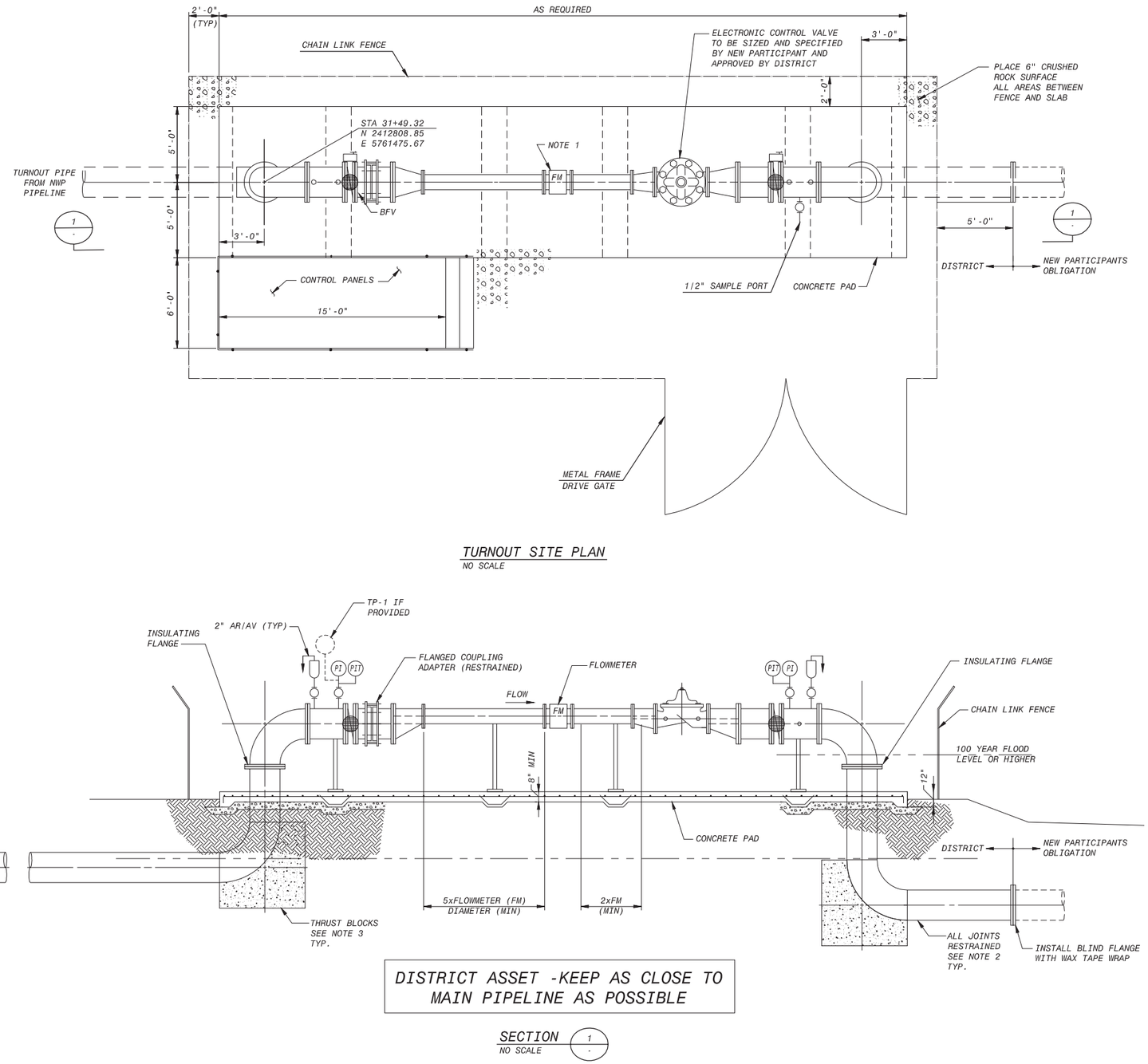
San Luis Obispo County Flood Control & Water Conservation District
3000187.08

DATE	REVISION OR ISSUE	NO	BY

TYPE TO-A-034
ABOVE GRADE TURNOUT WITH
TAPPING SLEEVE - STEEL PIPE

TM21
TO-034
SCALE
NO SCALE



TURNOUT SITE PLAN
NO SCALE

NOTES:

1. FLOWMETER TO BE SIZED FOR A VELOCITY RANGE 1 TO 18 FT/S.
2. STEEL PIPE JOINTS SHALL BE WELDED JOINTS AND DUCTILE IRON PIPE JOINTS SHALL BE FLANGED.
3. DESIGN AND INSTALL THRUST BLOCKS ON PIPELINE BENDS/ELBOWS AS NEEDED FOR PIPELINE DESIGN.
4. FOR TYPICAL ABOVE GRADE TURNOUT DETAILS REFER THE FOLLOWING DRAWINGS (USED FOR PASO ROBLES TURNOUT):
   - A. T2-C101: PASO ROBLES TURNOUT SITE PLAN AND SECTION
   - B. T2-E101: PASO ROBLES TURNOUT ELECTRICAL PLAN AND SECTIONS
   - C. T2-E301: PASO ROBLES TURNOUT ELECTRICAL ONE LINE DIAGRAM
   - D. T2-I601: PASO ROBLES TURNOUT P&ID

DISTRICT ASSET -KEEP AS CLOSE TO MAIN PIPELINE AS POSSIBLE

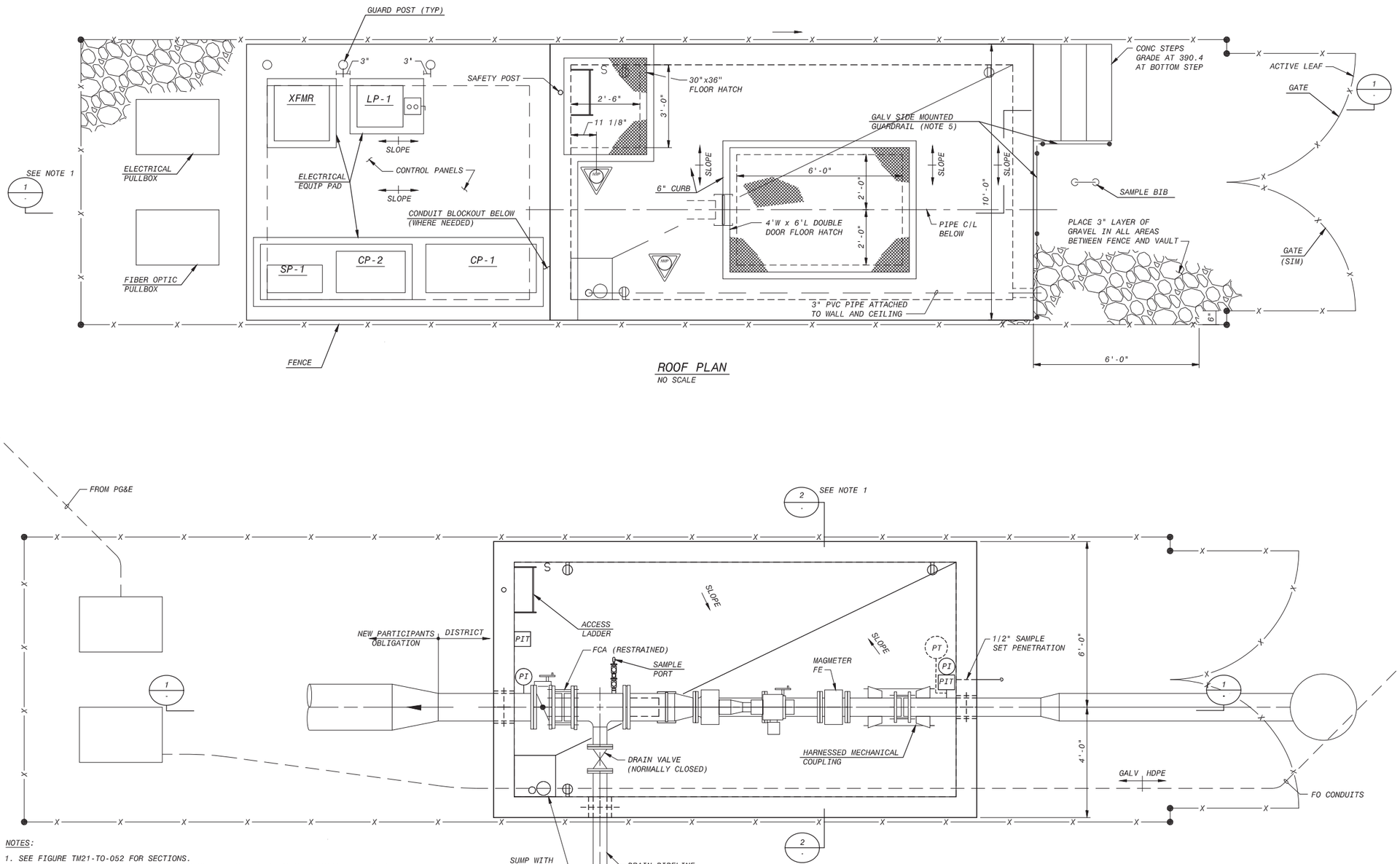
SECTION 1/-
NO SCALE

FB137522-MOP
B137522-MOP

FIGURE TM21-TO-041

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District

TYPE TO-A
ABOVE GRADE TURNOUT
TYPICAL LAYOUT



NOTES:

1. SEE FIGURE TM21-TO-052 FOR SECTIONS.
2. REFER THE FOLLOWING DRAWINGS FOR TYPICAL TURNOUT DETAILS (SLO/CSA10A TURNOUT):
   - A. T11-C101 - SLO TURNOUT FACILITY PLANS
   - B. T11-C102 - SLO TURNOUT SITE PLAN
   - C. T11-C301 - SLO TURNOUT FACILITY SECTIONS
   - D. T11-E101 - SLO TURNOUT ELECTRICAL SITE PLAN AND SECTIONS
   - E. T11-E601 - SLO TURNOUT ELECTRICAL ONE LINE DIAGRAM
   - F. T11-I601 - SLO TURNOUT P&ID

DISTRICT ASSET - KEEP AS CLOSE TO MAIN PIPELINE AS POSSIBLE

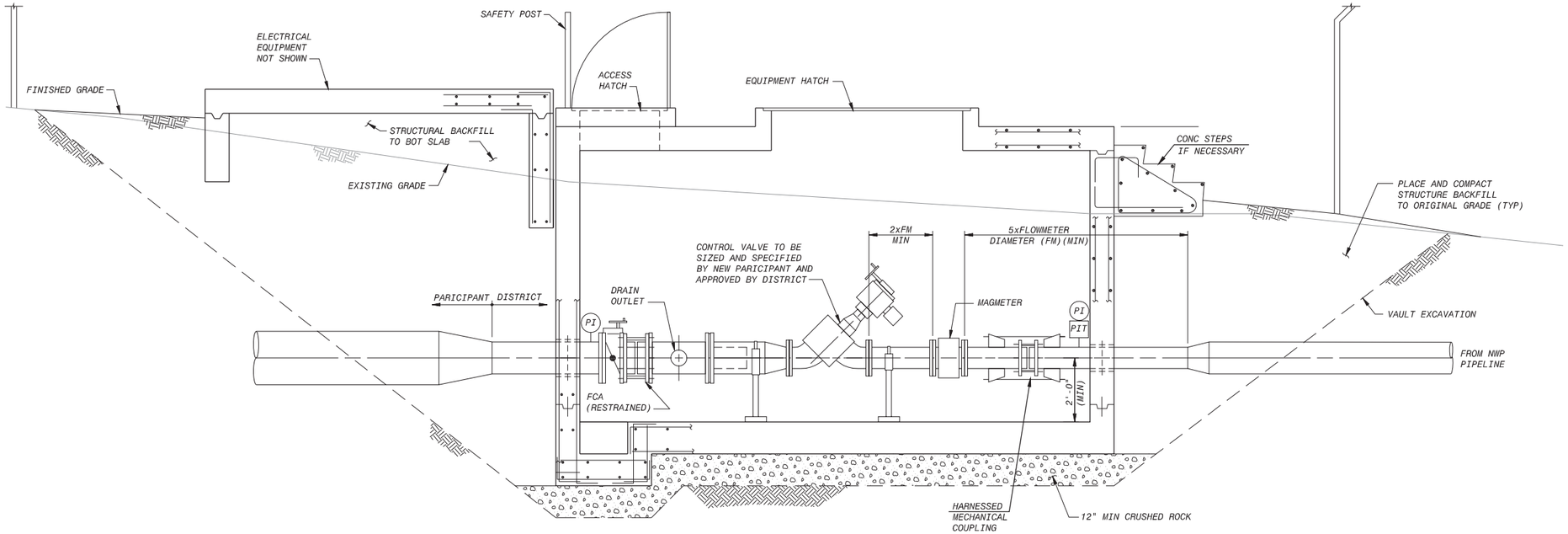
B137522-MOP

FIGURE TM21-TO-051

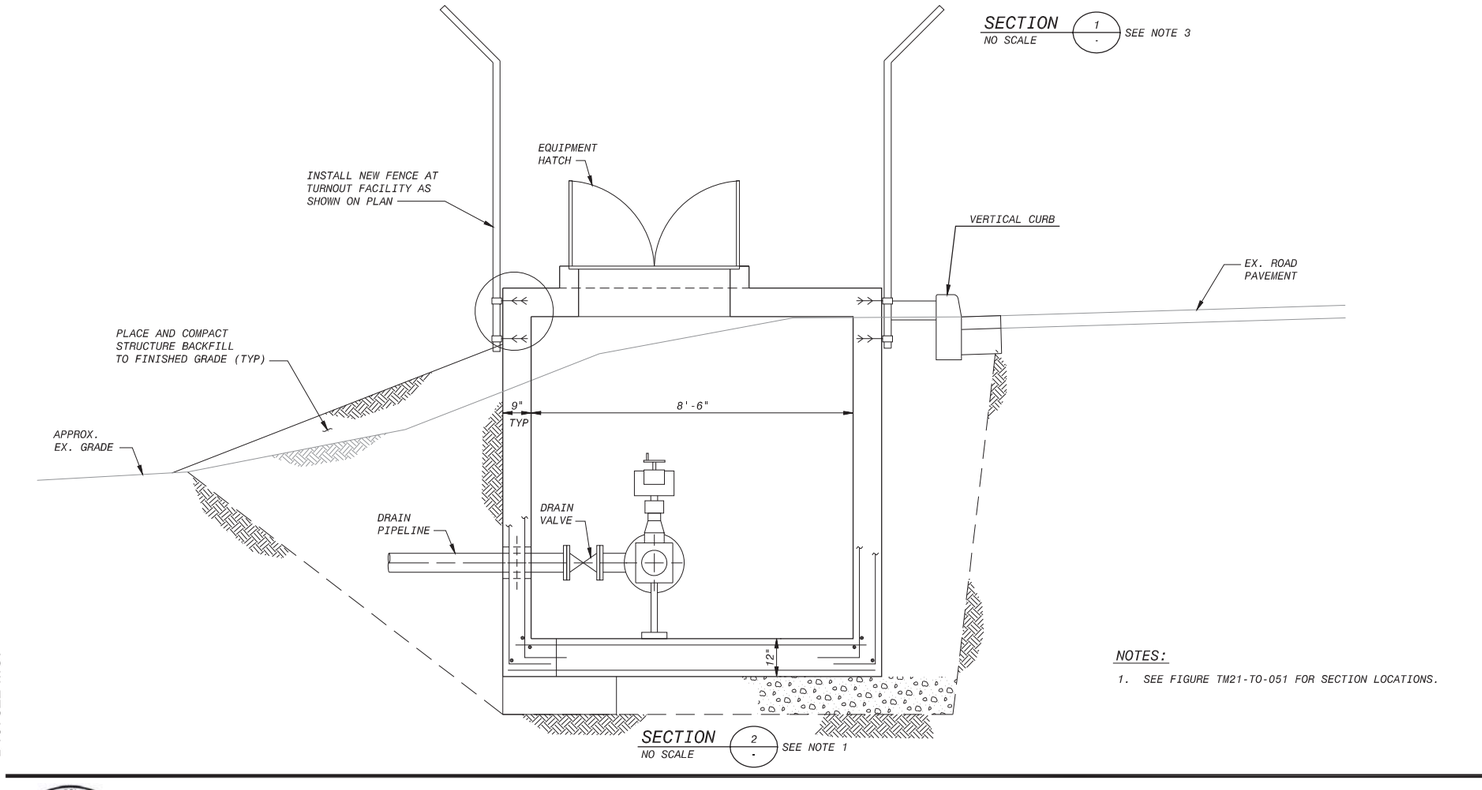
NWP NACIMIENTO WATER PROJECT

San Luis Obispo County Flood Control & Water Conservation District

TYPE TO-A UNDERGROUND TURNOUT TYPICAL LAYOUT PLAN



SECTION (1/-) SEE NOTE 3
NO SCALE



SECTION (2/-) SEE NOTE 1
NO SCALE

NOTES:

1. SEE FIGURE TM21-TO-051 FOR SECTION LOCATIONS.

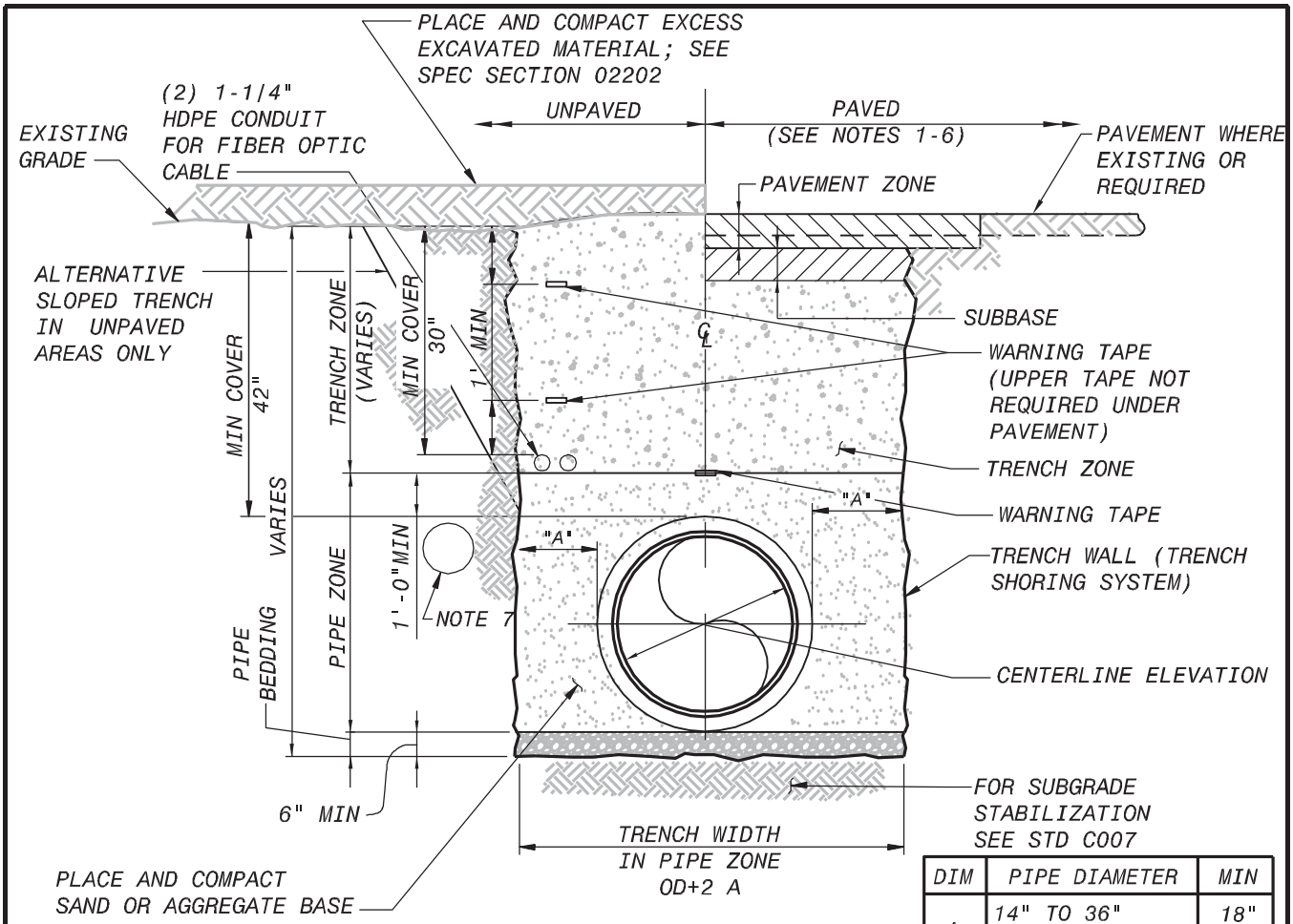
JAY37537, 3/8/2011 10:59:00 AM

B137522-MOP

FIGURE TM21-TO-052

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District

TYPE TO-A
UNDERGROUND TURNOUT
TYPICAL LAYOUT SECTIONS



DIM	PIPE DIAMETER	MIN
A	14" TO 36"	18"
	12" OR LESS	14"

NOTES:

1. FOR WORK IN CITY, COUNTY AND STATE RIGHT-OF-WAY, PERFORM EXCAVATION AND PAVEMENT REPLACEMENT IN ACCORDANCE WITH THE ENCROACHMENT PERMIT REQUIREMENTS AND AS SPECIFIED BELOW.
2. UNTIL PERMANENT PAVEMENT IS REPLACED OVER A BACKFILLED TRENCH, A MINIMUM 2" THICKNESS OF TEMPORARY ASPHALT CONCRETE PAVING SHALL BE PLACED WITHIN THE TRENCH AREA. THE TEMPORARY PAVING SHALL BE PLACED AND COMPACTED IN SUCH A MANNER AS TO PROVIDE A SAFE AND SMOOTH CONDITION UNTIL PERMANENT PAVING IS IN PLACE.
3. PRIOR TO PLACEMENT OF PERMANENT PAVING, SAW CUT EXISTING PAVEMENT OUTSIDE THE LIMITS OF CONTRACTOR DISTURBED PAVEMENT TO A NEAT STRAIGHT LINE. CRACKED PAVEMENT ADJACENT TO THE TRENCH SHALL BE REMOVED AND REPLACED.
4. ALL EDGES OF EXISTING PAVEMENT BEING JOINED AND SURFACE BEING OVERLAID SHALL RECEIVE A TACKCOAT OF ASPHALT EMULSION.
5. WHERE THE EDGE LINE OF THE PAVEMENT REMOVED FOR THE PIPELINE TRENCH EXCAVATION COMES WITHIN THREE (3) FEET OF THE EDGE OF PAVEMENT OR OUTER EDGE OF THE PAVEMENT AGAINST THE GUTTER OR CURB FACE, THE EXISTING PAVING SHALL BE REMOVED TO THE GUTTER LINE OR CURB FACE AND THE PERMANENT PAVEMENT LAID TO THE GUTTER LINE OR CURB FACE.
6. WHERE THE EDGE LINE OF THE PAVEMENT REMOVED FOR THE PIPELINE TRENCH EXCAVATION IS MORE THAN THREE (3) FEET FROM THE EDGE OF PAVEMENT, GUTTER OR CURB FACE, SAW CUT EXISTING PAVING AT LEAST SIX (6") INCHES BACK FROM THE EDGE OF THE TRENCH AND REMOVE THAT EXISTING PAVEMENT BEFORE PLACEMENT OF PERMANENT PAVING.
7. PROTECT EXISTING UTILITIES IN PLACE, SEE PLANS.

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San Luis Obispo County Flood Control & Water Conservation District
300187.08

BLACK & VEATCH
137522

BOYLE ENGINEERING CORPORATION

TRENCH AND BEDDING

DATE	REVISION OR ISSUE	NO	BY

STD
C005

SCALE
NO SCALE

PLOTTED:GLA36511, 11/8/2006 9:15:46 AM
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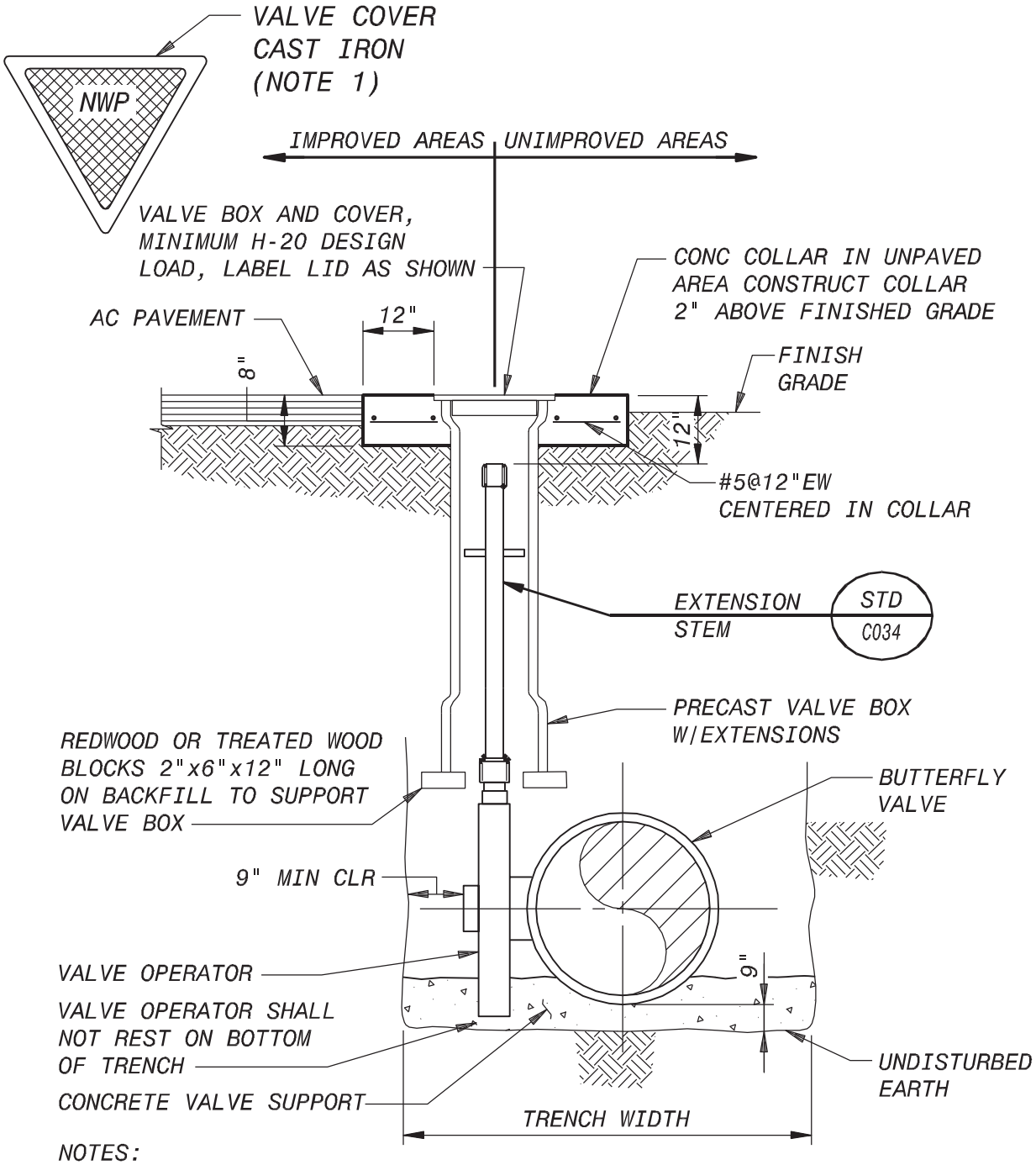
FAP137522
AP137522



NOTES:

1. PAINT COVER (ALL SIDES) PER COATING SYSTEM A5.

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District
300187.08

BLACK & VEATCH
137522

BOYLE ENGINEERING CORPORATION

BURIED VALVE OPERATOR

DATE	REVISION OR ISSUE	NO	BY

STD
C033

SCALE
NO SCALE

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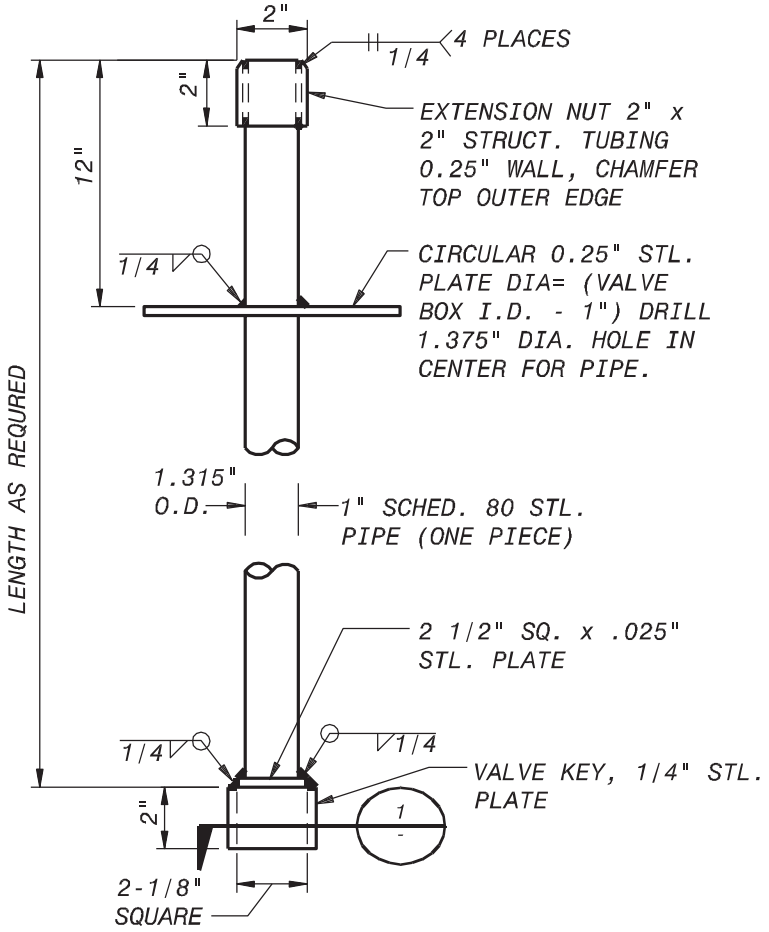
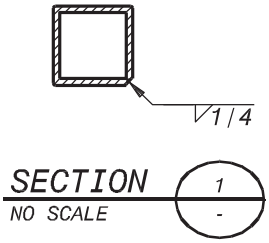


DETAIL
NO SCALE



SECTION 1 -
NO SCALE

NOTES:

1. LENGTH OF EXTENSION IN INCHES SHALL BE INSCRIBED WITH AN ARC WELD BEAD (MIN. OF 2" IN HEIGHT) ON TOP FACE OF CIRCULAR PLATE.
2. VALVE KEY SHALL FIT OVER STANDARD 2" VALVE OPERATING NUT.
3. EXTENSION NUT AND VALVE KEY TO BE IN ALIGNMENT WITH EACH OTHER.
4. PAINT EXTENSION STEM PER COATING SYSTEM A5.

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San Luis Obispo County Flood Control & Water Conservation District
300187.08

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137522

BOYLE ENGINEERING CORPORATION

EXTENSION STEM

DATE	REVISION OR ISSUE	NO	BY

STD
C034

SCALE
NO SCALE

PLOTTED:GLA36511, 11/7/2006 4:17:46 PM
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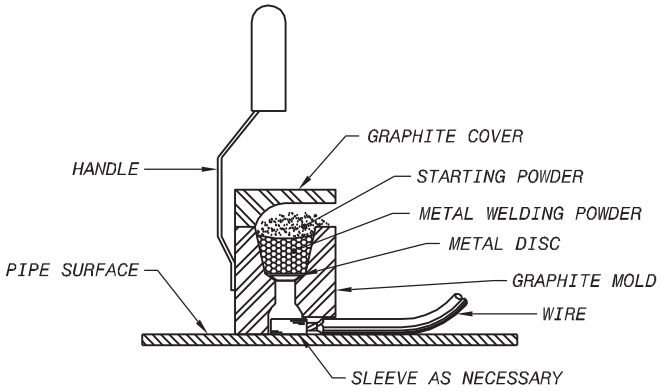
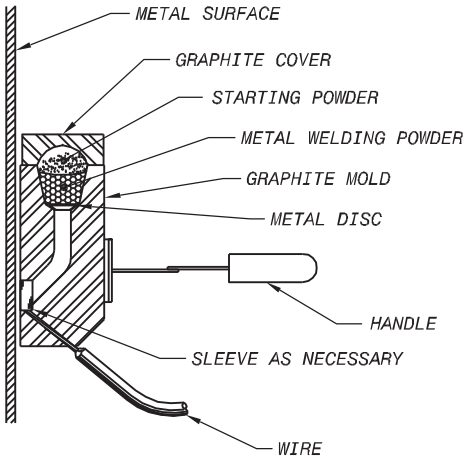
AP137522



HORIZONTAL SETUP



VERTICAL SETUP

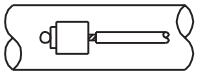
EXOTHERMAL WELDING PROCEDURE:

1. PREPARE STRUCTURE CONNECTION AREA TO BARE SHINY METAL AND CLEAN. REMOVE A MINIMUM AMOUNT OF THE EXISTING COATING REQUIRED FOR PLACEMENT OF THE WELD MOLD ON THE STEEL STRUCTURE. THE STEEL'S SURFACE MUST BE COMPLETELY CLEAN AND DRY (NEAR WHITE METAL SURFACE PREPARATION).

2. PLACE GRAPHITE MOLD OVER OR NEXT TO PIPE SURFACE. INSERT A STEEL DISK INTO THE BOTTOM OF THE CAVITY INSIDE THE MOLD. STANDARD WELD CARTRIDGES SHALL BE USED FOR STEEL SURFACES. FOR DUCTILE IRON, USE XF-19 ALLOY OR EQUIVALENT. DUMP THE WELD METAL INTO MOLD BEING CAREFUL NOT TO UPSET THE STEEL DISK. TAP THE BOTTOM OF THE TUBE TO LOOSEN ALL THE STARTING POWDER AND SPREAD IT EVENLY OVER THE WELD METAL. PLACE A SMALL AMOUNT OF STARTING POWDER ON THE TOP EDGE OF MOLD UNDER THE COVER OPENING FOR EASY IGNITION. CLOSE THE COVER.

3. STRIP INSULATION FROM WIRE. WHEN USING NO 10 TO NO 14 AWG WIRE CONDUCTORS, IT WILL BE NECESSARY TO INSTALL A COPPER SLEEVE OF ADEQUATE SIZE OVER THE BARE END WIRE AND CRIMP IN PLACE BEFORE ATTEMPTING TO MAKE THE CONNECTION. THE WIRE SHOULD PROTRUDE AT LEAST 1/8" FROM THE END OF THE SLEEVE.

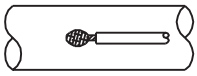
4. INSERT THE CONDUCTOR INTO THE MOLD NOTING ANY SPECIAL INFORMATION UNDER "POSITIONING" IN THE MANUFACTURERS INSTRUCTIONS PACKAGED WITH THE WELDER.



5. FOLLOW ALL PERTINENT SAFETY PRECAUTIONS PER THE MANUFACTURER'S INSTRUCTIONS. HOLD MOLD FIRMLY WITH OPENING AWAY FROM OPERATOR AND IGNITE WITH FLINT GUN. MOVE FLINT GUN AWAY QUICKLY TO PREVENT FOULING. IF FLINT GUN SHOULD BECOME FOULED, SOAK IT IN HOUSEHOLD AMMONIA.

6. AFTER IGNITION, HOLD THE WELDER IN PLACE FOR A MOMENT TO ALLOW THE WELD TO SOLIDIFY. AFTER THE WELD HAS COOLED, REMOVE THE SLAG WITH A CHIPPING HAMMER OR WIRE BRUSH.

7. TEST THE WELD INTEGRITY BY STRIKING IT FROM THE SIDE WITH A TWO POUND HAMMER. A TYPICAL PROBLEM FOR THIS TYPE OF WELD IS POOR SURFACE PREPARATION OF THE STEEL. THIS SITUATION WILL RESULT IN THE WELD NUGGET BEING ABLE TO BE KNOCKED OFF THE STEEL WITH THE TAP OF A HAMMER. IF THE WELD COMES OFF, MOVE AWAY A MINIMUM OF 3" AND REPEAT STEPS 1 THROUGH 7. DO NOT REWELD IN THE SAME LOCATION.



8. WET OR DAMP MOLDS WILL PRODUCE POROUS WELDS. MOLDS MUST BE DRIED OUT BEFORE ATTEMPTING TO WELD.

9. FOR CABLE TO MORTAR COATED STEEL PIPE CONNECTIONS USE STD-CP004; FOR DUCTILE IRON PIPE CONNECTIONS, USE STD-CP005.

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San Luis Obispo County Flood Control & Water Conservation District
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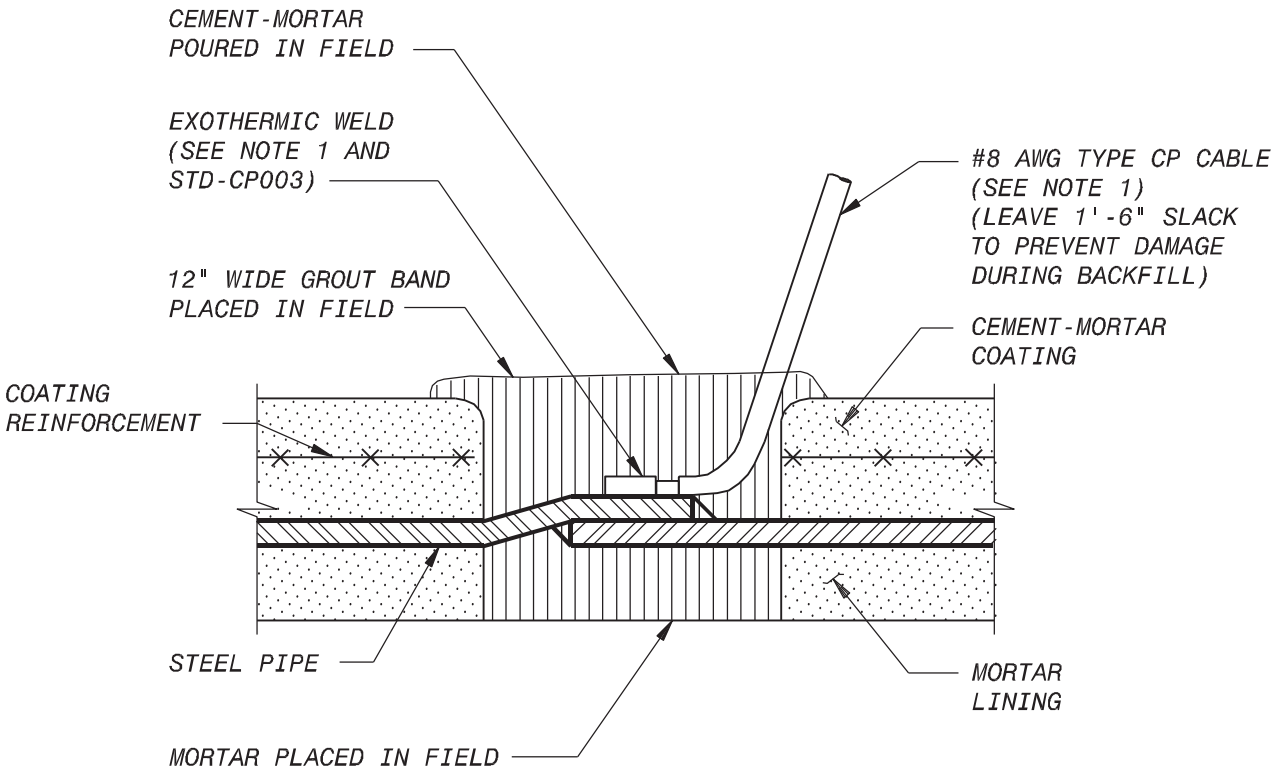
BLACK & VEATCH
137522

BOYLE ENGINEERING CORPORATION

EXOTHERMAL WELD PROCEDURE

DATE	REVISION OR ISSUE	NO	BY

STD
CP003
SCALE
NO SCALE



NOTE:

1. TYPICAL OF TWO PER CATHODIC TEST STATION; 6" MINIMUM SEPARATION BETWEEN WELDS.

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BOYLE ENGINEERING CORPORATION

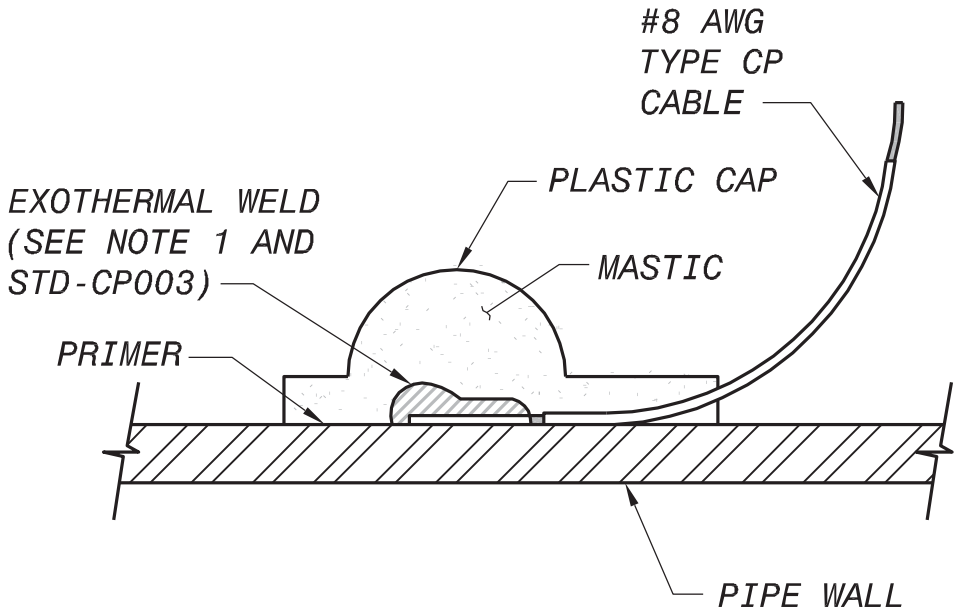
TEST LEAD TO STEEL PIPE

DATE	REVISION OR ISSUE	NO	BY

STD
CP004

SCALE
NO SCALE

PLOTTED:GUT45251, 11/8/2006 11:18:06 AM
SAVED:GUT45251, 11/8/2006 11:19:14 AM
CYGNET ID:137522-M-STD-E00007W2N
FAP137522
AP137522



NOTE:

1. COAT EXOTHERMAL WELD, PIPE AND WIRE WITH "747" PRIMER BY ROYSTON LABORATORIES OR EQUAL AND INSTALL ROYSTON HANDY CAP OR EQUAL TO PROTECT WELD.

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San Luis Obispo County Flood Control & Water Conservation District
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137522

BOYLE ENGINEERING CORPORATION

TEST LEAD TO DUCTILE IRON PIPE

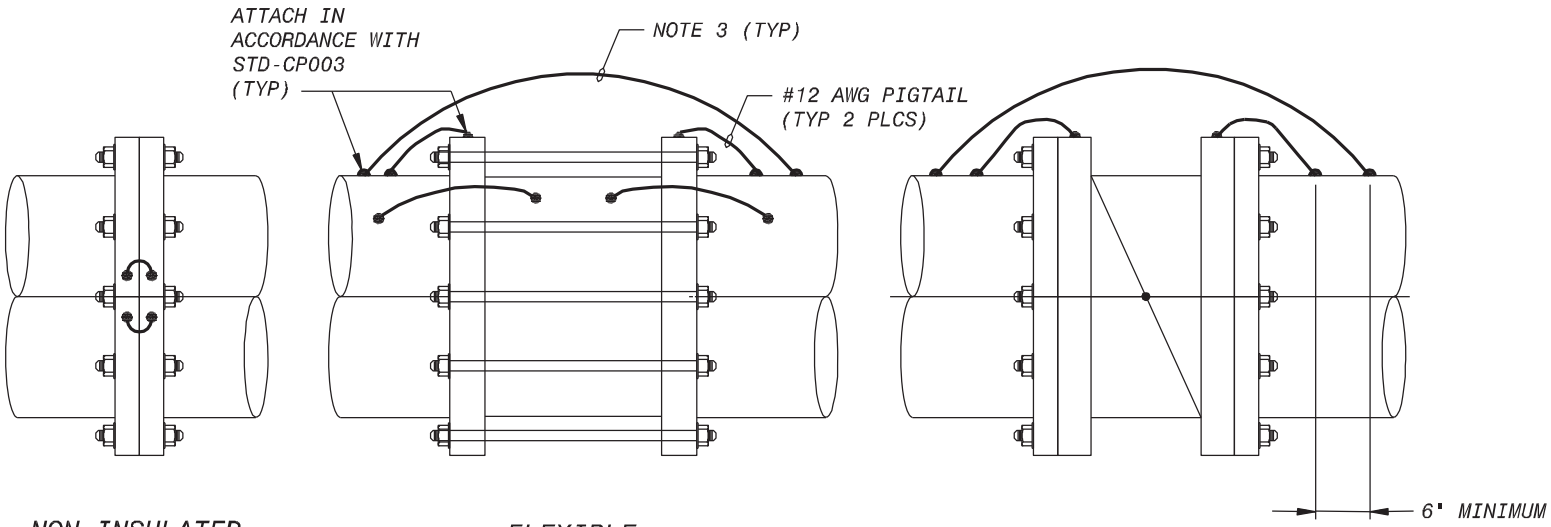
DATE	REVISION OR ISSUE	NO	BY

STD
CP005

SCALE
NO SCALE

PLOTTED:GUT45251, 11/8/2006 11:15:16 AM
SAVED:GUT45251, 11/8/2006 11:16:14 AM
CYGNET ID:137522-M-STD-E00007X6H
FAP137522
AP137522

PLOTTED: GLA36511, 6/9/2006 10:26:39 AM
SAVED: GLA36511, 6/9/2006 10:26:52 AM
CYGNET ID:137522-M-STD-E00007W2P
FAL137522
AL137522



NOTES:

1. PROVIDE THIS JOINT BONDING DETAIL AT ALL VALVES, PUSHON JOINTS, FLEXIBLE COUPLING AND NON-INSULATED FLANGED JOINTS.
2. TWO BONDING JUMPERS SHALL BE PLACED AT EACH JOINT.
3. ALL WIRE SHALL BE #8 AWG/HMW/PE, EXCEPT WHERE NOTED.
4. FOR STEEL PIPE PUSH-ON JOINTS, SEE STD. M052 & M052A.

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San Luis Obispo County Flood Control & Water Conservation District
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BOYLE ENGINEERING CORPORATION

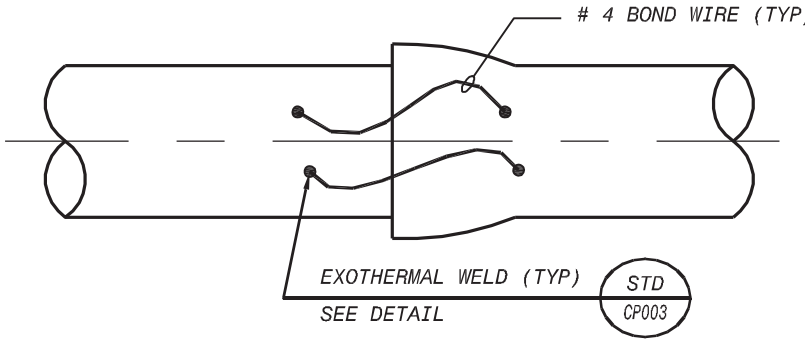
DATE	REVISION OR ISSUE	NO	BY

JOINT BONDING

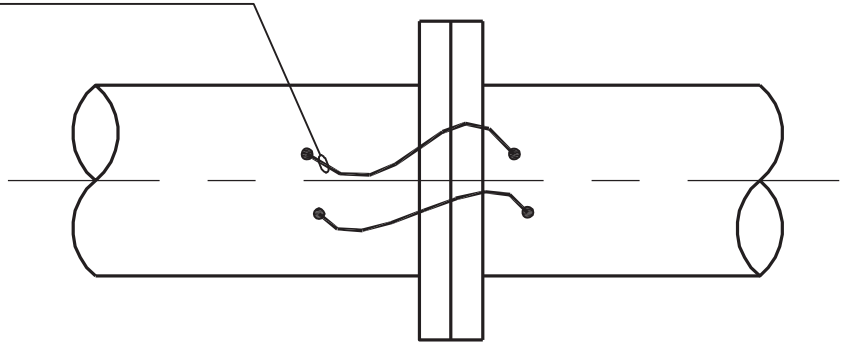
STD
CP026

SCALE
NO SCALE

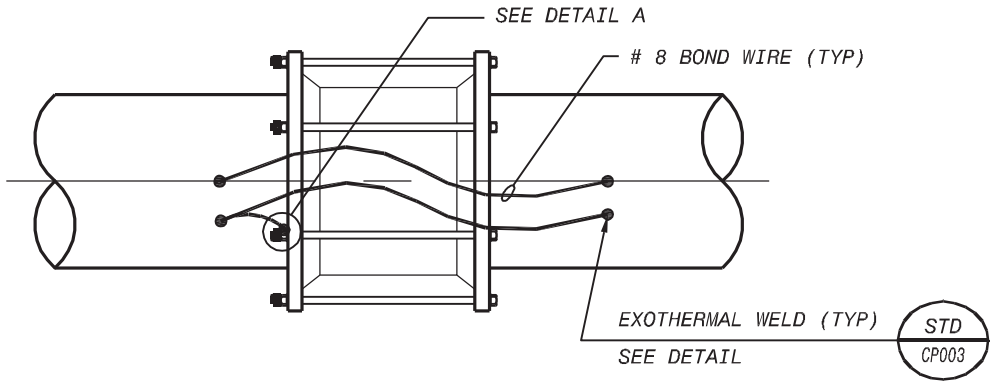
PLOTTED: GLA36511, 6/9/2006 11:24:55 AM
SAVED: GLA36511, 6/9/2006 11:40:10 AM
CYGNET ID:137522-M-STD-E00007WZT
FAL137522
AL137522



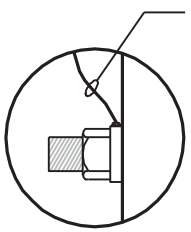
BELL AND SPIGOT PIPE JOINT



FLANGED OR MECHANICAL PIPE JOINT



FLEXIBLE COUPLING PIPE JOINT



DETAIL A

WIRE CONNECTION
TO FLANGED BOLT

NOTES:

1. ALL WIRE WELDS SHALL BE 6" APART MIN.
2. BOND WIRES SHALL NOT BE INSTALLED ACROSS INSULATING JOINTS.
3. COAT WELD PER STD-CP005.
4. TWO BOND WIRES ARE REQUIRED PER JOINT.
5. ENCASE FLEXIBLE COUPLING IN 8 MIL POLYTHYLENE WRAP.

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137522

BOYLE ENGINEERING CORPORATION

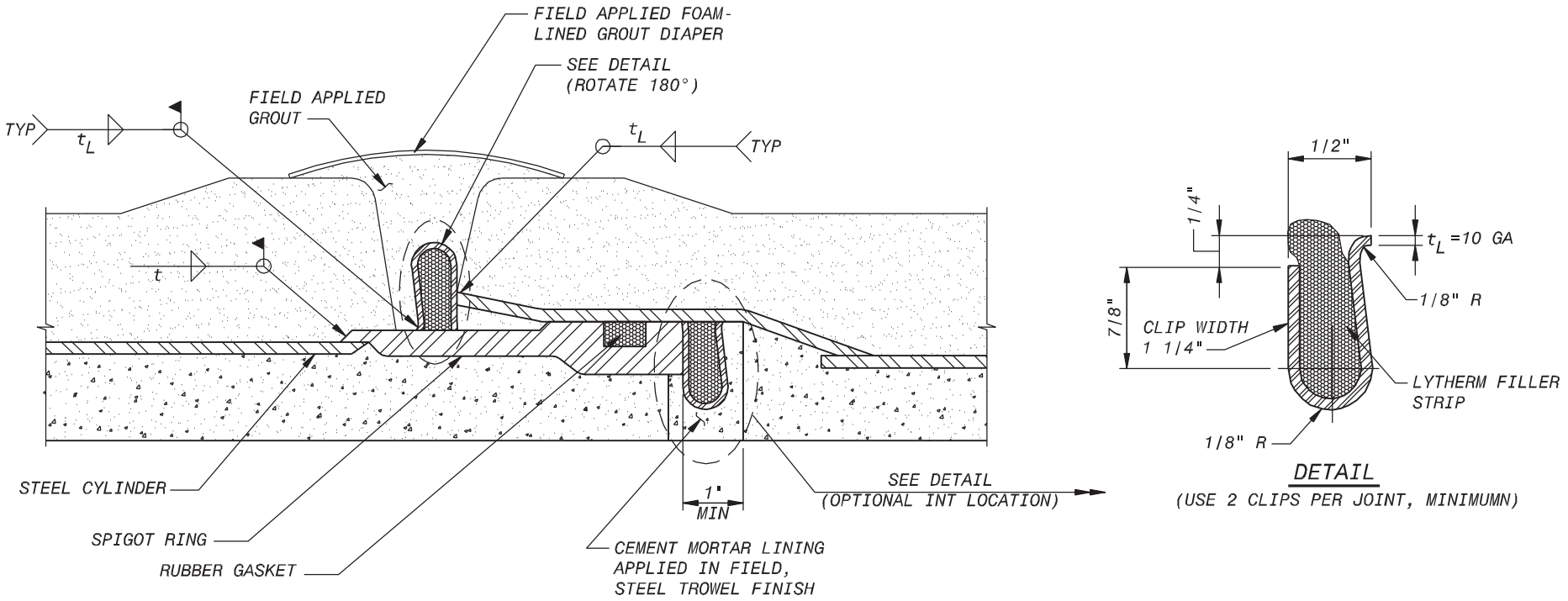
DATE	REVISION OR ISSUE	NO	BY

DUCTILE IRON PIPE JOINT BONDS

STD
CP027

SCALE
NO SCALE

PLOTTED: GLA36511, 11/8/2006 10:08:53 AM
SAVED: SAN43843, 5/4/2007 7:29:04 AM
CYGNET ID:137522-M-STD-E00007X01
FAL137522
AL137522



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San Luis Obispo County Flood Control & Water Conservation District
300187.08

BLACK & VEATCH
137522

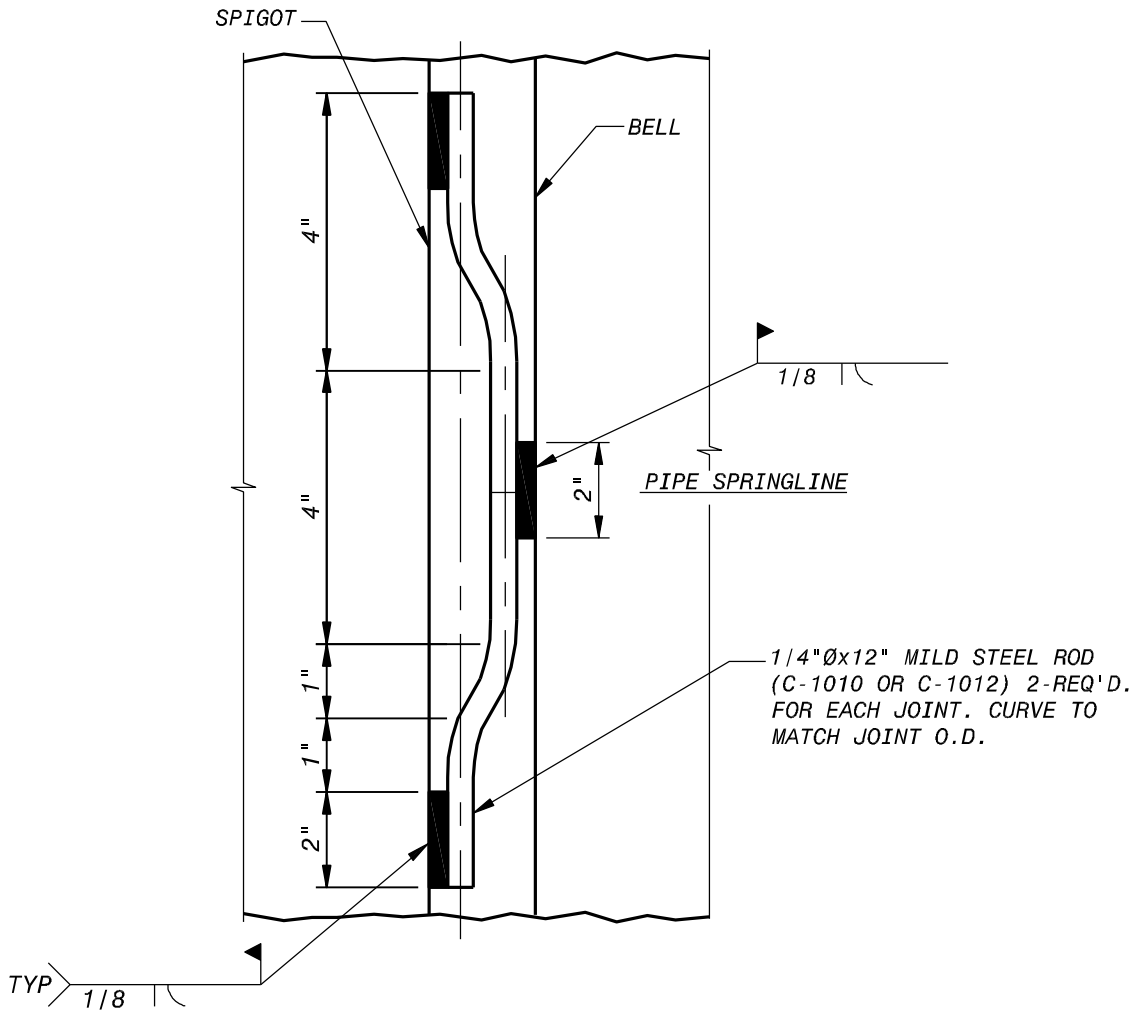
BOYLE ENGINEERING CORPORATION

DATE	REVISION OR ISSUE	NO	BY

RUBBER GASKET JOINT FOR STEEL PIPE

STD
M052

SCALE
NO SCALE



NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District
300187.08

BLACK & VEATCH
137522

BOYLE ENGINEERING CORPORATION

JUMPER ROD FOR STEEL PIPE (ALTERNATIVE TO BONDING CLIPS)

DATE	REVISION OR ISSUE	NO	BY

STD
M052A

SCALE
NO SCALE

PLOTTED: GUT45251, 11/8/2006 11:18:06 AM
SAVED: SAN43843, 5/3/2007 1:54:18 PM
CYGNET ID: 137522-M-STD-E0007W2N
FAP137522
AP137522

ATTACHMENT TM21-3
UNIT MAPS

List of Unit Maps

Figure Number	Title
2-3	Map of Unit A Map 1
2-4	Map of Unit A Map 2
2-5	Map of Unit A1 Map 1
2-6	Map of Unit A1 Map 2
2-7	Map of Unit C
2-8	Map of Unit C1 Map 1
2-9	Map of Unit C1 Map 2
2-10	Map of Unit D
2-11	Map of Unit B
2-12	Map of Unit E
2-13	Map of Unit F
2-14	Map of Units F1 & F2
2-15	Map of Unit G Map 1
2-16	Map of Unit G Map 2
2-17	Map of Unit G1
2-18	Map of Unit G2
2-19	Map of Unit H
2-20	Map of Unit H1
2-21	Map of Unit T2
2-22	Map of Unit T4
2-23	Map of Unit T6
2-24	Map of Unit T11

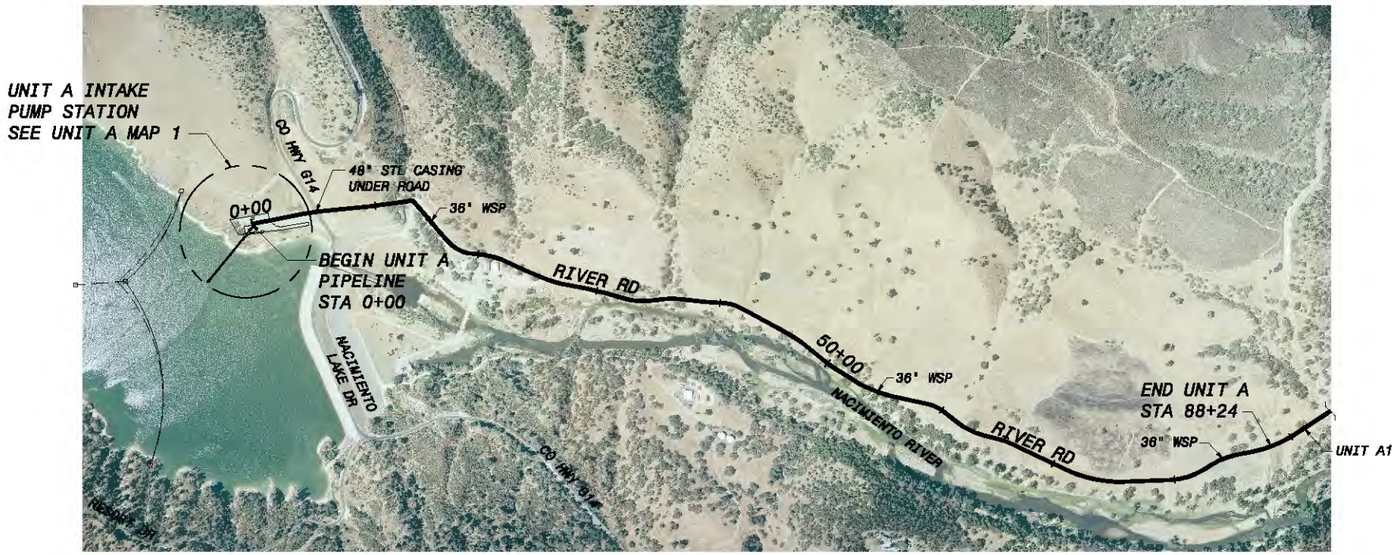
MCC10764, 11/16/2010 8:30:57 AM
137522-G-FIG-N0001HRTH

FB137522-MOP
B137522-MOP

SCALE: 1"=100'

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District

MANUAL OF PROCEDURES
MAP OF UNIT A
MAP 1



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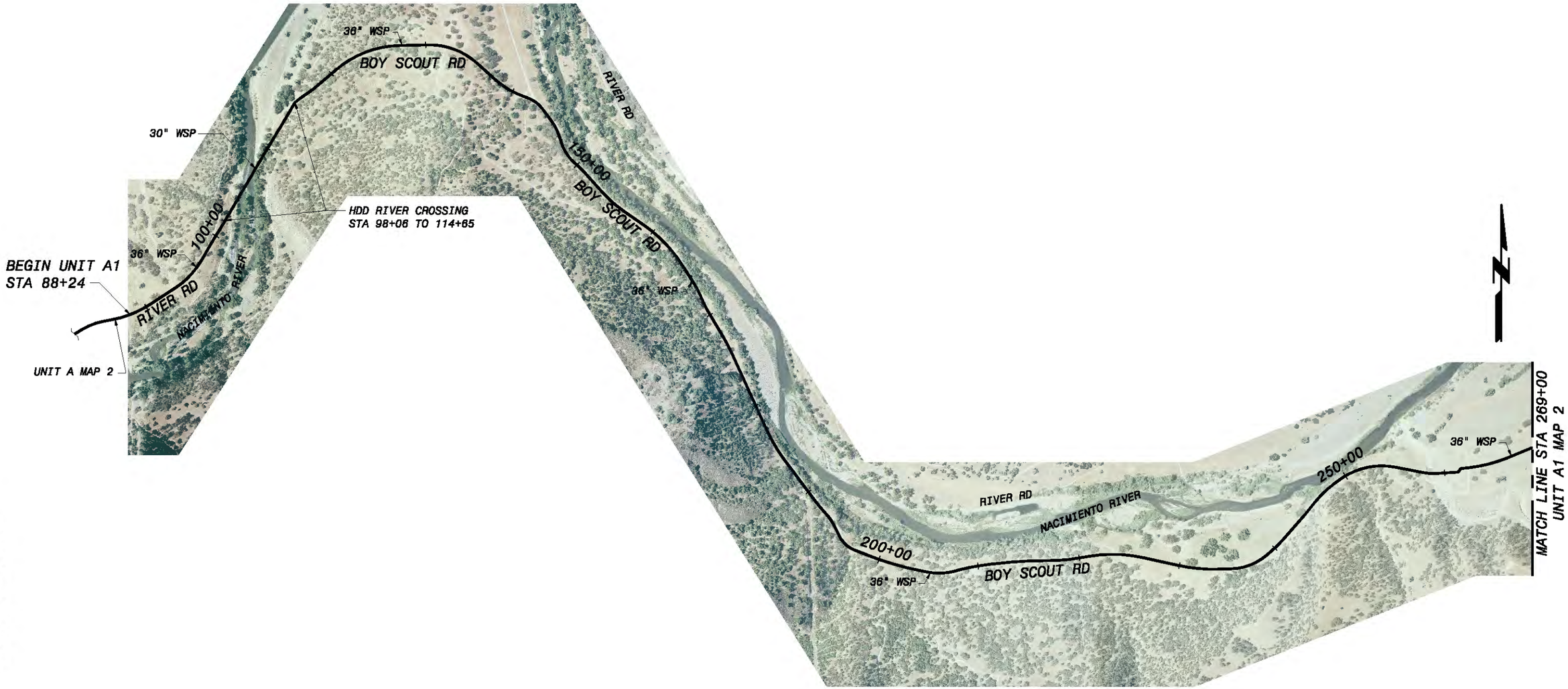
137522-G-FIG-N0001HRTG

FB137522-MOP
B137522-MOP

SCALE: 1"=1000'
NOTE: ONLY MAJOR STATION EQUATIONS ARE SHOWN.

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District

MANUAL OF PROCEDURES
MAP OF UNIT A
MAP 2



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137522-G-FIG-N0001HRTJ

FB137522-MOP
B137522-MOP

SCALE: 1"=1000'
NOTE: ONLY MAJOR STATION EQUATIONS ARE SHOWN.

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District

MANUAL OF PROCEDURES
MAP OF UNIT A1
MAP 1

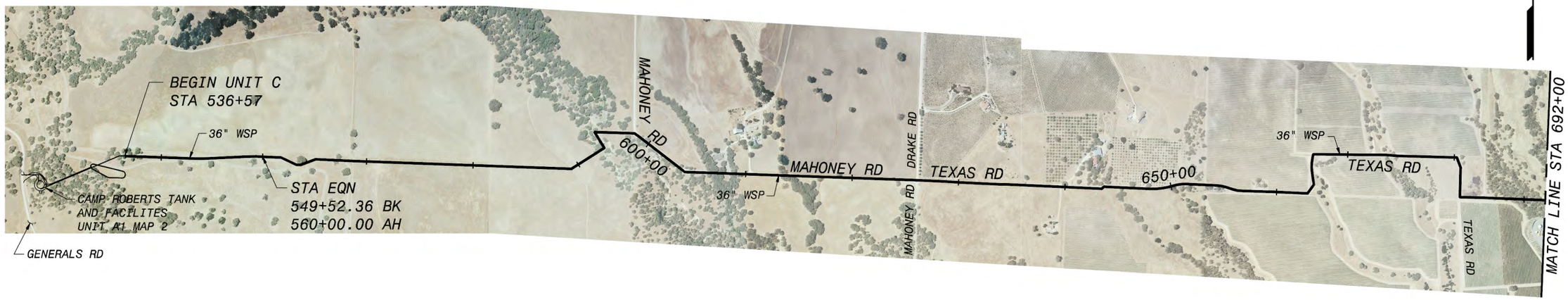
MCC10764, 11/16/2010 2:10:42 PM
137522-G-FIG-N0001HRTK

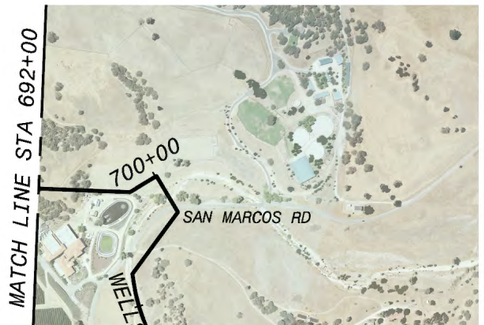
FB137522-MOP
B137522-MOP

SCALE: 1"=1000'
NOTE: ONLY MAJOR STATION EQUATIONS ARE SHOWN.

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District

MANUAL OF PROCEDURES
MAP OF UNIT A1
MAP 2





SCALE: 1"=1000'
NOTE: ONLY MAJOR STATION EQUATIONS ARE SHOWN.

MCC10764, 11/16/2010 2:13:18 PM
137522-G-FIG-N0001HRTL

FB137522-MOP
B137522-MOP

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District

MANUAL OF PROCEDURES
MAP OF UNIT C

MCC10764, 11/16/2010 2:14:28 PM
137522-G-FIG-N0001HRTM

FB137522-MOP
B137522-MOP

SCALE: 1"=1000'
NOTE: ONLY MAJOR STATION EQUATIONS ARE SHOWN.

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District

MANUAL OF PROCEDURES
MAP OF UNIT C1
MAP 1

MCC10764, 11/17/2010 8:32:48 AM
137522-G-FIG-N0001HRTN

FB137522-MOP
B137522-MOP

SCALE: 1"=1000'
NOTE: ONLY MAJOR STATION EQUATIONS ARE SHOWN.

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MANUAL OF PROCEDURES
MAP OF UNIT C1
MAP 2

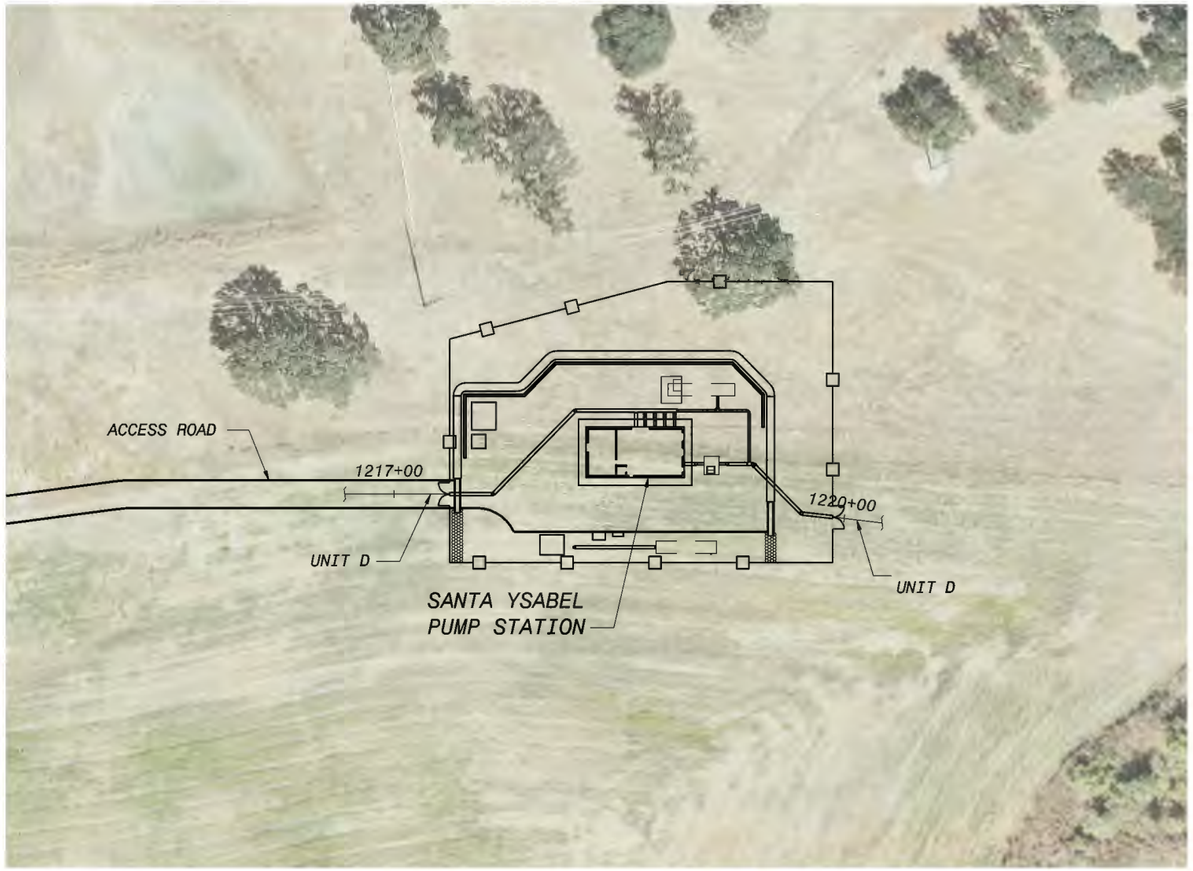
MCC10764, 2/23/2011 12:23:20 PM
137522-G-FIG-N0001HSFV

FB137522-MOP
B137522-MOP

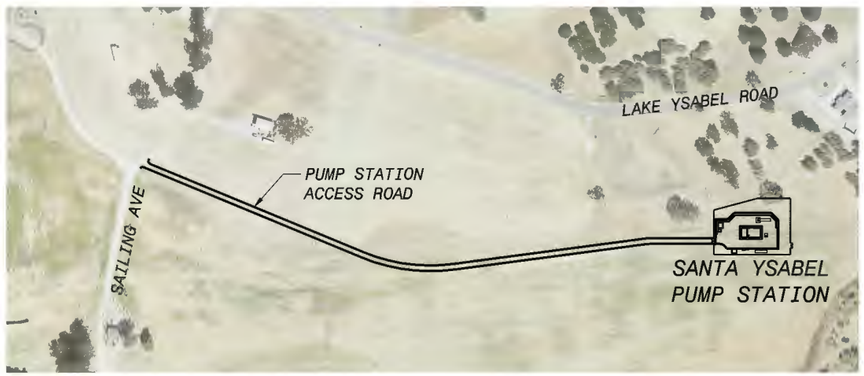
SCALE: 1"=1000'
NOTE: ONLY MAJOR STATION EQUATIONS ARE SHOWN.

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District

MANUAL OF PROCEDURES
MAP OF UNIT D



SCALE: 1"=100'



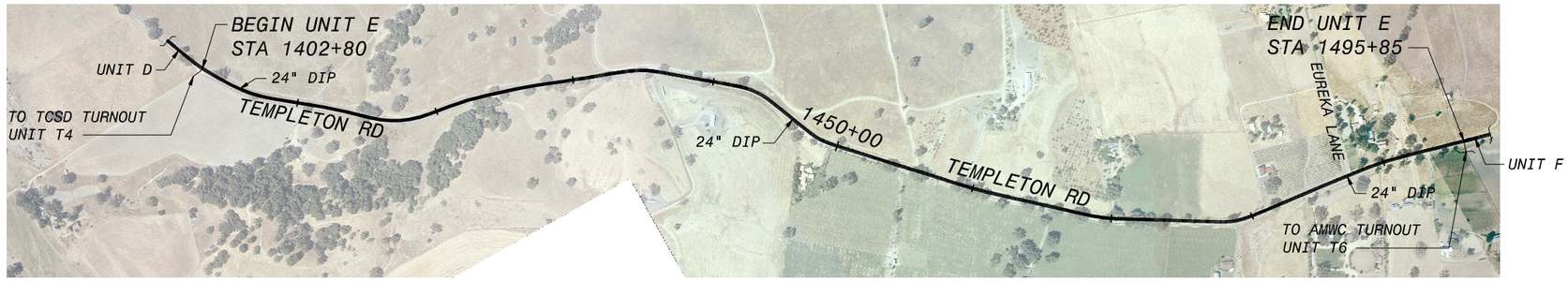
SCALE: 1"=500'

MCC10764, 11/16/2010 9:12:33 AM
137522-G-FIG-N0001HS80

FB137522-MOP
B137522-MOP

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District

MANUAL OF PROCEDURES
MAP OF UNIT B



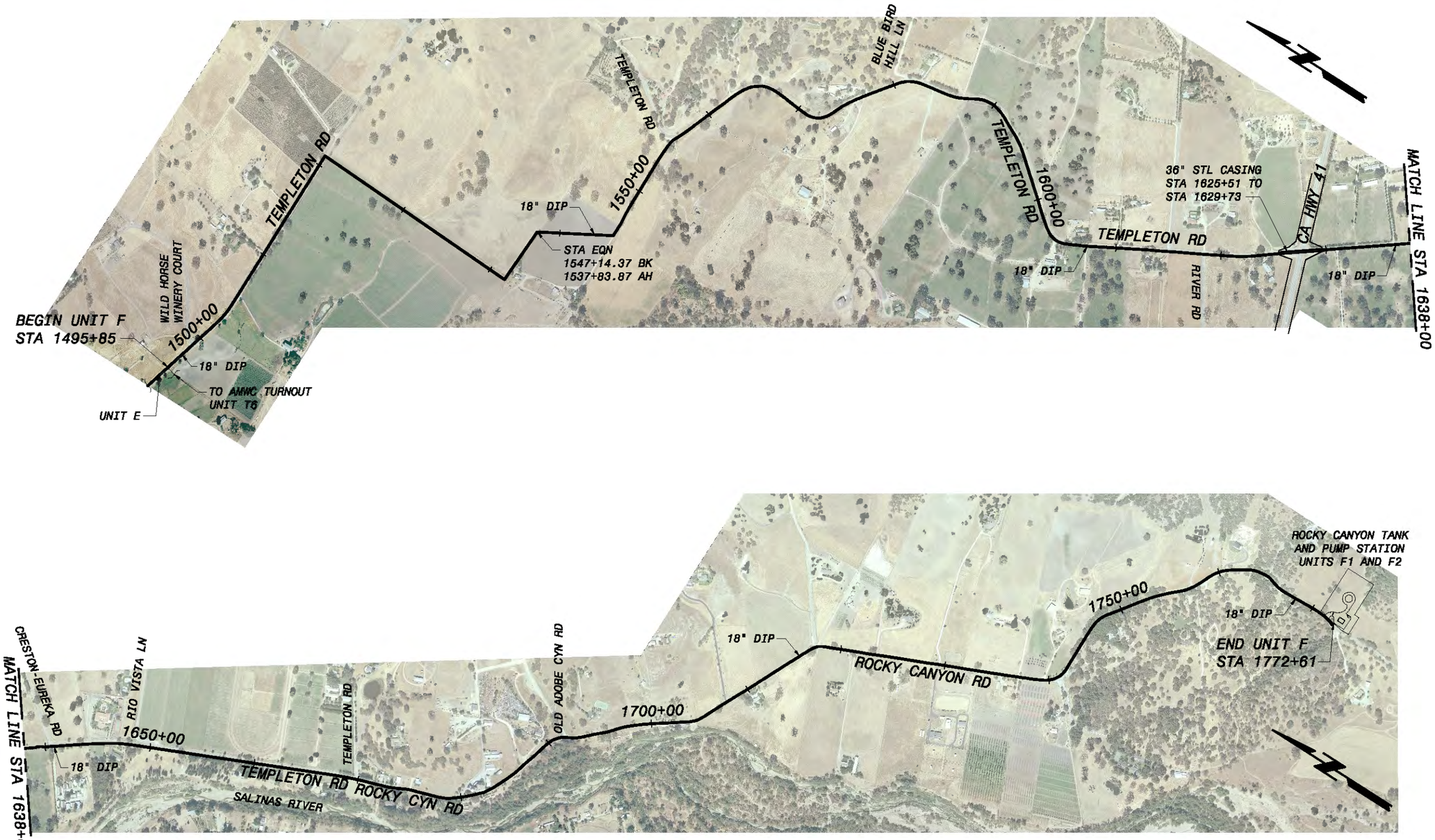
SCALE: 1"=1000'
NOTE: ONLY MAJOR STATION EQUATIONS ARE SHOWN.

FIGURE 2-12

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District

MANUAL OF PROCEDURES
MAP OF UNIT E

MCC10764, 2/23/2011 12:25:15 PM
137522-G-FIG-N0001HSFT
FB137522-MOP
B137522-MOP



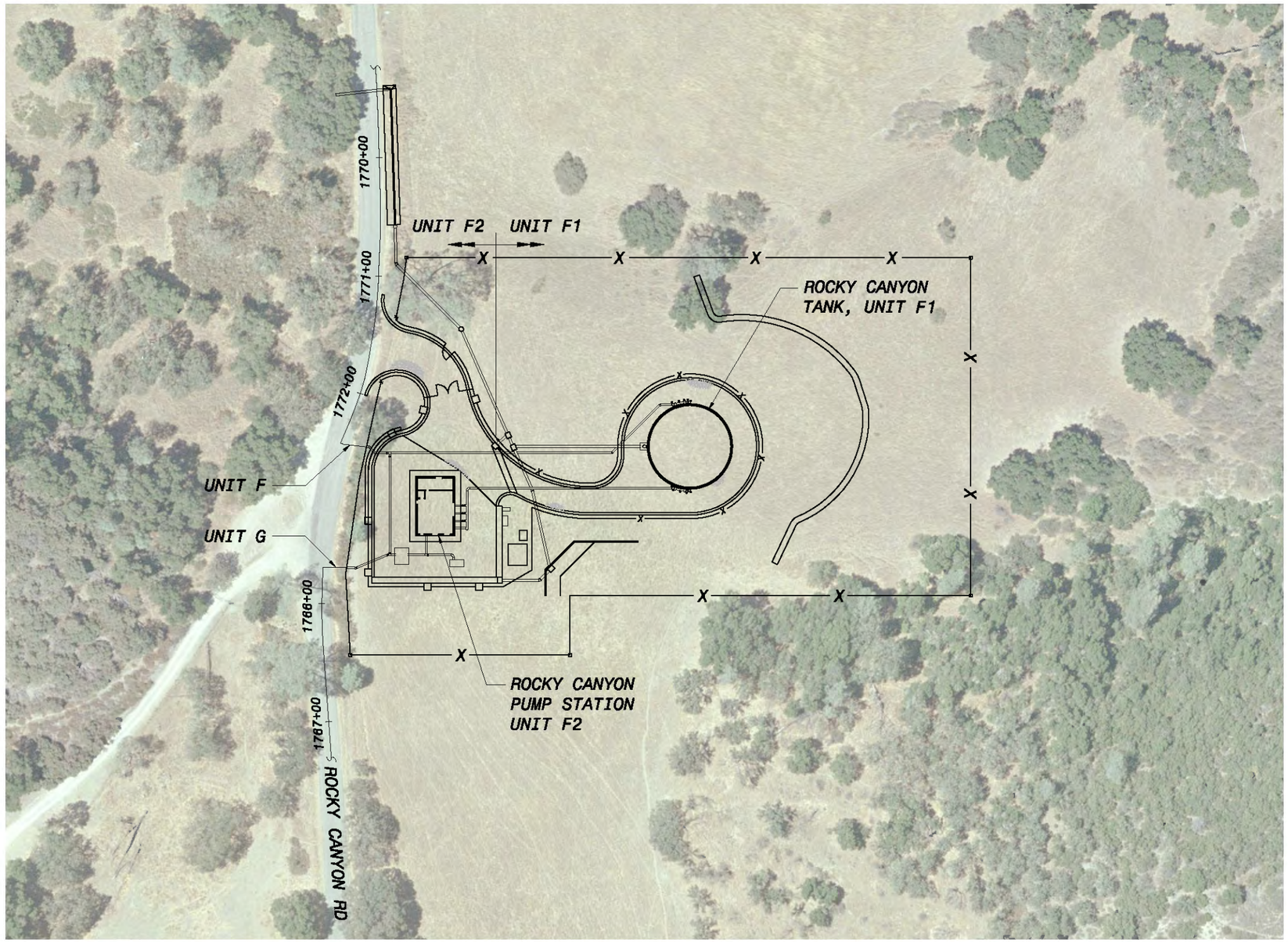
MCC10764, 2/23/2011 12:26:50 PM
137522-G-FIG-N0001HN3Z

FB137522-MOP
B137522-MOP

SCALE: 1"=1000'
NOTE: ONLY MAJOR STATION EQUATIONS ARE SHOWN.

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District

MANUAL OF PROCEDURES
MAP OF UNIT F



MCC10764, 11/16/2010 8:50:46 AM
137522-G-FIG-N0001HT5Z

FB137522-MOP
B137522-MOP

SCALE: 1"=100'

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San Luis Obispo County Flood Control & Water Conservation District

MANUAL OF PROCEDURES
MAP OF UNITS F1 AND F2

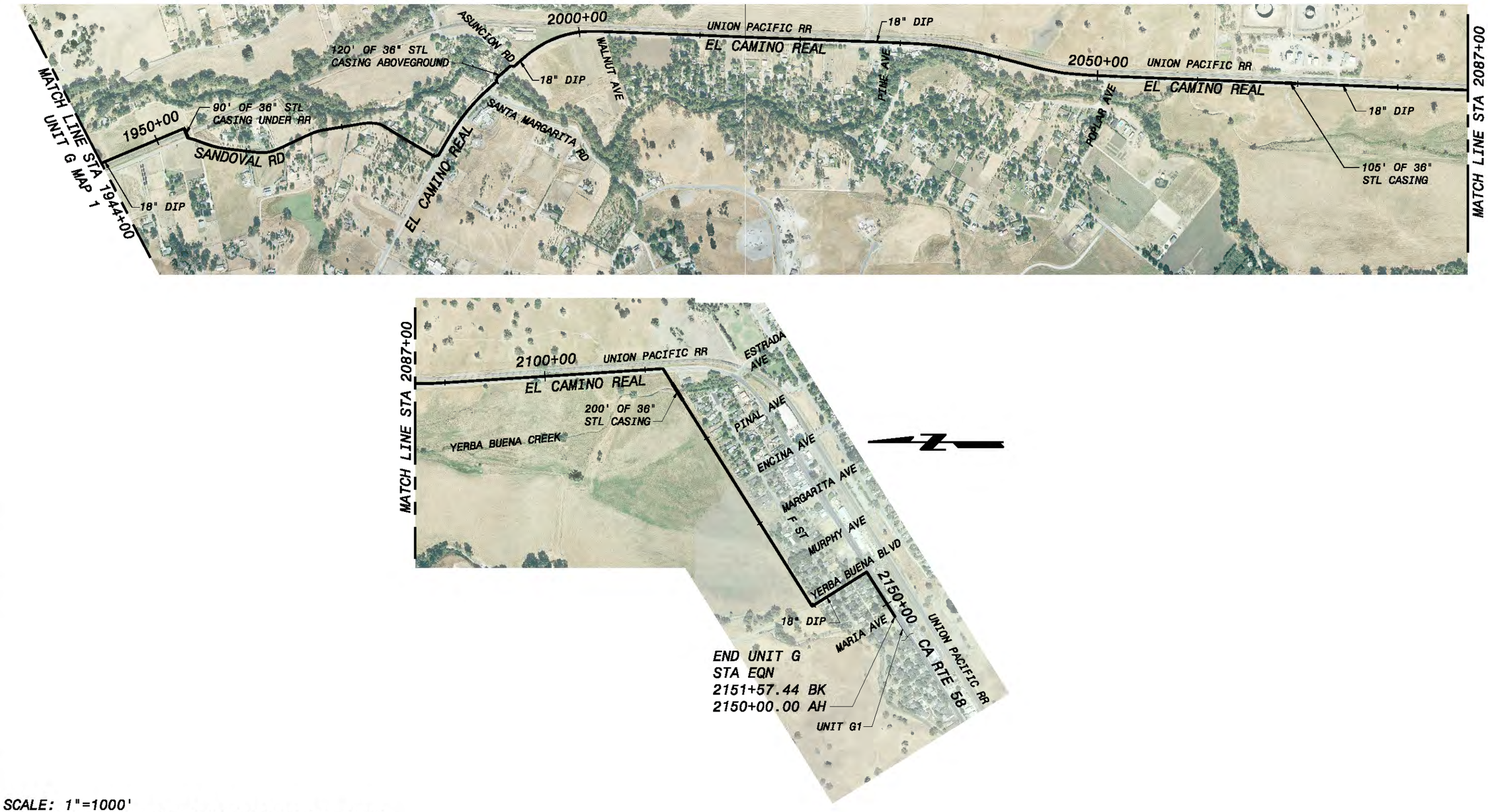
MCC10764, 11/16/2010 8:51:46 AM
137522-G-FIG-N0001HTBN

FB137522-MOP
B137522-MOP

SCALE: 1"=1000'
NOTE: ONLY MAJOR STATION EQUATIONS ARE SHOWN.

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District

MANUAL OF PROCEDURES
MAP OF UNIT G
MAP 1



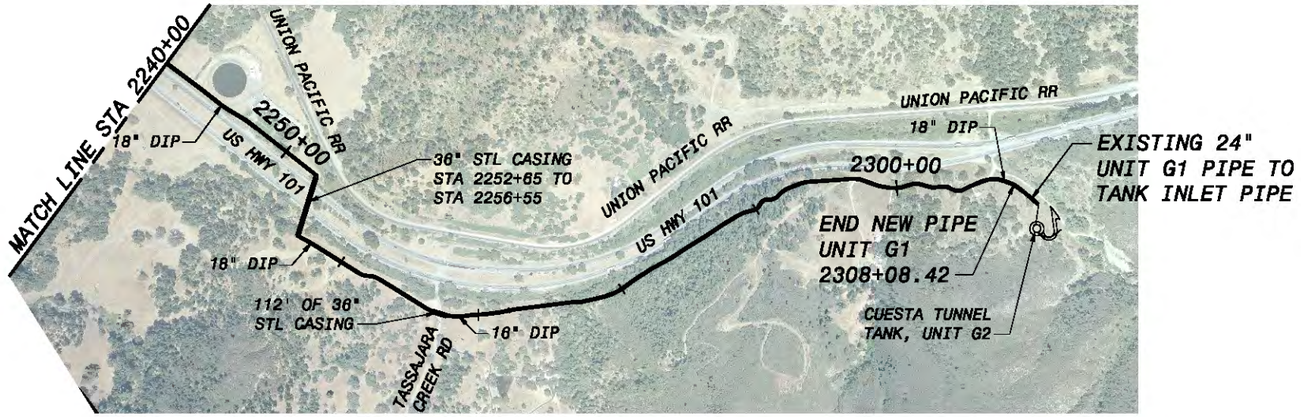
MCC10764, 11/16/2010 8:52:30 AM
137522-G-FIG-N0001HTTR

FB137522-MOP
B137522-MOP

SCALE: 1"=1000'
NOTE: ONLY MAJOR STATION EQUATIONS ARE SHOWN.

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District

MANUAL OF PROCEDURES
MAP OF UNIT G
MAP 2



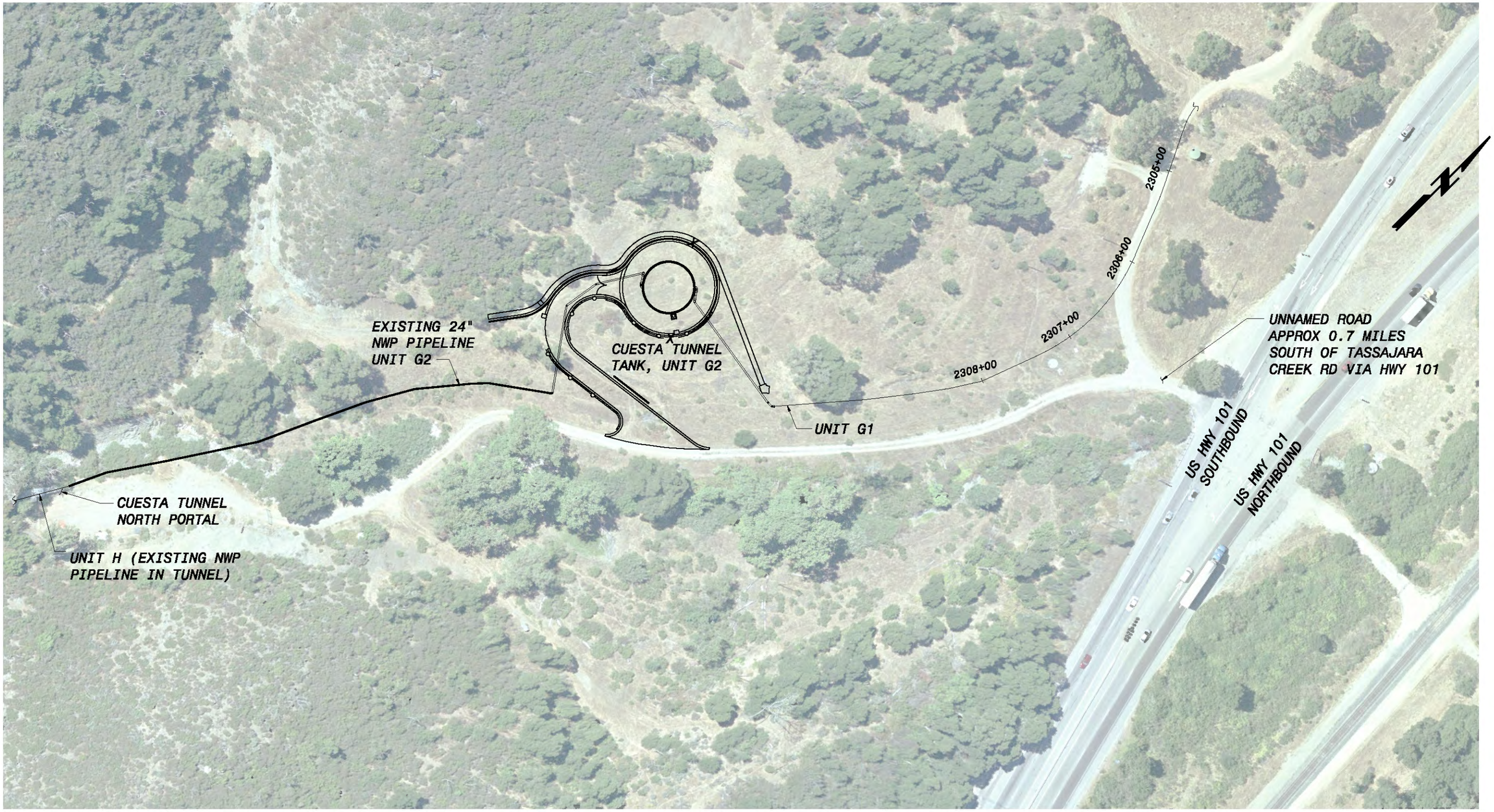
MCC10764, 11/16/2010 9:00:20 AM
137522-G-FIG-N0001HTBQ

FB137522-MOP
B137522-MOP

SCALE: 1"=1000'
NOTE: ONLY MAJOR STATION EQUATIONS ARE SHOWN.

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District

MANUAL OF PROCEDURES
MAP OF UNIT G1



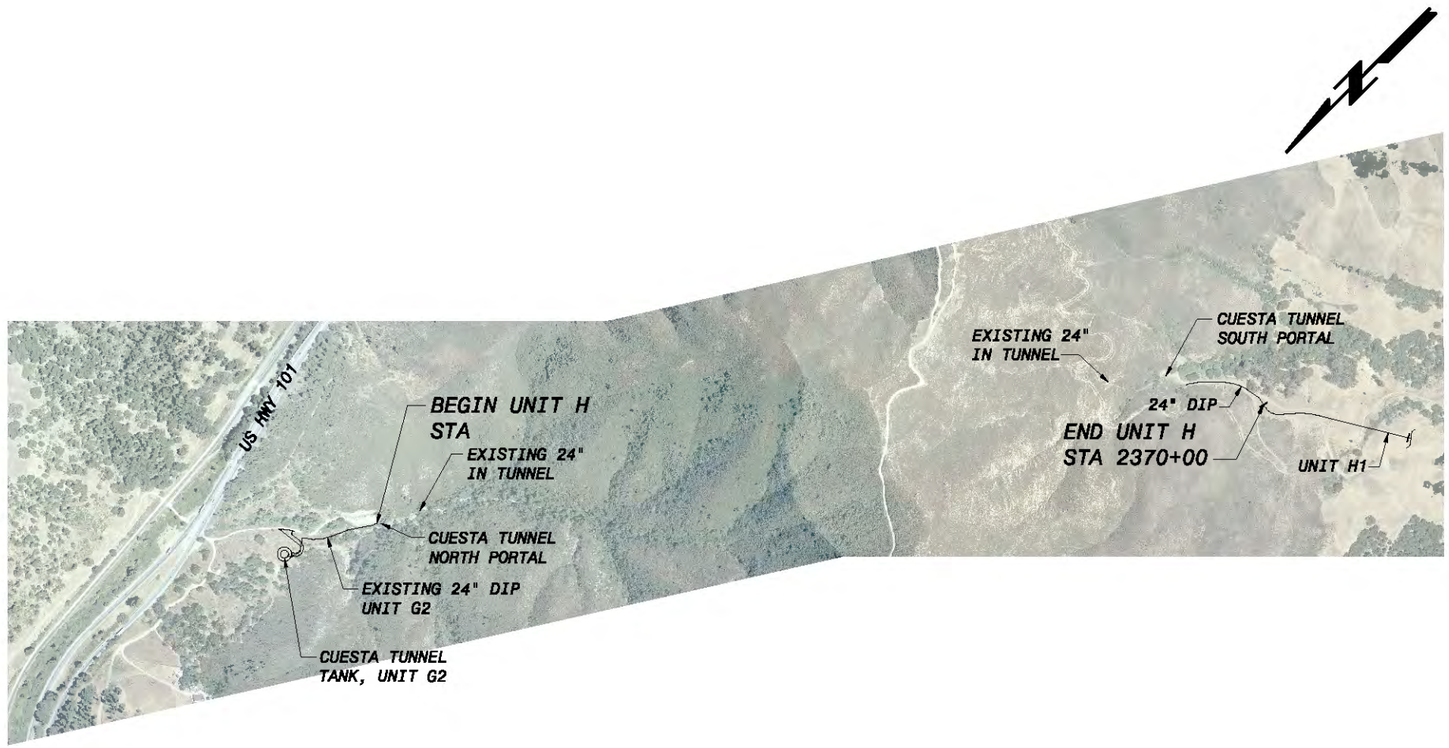
MCC10764, 11/16/2010 9:01:29 AM
137522-G-FIG-N0001HT5Y

FB137522-MOP
B137522-MOP

SCALE: 1"=100'

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District

MANUAL OF PROCEDURES
MAP OF UNIT G2



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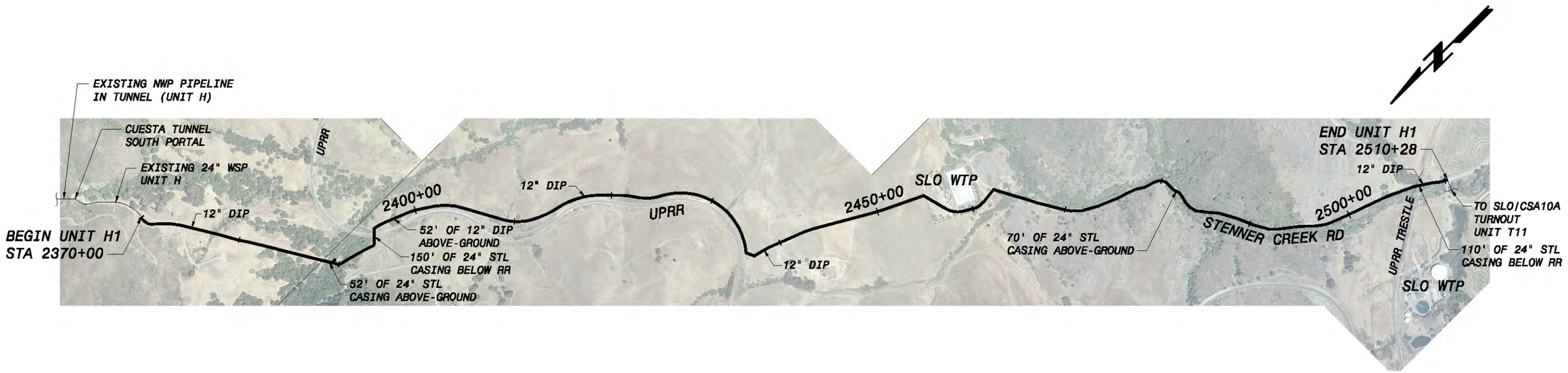
137522-G-FIG-N0001HTD5

FB137522-MOP
B137522-MOP

SCALE: 1"=1000'
NOTE: ONLY MAJOR STATION EQUATIONS ARE SHOWN.

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District

MANUAL OF PROCEDURES
MAP OF UNIT H



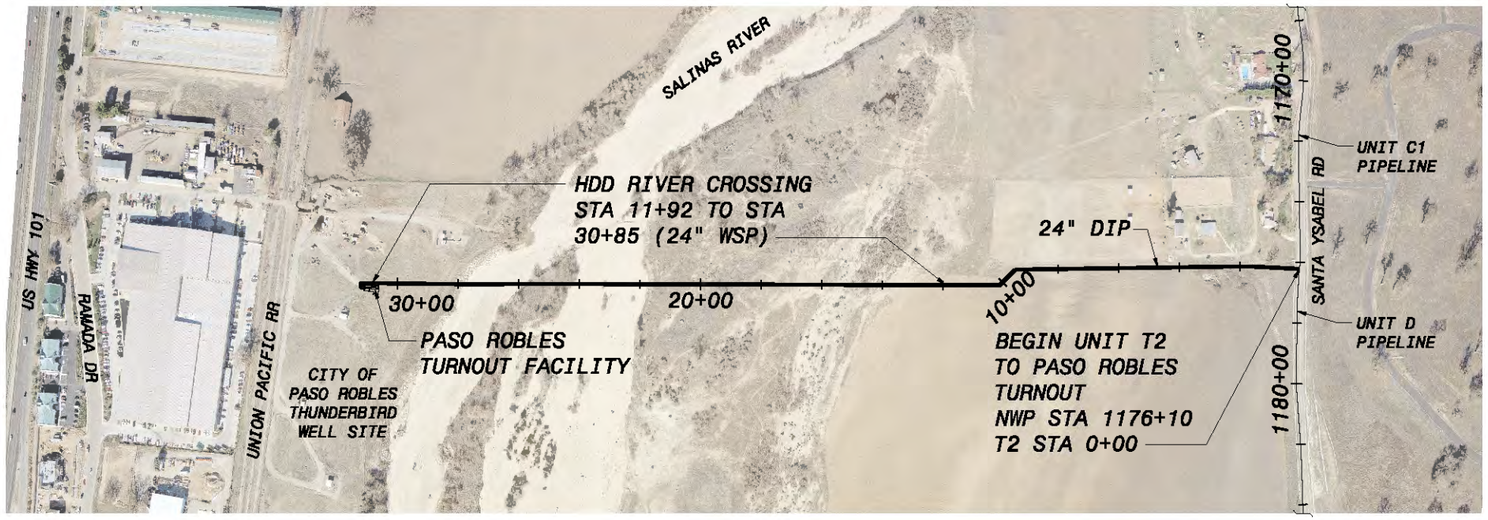
MCC10764, 3/18/2011 11:24:33 AM
137522-G-FIG-N0001HRTP

FB137522-MOP
B137522-MOP

SCALE: 1"=1000'
NOTE: ONLY MAJOR STATION EQUATIONS ARE SHOWN.

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District

MANUAL OF PROCEDURES
MAP OF UNIT H1



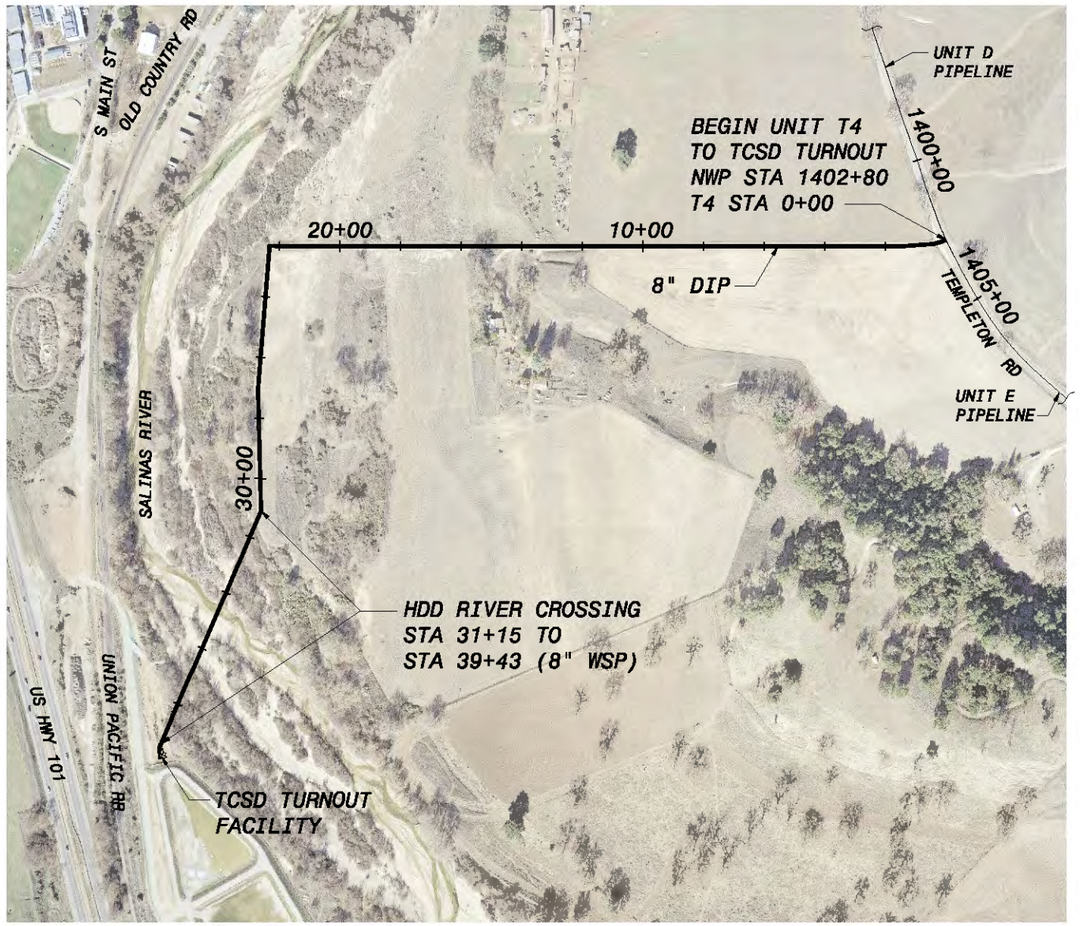
MCC10764, 11/16/2010 3:34:02 PM
137522-G-FIG-N0001HV34

FB137522-MOP
B137522-MOP

SCALE: 1"=500'
NOTE: ONLY MAJOR STATION EQUATIONS ARE SHOWN.

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District

MANUAL OF PROCEDURES
MAP OF UNIT T2



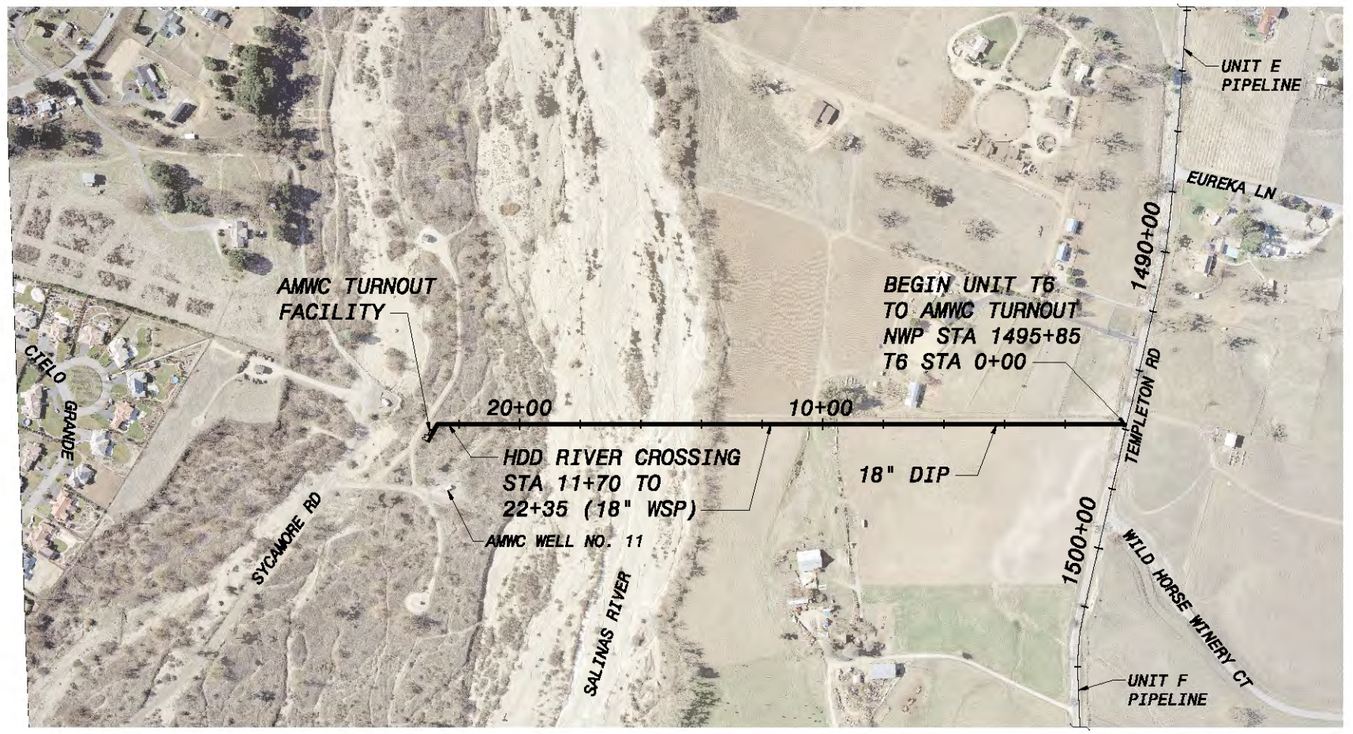
MCC10764, 2/23/2011 12:35:00 PM
137522-G-FIG-N0001HV3K

FB137522-MOP
B137522-MOP

SCALE: 1"=500'
NOTE: ONLY MAJOR STATION EQUATIONS ARE SHOWN.

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District

MANUAL OF PROCEDURES
MAP OF UNIT T4



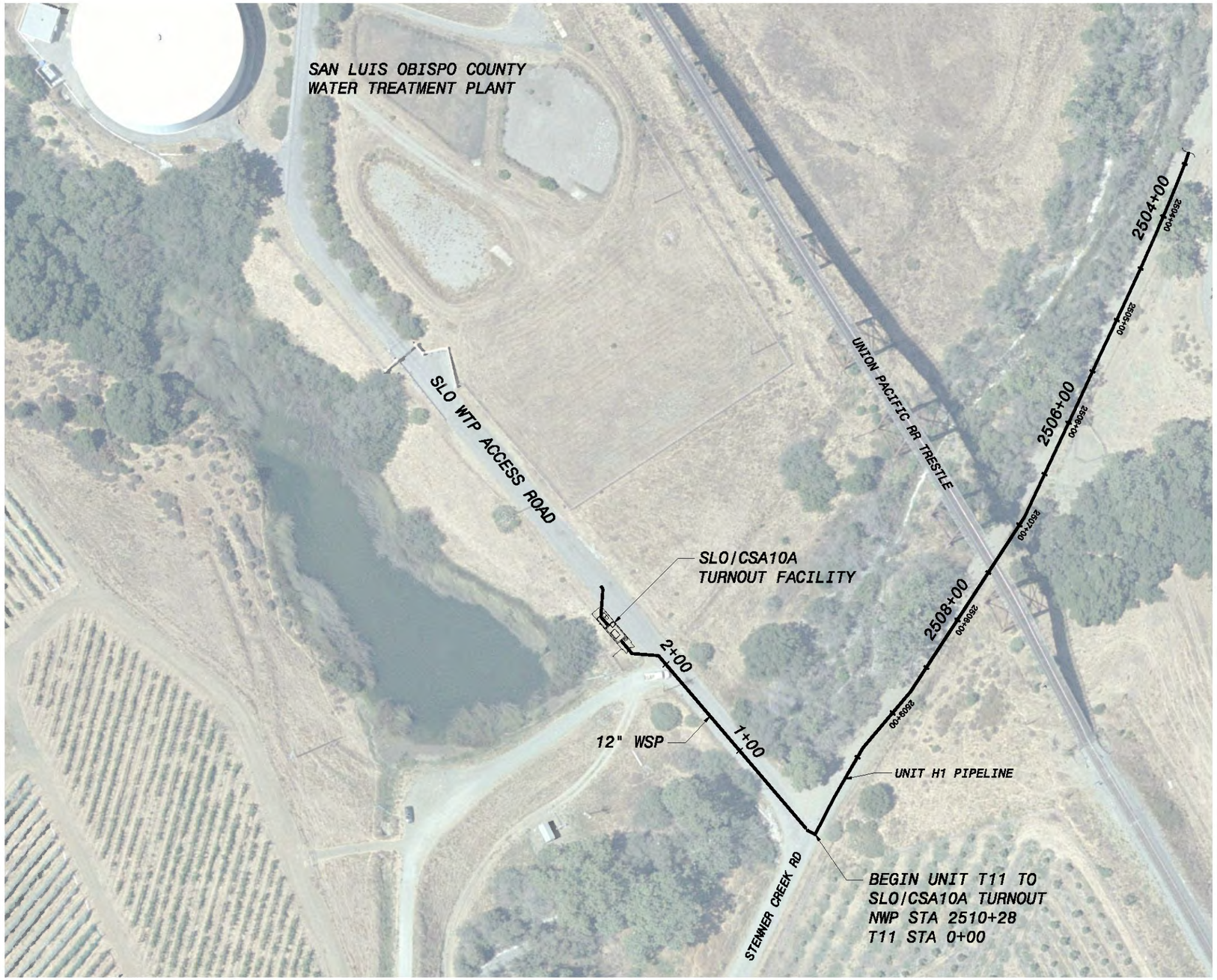
MCC10764, 2/23/2011 12:37:02 PM
137522-G-FIG-N0001HV40

FB137522-MOP
B137522-MOP

SCALE: 1"=500'
NOTE: ONLY MAJOR STATION EQUATIONS ARE SHOWN.

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District

MANUAL OF PROCEDURES
MAP OF UNIT T6



MCC10764, 2/23/2011 12:38:58 PM
137522-G-FIG-N0001HV43

FB137522-MOP
B137522-MOP

SCALE: 1"=100'
NOTE: ONLY MAJOR STATION EQUATIONS ARE SHOWN.

NWP NACIMIENTO WATER PROJECT
San Luis Obispo County Flood Control & Water Conservation District

MANUAL OF PROCEDURES
MAP OF UNIT T11