Memo

To:	Brian Goetz, Terry Desmarais, Albert Pratt	From:	Erica Lotz
	City of Portsmouth		Stantec Consulting Services, Inc.
File:	195150196	Date:	September 5, 2017

Reference: **Newington Transmission Main – Short Term and Long Term Alternatives**

Background

The Madbury-Newington Transmission Main (MNTM) is a 24-inch diameter, 6-mile pipeline which supplies water from the Madbury Water Treatment Plant to the Newington Booster Pump Station to provide water to the City of Portsmouth, Town of Newington, and Pease Tradeport, formerly Pease Air Force Base. The transmission main was placed in service in 1957 and provided water supply to Portsmouth, Pease Tradeport and surrounding communities for nearly 60 years. On April 13 and 14, 2016 a walkover of the transmission main was conducted by a team of Stantec engineers and operators. The walkover was used to document the pipeline route, observe the external facilities of the transmission pipeline and determine types of rehabilitation needed. A summary of this inspection is included as Attachment A.

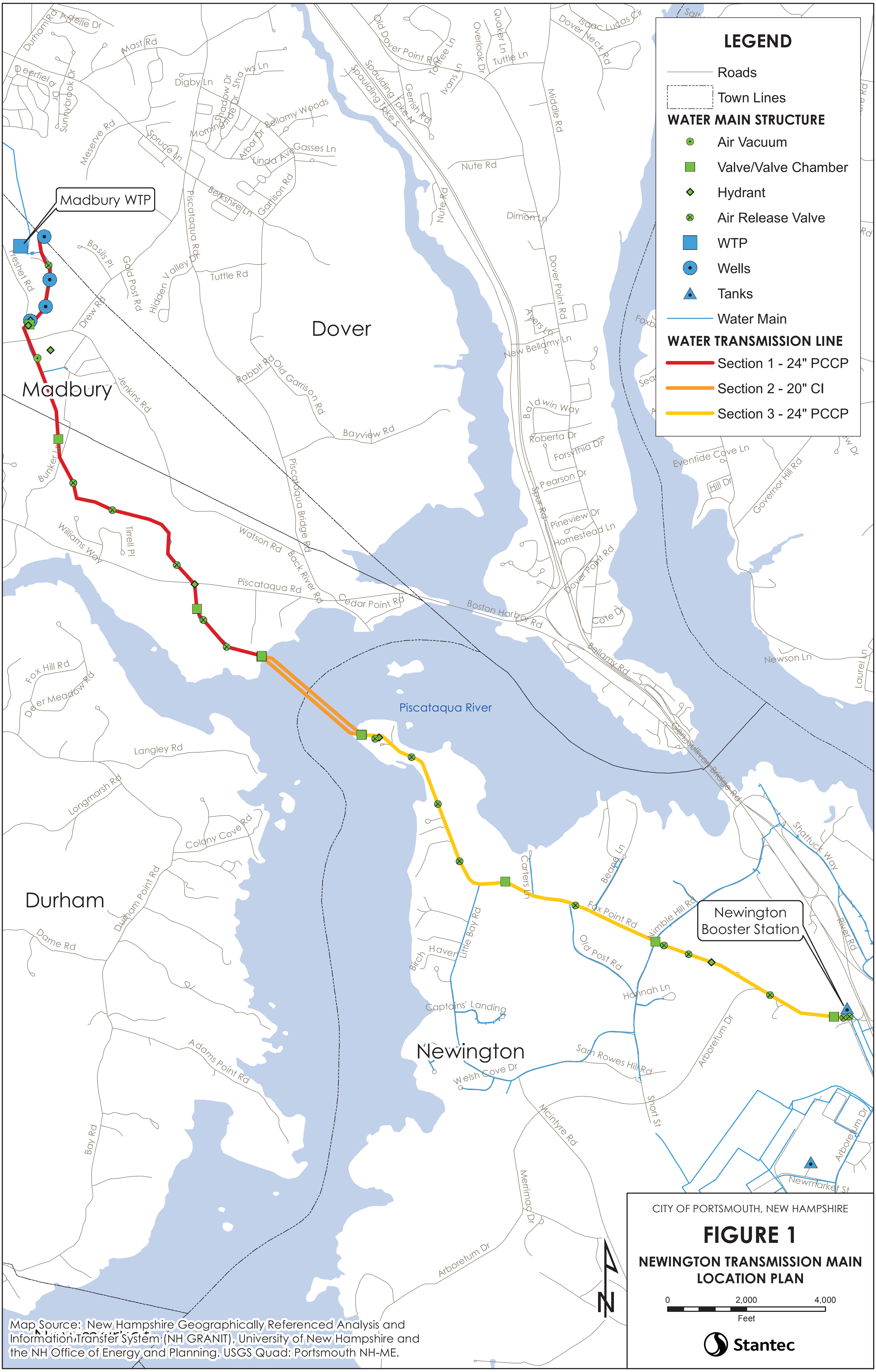
For the purposes of this evaluation, the pipeline route has been separated into three sections. These sections are summarized below and are shown in Figure 1.

- Section 1 – Approximately 14,000 feet of 24-inch prestressed concrete cylinder pipe (PCCP) from the Madbury Wells to Little Bay

- Section 2 – Two (2) parallel 20-inch cast iron pipes, each approximately 3,200 feet, crossing under Little Bay

- Section 3 – Approximately 17,000 feet of 24-inch PCCP from Little Bay to the Newington Water Storage Tank and Booster Pump Station.

While Stantec and City of Portsmouth staff completed a walkover of Sections 1 and 3, the City of Portsmouth hired Black Dog Divers, Inc. to visually inspect Section 2, the subaqueous pipeline crossing of Little Bay. A copy of this inspection report is included as Attachment B. This inspection identified that the pipeline is exposed in areas. The reliability of this subaqueous crossing is a concern since this pipeline is critical to maintaining water supply to the City of Portsmouth and surrounding communities. This memorandum summarizes both short term and long term solutions for addressing the reliability of this transmission main.



Map Source: New Hampshire Geographically Referenced Analysis and Information Transfer System (NH GRANIT), University of New Hampshire and the NH Office of Energy and Planning. USGS Quad: Portsmouth NH-ME.

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FIGURE 1

NEWINGTON TRANSMISSION MAIN LOCATION PLAN

0 2,000 4,000
Feet

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Surface Pipe – Sections 1 and 3

As summarized in the Madbury-Newington Transmission Main Inspection Report, the existing transmission main easement has not been adequately maintained and encroachment has occurred in various locations along the easement. Also, maintenance has not been regularly performed on the structures along the pipeline. The following sections summarize recommendations for maintenance and further evaluation of Sections 1 and 3.

Maintenance Recommendations

Stantec recommends clear cutting the pipe route, focusing on the Madbury/Durham side and continuously maintaining this easement. On the Newington side the pipeline is primarily located just off of the roadway. As part of the maintenance of the easement, markers should be placed along the cross country portions of the alignment to identify the pipeline location. Encroachment on the easement should also be addressed by notifying existing property owners of the encroachment and posting signs to prevent these activities in the future. In addition to maintaining the easement, Stantec also recommends that the City visually inspect all structures along the alignment at least twice per year. The months of November and April/May would be recommended so the structures can be observed both before and after the snow season and outside of the high growth time periods. Stantec has also developed a Standard Operating Procedure (SOP) for shutting down the transmission main in the event of the repair. This SOP in included as an Attachment.

Pipeline Condition Assessment

While PCCP pipe manufactured in the 1970s by Interpace has experienced failures due to quality issues during the manufacturing process, the era of this PCCP pipe has not experienced these types of issues. PCCP pipe in general can be subject to external corrosion which can impact the mortar and then expose the prestressing wire and cylinder. As part of the transmission main evaluation, CorrTech completed a soil resistivity evaluation in June 2016. A copy of CorrTech's field report is included as Attachment C. The measurement of soil resistivity is used as an indicator of the corrosivity of soil. Of the measurable soil characteristics, resistivity is generally accepted as the primary indicator of soil corrosivity.

Soil resistivity data was measured at 54 locations along the approximately 30,000 linear feet of PCCP water main that comprises Sections 1 and 3. Measurements were made at the surface, 3-ft, 6-ft and 9-ft depths. The results of the 216 measurements identified areas of interest where CorrTech recommends the following locations for further investigation.

Section 1 (Madbury Water Treatment Plant to Great Bay)

-Sta. No. 85+00

-Sta. No. 114+00

-Sta. No. 130+60

-Sta. No. 134+00

-Sta. No. 139+00 (Transition Location)

Section 3 (Great Bay to Newington Booster Pump Station)

-Sta. No. 1+07 (Transition Location)

-Sta. No. 56+00

-Sta. No. 69+00

-Sta. No. 124+00

-Sta. No. 143+50

CorrTech recommend that direct assessment be performed at four (4) of the above locations along the pipeline and considers the transition locations noted above as high priority.

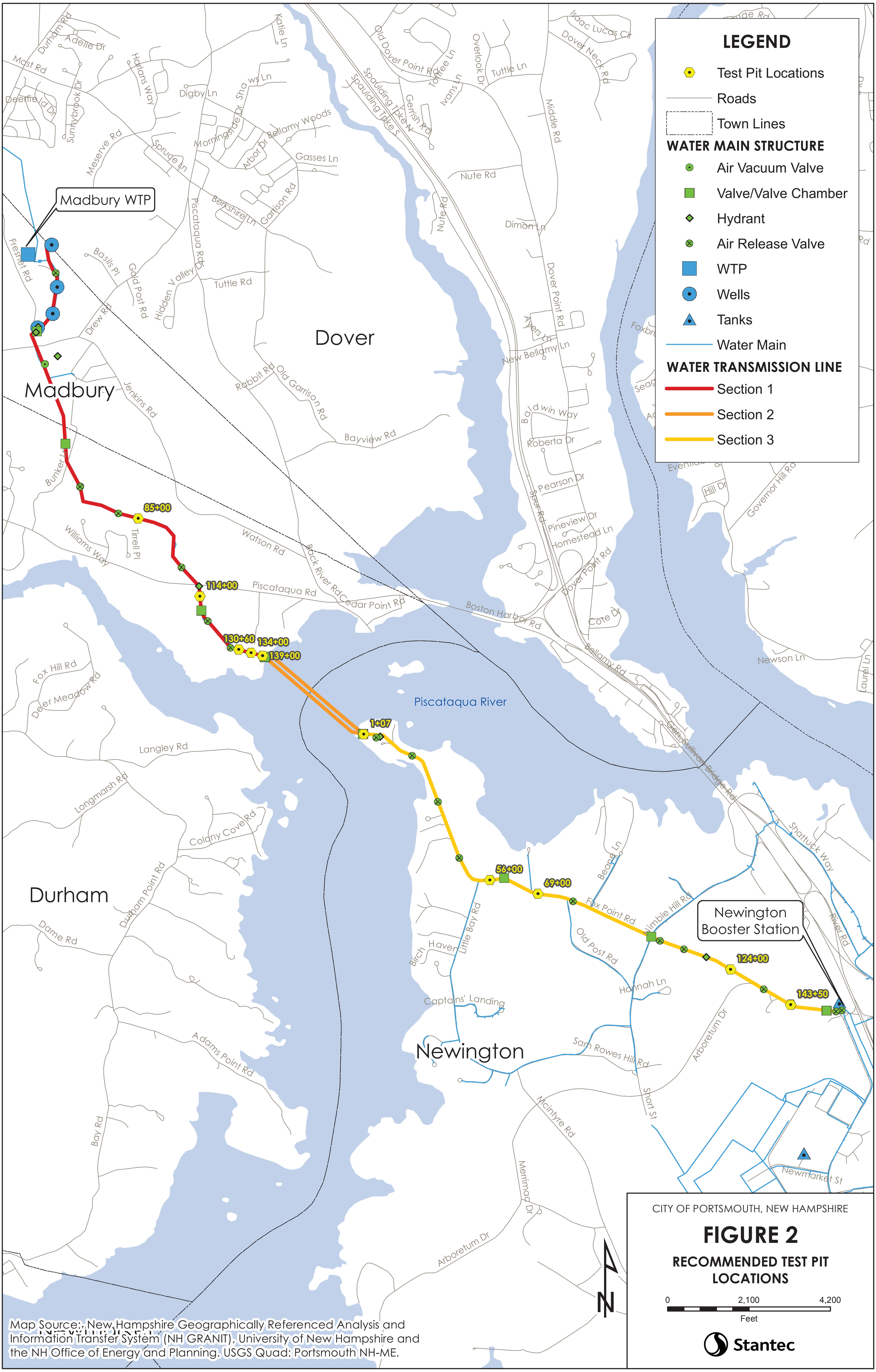
Corrtech has only tested for soil resistivity and has not completed any direct assessment of the pipe. Cortech has recommended further investigation near where the pipe transitions from PCCP to Cast Iron. The cast iron piping surrounded by salt water faces similar corrosion exposure to the PCCP on the approach to the transition section which is why this area is recommended for further testing. Based on the testing, the mud-based electrolyte there is moist with salt water. These are the focused areas for further investigation since there is less concern for sections of PCCP in areas with higher resistivity in the hills where the soils are drier.

To facilitate inspection as these four (4) locations the entire buried section of pipe under investigation would be exposed. At each location, the excavation should be large enough to provide 10 to 15-ft along the pipe, for the entire circumference, with 3-ft of clearance below the invert. A dewatering system may be required. Within the excavation, the pipe surface would be cleaned and divided into 1-ft squares for inspection. Within each square foot the following inspection activities would be completed:

- A prioritization of any defects or conditions found
- An examination of the exposed pipe area, coating, mortar cracking
- Measurement of any corrosion or any damage
- Mortar pH and Schmidt hammer hardness testing
- Mortar sounding
- Wire resistance evaluation
- Wire Resistance

CorrTech would evaluate the resistance of the wire to determine areas where the wire has corroded and lost section, thereby increasing longitudinal resistance. This involves removing some of the mortar along the exposed section of pipe so that the wire spacing and wire diameter can be determined. Several 3-inch wide by 12-inch windows would be made along the pipe surface as allowed by the excavation. This also allows for inspection of the wires in the window of removed mortar. Where a pipe bell is located in the excavation, electrical continuity between pipe segments would be determined. Following testing, the mortar would be repaired.

Photographs would be taken in each excavation to document the existing conditions. The presence and condition of the coating on the pipe would be evaluated. A map of these recommended locations is included as Figure 2.



Map Source: New Hampshire Geographically Referenced Analysis and Information Transfer System (NH GRANIT), University of New Hampshire and the NH Office of Energy and Planning. USGS Quad: Portsmouth NH-ME.

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FIGURE 2

RECOMMENDED TEST PIT LOCATIONS

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Electromagnetic Pipe Evaluation

Other, more comprehensive pipe evaluation methods are also available for PCCP pipe. Pure Technologies has a condition assessment tool for evaluating the integrity of the pre-stressing wire and the cylinder to detect wire breaks and cylinder corrosion. Pure's PipeDiver® device is inserted into an active pipeline through a 12-inch connection and travels with the flow of water through the pipeline collecting data on the pipeline's integrity. If completing the test pitting along the pipeline as recommended by CorrTech is not acceptable to the city due to concerns over exposing the pipeline, additional investigative options such as the PipeDiver® are available for consideration.

Redundancy

Sections 1 and 3 of the transmission main are single pipelines that are critical to the City of Portsmouth's water supply system. While this pipeline has operated reliably over the last 60-years, consideration should be given to whether a redundant pipeline should be installed so that the existing pipeline can be removed from service for maintenance. The economic impacts of a failure of this pipeline are significant and therefore planning for a redundant pipeline would be prudent.

The existing pipeline is installed in a 20-ft easement and is generally offset from the centerline of the easement. This offset provides available space to construct a parallel main within the existing easement. The length of Sections 1 and 3 total approximately 30,000 feet of pipe. Assuming a construction cost of $400 per foot, budgetary cost for a second pipeline would be approximately $12 million. This work does not need to be implemented immediately, nor does it need to be completed as one large project. Consideration should be given to the long term reliability of this pipeline and the construction of a new redundant pipeline.

Little Bay Crossing – Section 2

The diving inspection by Black Dog Divers indicates sections of exposed pipe along the bottom of the channel. Located 200 feet from the northwest shoreline and along the north pipe the diving inspection indicated the pipe is exposed in three locations; one section 50 feet in length and two sections each 100 feet in length. Heavy pitting was observed as well. The divers recommended covering the exposed sections of pipe. The following section evaluates the short-term pipe protection.

Short Term Pipeline Protection

There are advantages and disadvantages associated with temporarily protecting the pipelines until they can be replaced. If the pipe is left undisturbed, there is potential for additional exposure of the pipe and risk of damage. If protection methods are implemented, the act of reinforcing the pipeline could cause the pipe to rupture. The following are some potential measures for consideration by the City to prevent additional erosion of the pipe cover and provide stability. Catalog cut sheets of these products are included in Attachment D.

- Submat Bitumen Mattress is a pipeline stabilization and protection system that consists of a durable outer canvas filled with a dense bitu-mastic filler material which is laid over top of pipe to protect against erosion and hydraulic lift and specifically designed for underwater applications

- Hydrotex fabric forms constructed of concrete linings with patterned surfaces which provide high hydraulics resistance.
- ArmorFlex is a flexible, interlocking matrix of concrete blocks which are overlaid on top of pipelines for erosion control. This product is typically used as an alternative to rip rap to address erosion and stabilization.

Extensive permitting will be required if any of these temporary protection methods are implemented. The following is a list of anticipated required permits for protecting the pipelines:

- NH Department of Environmental Services (DES) Shoreland Permit and Shoreland Impact Permit
- Army Corps of Engineers Section 401 Water Quality Certificate
- NH Natural Heritage Bureau Review
- Durham and Newington Notices of Intent

Long Term Pipeline Reliability

Addressing the long-term reliability of the subaqueous portion of the transmission line presents a greater challenge. The following summarizes the available options for this portion of the transmission line.

- Install two new 20-inch pipelines using Horizontal Directional Drill (HDD)
- Pipe bursting of existing pipelines with equal or larger new water mains
- Line existing pipelines with structural liner
- Lay new high density polyethylene (HDPE) pipe along bottom of Little Bay
- Construct new pipeline along Boston Harbor Road Bridge and Route 4 Bridge

<u>Horizontal Directional Drill</u>

New pipelines could be constructed across Little Bay through horizontal directional drilling (HDD). The first step of HDD involves digging a pilot hole along a predetermined path by means of a jet bit or a downhole motor, with a work string attached. A sensing unit on the bit guides the downhole steering system to maintain the correct path. Any course adjustments can be made while the pilot hole is being dug. Once the pilot hole is complete, a reamer is attached to the work string, and a swivel is placed between the reamer and the pipeline to prevent the pipeline from rotating. The work string is then pulled back to the rig through the reamed hole with the new pipe attached. Typically either high-density polyethylene (HDPE) or steel pipe can be used in a directional drill application.

Pipe Bursting

Pipe bursting is a trenchless method of replacing pipelines and can allow for upsizing of existing pipelines in the process. The length of the existing subaqueous pipeline is approximately 3,000 feet. Pipe bursting typically involves the insertion of a cone shaped bursting heading into the existing pipeline through an insertion shaft. The back end of the bursting head is attached to the new pipeline and the front end is attached to a cable or pulling rod. The new pipe and bursting head are launched from the insertion shaft and the cable is pulled from the pulling shaft. Typical utility pipe bursting projects are on the order of 300 to 500 feet although longer lengths can be achieved in favorable conditions. With a pipe length of approximately 3,200 feet, this distance well exceeds the typical pipe bursting project and the equipment limitations associated with pipe bursting therefore this is not a feasible option for replacing the existing subaqueous portion of the transmission main.

Cured in Place Structural Liner

Cured in place pipe (CIPP) is a trenchless rehabilitation method used to repair existing pipelines. While CIPP has been completed in water and sewer mains for many years, more recently technologies have been improving to structurally rehabilitate water mains through the use CIPP. Aqua-Pipe is the brand name of a structural liner for water mains and is available for 6 to 24 inch diameter pipelines. Aqua-Pipe is impregnated onsite with a proprietary epoxy resin and is then pulled in place through the host pipe. The Aqua-Pipe liner is installed by pushing a pig through the liner using water pressure and then is cured with circulating hot water.

While the Aqua-Pipe structural liner is available for up to 24-inch pipe, the lining length between access pits is limited to about 500 feet for diameters of 14-inch and larger. This technology is not feasible for use for addressing the subaqueous pipeline portion.

New HDPE Pipe Installed along bottom of Little Bay

The installation of a new subaqueous pipeline can be done in one of several ways:

- Pipe can be assembled on one riverbank and pulled into place from the other riverbank
- Pipe can be floated out into the river on a barge and lowered into place
- River water can be diverted and the pipe can be installed in a dry trench

Bank installation consists of two basic steps: assembly of the pipe at the water's edge and pulling the line into place from the opposite bank. This method requires a large staging area for material and equipment storage and room for pipe handling and assembly. The bank material needs to be stable enough to support the pipe and assembly equipment and must be able to be graded to provide the appropriate angle for the pipe to enter the water. If pull lengths are too long or water currents are too strong this method cannot be used because the forces required to pull the entire pipeline become too excessive. In this case a barge method could be used.

Using a barge to install a pipe can be completed one of two ways. The pipe can be floated out on the barge, lowered into the water and assembled underwater by divers. The other method involves the pipe being assembled on a ramp on the barge and slide into place as the barge moves forward.

The depth of bury of the pipeline will depend on the pipe material chosen. Buoyant forces of the pipe will need to be taken into consideration when determining a bury depth. HDPE pipe, being lighter in weight than ductile iron, will also be more buoyant. The pipe must be installed deep enough to prevent tidal currents from uncovering the pipe.

Due to the depth, current, and boat traffic of Little Bay, it will most likely not be possible to divert the water and install the main in a dry trench.

The environmental impacts of a subaqueous pipeline installation will be extensive for work done in the water and along the banks and therefore the permitting for this work will also be extensive and time consuming.

Construct new pipeline along Boston Harbor Road Bridge and Route 4 Bridge

Another option for providing redundancy is install a new pipeline within roadways between the Madbury Water Treatment Plant and the Newington Pump Station. The approximate limits of this pipeline are shown in Figure 3 and would include:

- Piscataqua Road – Madbury WTP to Route 4 Bridge - 6,400 feet
- Route 4 Bridge – 1,100 feet
- Boston Harbor Road from Route 4 Bridge to Boston Harbor Road Bridge – 6,400 feet
- Boston Harbor Road Bridge – 1,500 feet
- Shattuck Way from Boston Harbor Road Bridge to Nimble Hill Road – 2,300 feet
- Nimble Hill Road from Shattuck Way to Fox Point Road – 3,500 feet
- Total Length – 4 miles

The open cut construction within the roadways would be typical construction. There are two bridge crossings along this alignment and it is unlikely a new 20-inch or 24-inch pipe could be hung from the existing bridge. The ability to hang and support two smaller diameter pipes to make up the pipe capacity is also unlikely. Instead, a dedicated pipe bridge would likely be required. These water ways spans are over 1,000 and therefore the bridge design would be more complex. The construction of these two pipe bridges could easily reach $10 million each so the overall project cost would be well over $20 million.

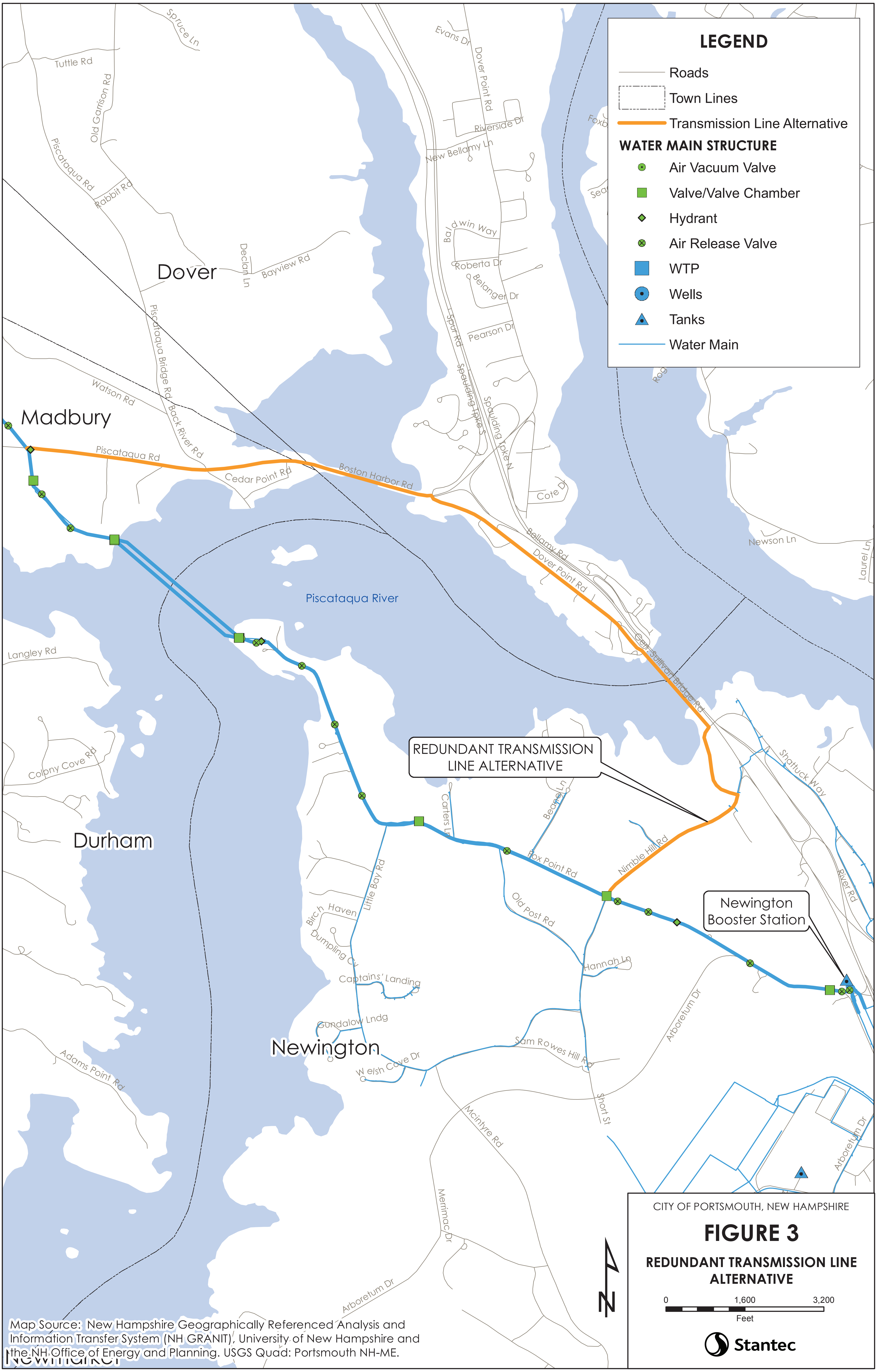

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FIGURE 3

REDUNDANT TRANSMISSION LINE ALTERNATIVE

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Map Source: New Hampshire Geographically Referenced Analysis and Information Transfer System (NH GRANIT), University of New Hampshire and the NH Office of Energy and Planning. USGS Quad: Portsmouth NH-ME.

Summary and Long Term Recommendation

The following table summarizes the feasible options for addressing the reliability of the existing subaqueous pipeline.

Table 1 - Summary of Long Term Pipeline Reliability Options

Option	Advantages	Disadvantages
Install two new 20-inch pipelines using horizontal directional drill (HDD)	• Shorter pipe length • Alignment is similar to existing crossings and addition pipe work is minimized	• Temporary and new permanent easements required for construction staging and new alignment
Lay HDPE pipe along bottom of Little Bay	• Shorter pipe length • Alignment is similar to existing crossings and addition pipe work is minimized	• Extensive Permitting • Tidal impacts for new pipe • May have similar construction costs to HDD
Construct new pipeline along Boston Harbor Road Bridge and Route 4 Bridge	• Future accessibility of pipeline	• Longest pipe length • New pipe bridges would likely be required due to pipe size • Extensive Permitting • Additional pipe improvements in Newington beyond just bridge crossings

The HDD alternative is the most constructable alternative and is therefore the recommended approach to address reliability concerns with the subaqueous portion of the Newington Transmission Line. Preliminary work would need to be completed prior to the HDD work. This work would include:

- Completion of a bathymetric survey to map the ground surface under Little Bay
- Seismic refraction survey to generate a rock profile along the HDD route
- Land side borings to understand soil and rock conditions

This preliminary evaluation work will provide the basis for the HDD design. Pipe material would also be evaluated during this phase to determine what pipe material is best suited for the HDD. The following summarizes budgeting level costs for this project.

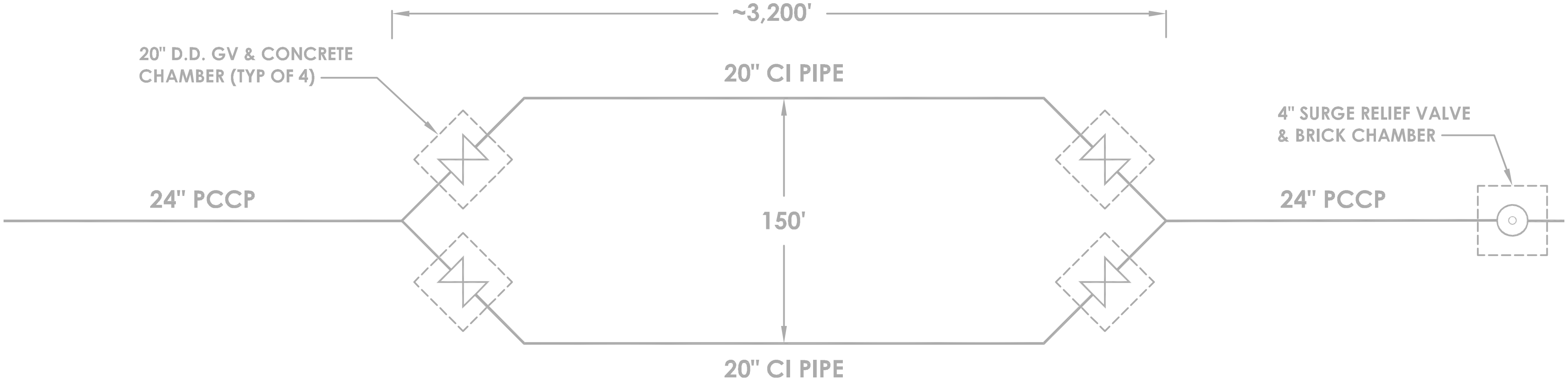
Table 2 - Summary of Budgetary Costs for HDD Construction of two 20-inch lines

	Cost
HDD two (2) new 20-inch pipelines	$5,000,000
Connections to existing pipe	$150,000
Linestops	$100,000
Construction Contingency (20%)	$1,050,000
Subtotal Construction	**$6,300,000**
Engineering (20%)	$1,260,000
TOTAL PROJECT COST	**$7,560,000**

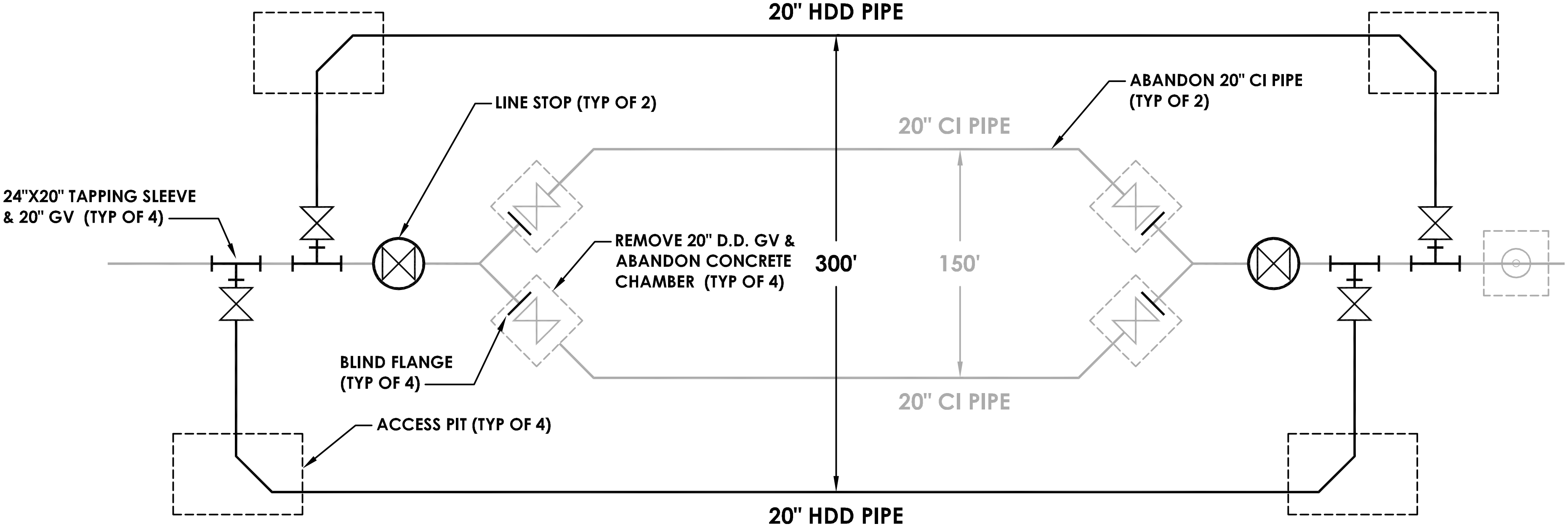
Based on Stantec's walkover of the transmission line along with conversations with City staff, the existing valving on transmission line is not typically exercised and therefore critical valves are inoperable. To construct two new parallel water mains through HDD, connections will need to be made to the existing pipe to activate the new pipe and to isolate the existing subaqueous crossings. The following steps outline how this work could be constructed without removing this critical pipeline from services. These steps area also shown schematically in Figure 4.

- HDD two (2) new 20" pipelines
- Install two (2) 24"x 20" taping sleeves and valves on both the north and south sides of Little Bay
- Connect and activate new 20" pipelines
- Install two (2) linestops on north and south sides between new tapping sleeves and existing valve vaults
- Isolate work area, remove all four (4) 20" gate valves from the valve chambers and install blind flanges in place of gate valves
- Remove linestops

While one single HDD crossing would meet the hydraulic goals of the project and would replace the existing exposed crossings, two crossings are recommended. The total project cost for one crossing would be approximately $5.4M as compared to $7.56M. While this provides a savings of about 30 percent, this would result in the future reliance on a single crossing in the future. For a modest percentage increase, full redundancy for the crossing of Little Bay can be provided to have a reliable crossing for the next 100-years.



EXISTING



PROPOSED

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FIGURE 4

HORIZONTAL DIRECTIONAL DRILL SCHEMATIC

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Emergency Supply Alternatives

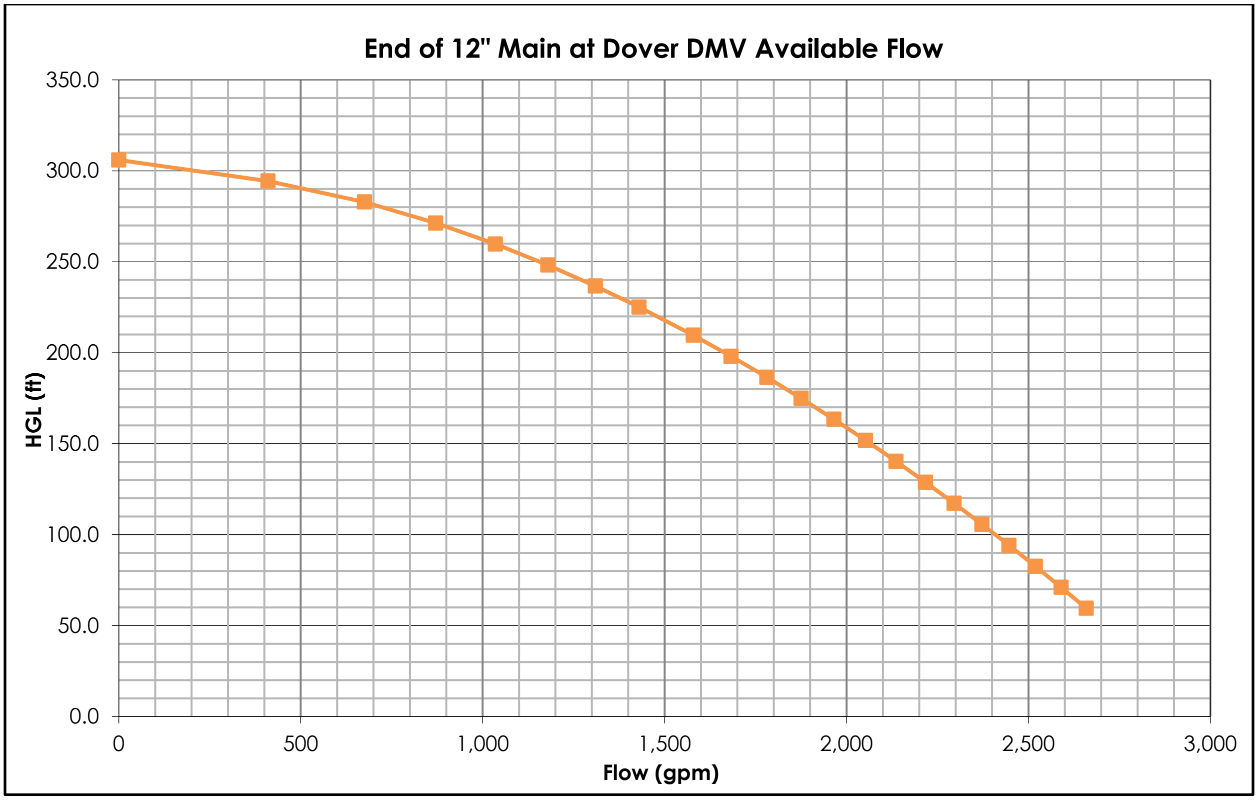
While Stantec recommends that additional investigations be conducted along the transmission main and that new pipeline crossings of Little Bay be constructed through HDD, until this work is completed, understanding the available emergency water supply options is critical.

Temporary Connection from Dover

The City of Portsmouth has interconnections with a number of neighboring communities including Rye, Greenland, New Castle and Dover. The Town of Dover is located closest to the Newington Pump Station and therefore provides the most convenient location to supply water to the pump station in the event of a problem with the Newington Transmission Main. The Town of Dover recently calibrated its water system hydraulic model and the Town's water consultant completed an evaluation to determine the water supply that would be available at Dover Point Road, just prior to the Little Bay Bridge and parallel pedestrian bridge. A copy of a memorandum summarizing the available flow from Dover is included as Attachment E.

Using the data provided by the Town of Dover, the available flow from Dover is represented in the following graph. The pressures identified in the Town's hydraulic model were converted to hydraulic gradeline elevations so this information could be used in the City of Portsmouth's hydraulic model.

Figure 5 Available Flow at 50 Boston Harbor Rd, Dover



The City of Portsmouth's Newington Tank is a 1.5 MG tank. The tank has an over overall height of 40 feet with the floor of the tank at elevation 102 feet and the overflow elevation of 142 feet. In order to evaluate the amount of water that could be supplied from Dover to Portsmouth, Stantec estimated a minimum tank hydraulic gradeline elevation of 120 feet. While this is lower than the City allows the tank to currently drop, this still leaves acceptable pressures in the Newington area supplied prior to the Newington Booster Pump Station and can maximize the available flow from Dover.

Using the City's hydraulic model, Stantec completed hydraulic model runs to identify available flows from Dover for various pipe configurations. In the event that the City would receive water from the Town of Dover, temporary piping would have to be installed along the pedestrian bridge since there is not an existing pipeline on the Little Bay Bridge. On the Newington side of the bridge, the water system includes an 8-inch water main in Nimble Hill Road. Because the goal of this analysis is to get water from Dover to the Newington tank, Stantec also considered pipeline alternatives that include a temporary pipeline installed in parallel with the 8-inch Nimble Hill Road main. Once a connection to the 24-inch transmission main in Fox Point Road can be made, no additional pipe improvements would be required.

The following table summarizes available gravity flows from Dover with various temporary pipe connections while maintaining the Newington Tank at elevation 120 feet.

Table 3 – Available Flow from Dover – Maintaining Newington Tank at el. 120 feet

Scenario	Flow (gpm) to Main Zone	Flow (MGD) to Main Zone	HGL at Dover
8" Pipe Over Bridge	765	1.10	276.5
2-6" Pipes Over Bridge	750	1.08	275.8
2-8" Pipes Over Bridge	840	1.21	271.2
2-6" Pipes Over Bridge & additional 6" on Nimble Hill Road to 24" Transmission	875	1.26	268.0
2-8" Pipes Over Bridge & additional 6" on Nimble Hill Road To 24" Transmission	1,020	1.47	258.9
12" Pipe Over Bridge & Additional 12" on Nimble Hill Road to 24" Transmission	1,245	1.79	240.2
16" Pipe Over Bridge & Additional 16" on Nimble Hill Road to 24" Transmission	1,310	1.89	233.3
20" Pipe Over Bridge & Additional 20" on Nimble Hill Road to 24" Transmission	1,330	1.92	231.8
24" Pipe Over Bridge & Additional 24" on Nimble Hill Road to 24" Transmission	1,340	1.93	231.9

Table 3 illustrates that smaller more manageable temporary pipe sizes, limits water supply from Dover due to the accumulating headlosses in the temporary and existing pipelines. Since gravity flow conditions significantly limit the available flows, Stantec also evaluated various pumped conditions.

Average day demands in the City of Portsmouth are approximately 4.5 million gallons per day. The City has five (5) active well supplies on the Portsmouth side of the Little Bay pipeline crossing. In the event of a failure of this pipeline the wells would be available to supply water. Reviewing the City of Portsmouth's Water System Master Plan Report, the likely sustainable yield from these six (6) wells is approximately 2.4 MGD. Therefore, in order to meet an average day demand during a critical pipeline failure, approximately 2 MGD would be required from an interconnection.

Since the gravity supply options from Dover could only supply close to 2 MGD, additional pumping and pipeline options were evaluated to determine all feasible combinations to achieve 2 MGD of water from the Town of Dover. These various options and resulting pressures are presented in Table 4. For reference, Figure 6 shows the location of the proposed connection in the Town of Dover, along with the Town of Newington.

In Table 4, some options are not feasible since discharge pressures under a pumping condition would need to exceed 125 psi to maintain an HGL of 120 feet at the Newington Tank. Similarly, some conditions result in negative pressures on the suction size of the temporary pump and therefore are not feasible. Piping configurations that are not feasible are presented with an "X" Table 4. For those options that are hydraulically feasible, the table is tabled with "Gravity" for those options which can be supplied without a temporary pump and options that require pumping are labeled "Pump". When pumping is required, a minimum total dynamic pump head (TDH) is also provided as reference for selecting an appropriate temporary pump size.

Table 4 - Summary of Hydraulics for Temporary Pumping from Dover

Pipe Improvements on Discharge to Provide 2 MGD (1400 GPM) at HGL 120' at Tank	Discharge HGL Required (ft)	8" Pipe Over Little Bay Bridge[2]	8" Pipe Over Little Bay Bridge & 8" Surface Pipe in Dover	2-6" Pipes Over Little Bay Bridge[2]	2-6" Pipes Over Little Bay Bridge & 8" Surface Pipe in Dover[3]	2-8" Pipes Over Little Bay Bridge	2-8" Pipes Over Little Bay Bridge & 8" Surface Pipe in Dover	12" Pipe Over Little Bay Bridge	12" Pipe Over Little Bay Bridge & 8" Surface Pipe in Dover	16" Pipe Over Little Bay Bridge	16" Pipe Over Little Bay Bridge & 8" Surface Pipe in Dover	20" Pipe Over Little Bay Bridge	20" Pipe Over Little Bay Bridge & 8" Surface Pipe in Dover	24" Pipe Over Little Bay Bridge	24" Pipe Over Little Bay Bridge & 8" Surface Pipe in Dover
Existing Water Main[1]	**350.1**	X	X	X	X	X	X	X	X	X	X	X	X	X	X
6" on Nimble Hill to 24" Tranmission	**221.7**	X	Pump(140)	X	X	Pump(166)	Pump(83)	Pump(126)	Pump(44)	Pump(115)	Pump(32)	Pump(112)	Pump(30)	Pump(111)	Pump(29)
8" on Nimble Hill to 24" Tranmission	**171.3**	X	Pump(89)	X	X	Pump(115)	Pump(33)	Pump(76)	Gravity	Pump(64)	Gravity	Pump(62)	Gravity	Pump(61)	Gravity
12" on Nimble Hill to 24" Tranmission	**134.0**	X	Pump(52)	X	X	Pump(78)	Gravity	Pump(38)	Gravity	Pump(27)	Gravity	Pump(24)	Gravity	Pump(24)	Gravity
16" on Nimble Hill to 24" Tranmission	**125.2**	X	Pump(43)	X	X	Pump(69)	Gravity	Pump(30)	Gravity	Pump(18)	Gravity	Pump(16)	Gravity	Pump(15)	Gravity
20" on Nimble Hill to 24" Tranmission	**122.8**	X	Pump(41)	X	X	Pump(67)	Gravity	Pump(27)	Gravity	Pump(16)	Gravity	Pump(13)	Gravity	Pump(12)	Gravity
24" on Nimble Hill to 24" Tranmission	**122.0**	X	Pump(40)	X	X	Pump(66)	Gravity	Pump(26)	Gravity	Pump(15)	Gravity	Pump(12)	Gravity	Pump(12)	Gravity

X = Not Feasible
Pump(XXX) = Pump Required (TDH)
Gravity = HGL acheivable without Pump

[1] Discharge HGL would result in Pressures >125 psi
[2] Negative pressures observed at pump suction.
[3] Pressures <10psi observed at pump suction.

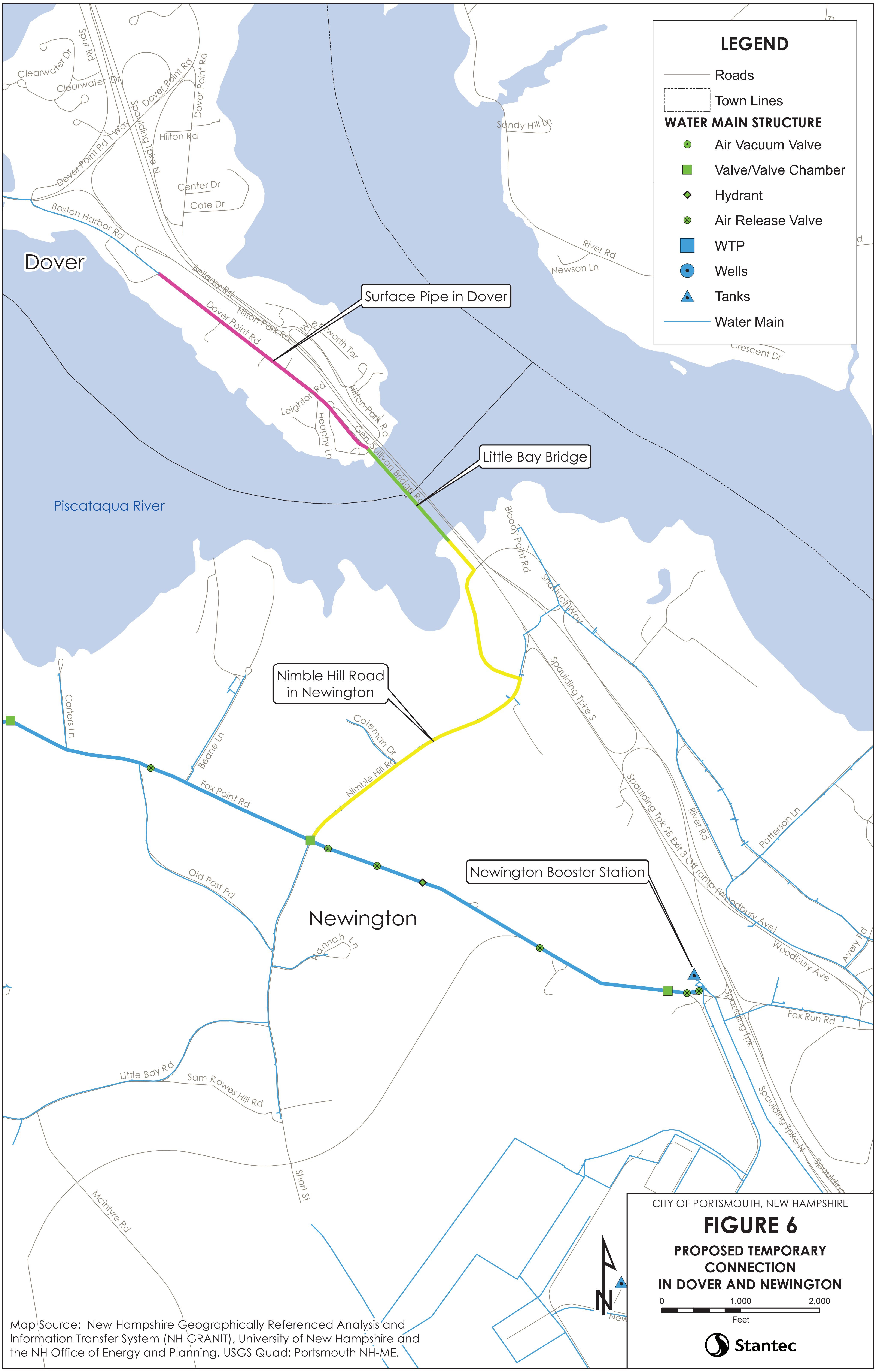


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FIGURE 6

PROPOSED TEMPORARY CONNECTION IN DOVER AND NEWINGTON

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Map Source: New Hampshire Geographically Referenced Analysis and Information Transfer System (NH GRANIT), University of New Hampshire and the NH Office of Energy and Planning. USGS Quad: Portsmouth NH-ME.

For many of the pumping options, smaller pipe sizes can be used and the pump sized to overcome the headlosses without over pressurizing existing system. The logistics of deploying a temporary pump and installing the larger diameter piping will be difficult to overcome.

For budgetary purposes Stantec has assumed the temporary emergency supply will be completed with approximately 1,600 feet of 12-inch HDPE pipe over Little Bay Bridge and approximately 5,700 feet of 8-inch HDPE pipe along Nimble Hill Road to connect to the 24-inch transmission main. Based on discussions with temporary pump suppliers, this amount of pipe is often in stock. Assuming all pipe is available in stock and an installation rate of approximately 800 feet per day per fusing machine and with two machines on site it will take about 5 days for installation. The temporary 1,400 gpm pump could be set up just after the Little Bay Bridge before Shattuck Way. Approximate costs for setup and take down of the rental equipment and material for one month is presented in Table 5.

Table 5 - Summary of Budgetary Monthly Costs for Emergency Supply Alternative

	Cost/Month
Temporary Pump	$5,000
Suction and Discharge Fittings	$2,000
1,600 ft 12-inch HDPE Pipe	$32,000
5,700 ft 8-inch HDPE Pipe	$90,000
Contingency (20%)	$26,000
TOTAL PROJECT COST	**$155,000**

Stantec recommends that the City begin engaging the Town of Dover in discussions for a temporary water connection in the event of an emergency. New Hampshire DOT should also be consulted so it is aware that an emergency situation may require the installation of temporary piping over the pedestrian bridge. Engaging these stakeholders prior to an emergency will streamline the deployment of this material and equipment in the event of an emergency.

Dover Supply

If the Dover water system is unable to supply the Newington Tank with the estimated 2.0 MGD under emergency conditions, additional improvements to the Dover system can be made that would allow the Madbury Water Treatment Plant to supply water directly into the Dover distribution system. The water pumped into the Dover distribution system would then supply the Newington Tank through the temporary interconnection described in the previous section.

One option to connect the Madbury Water Treatment Plant with the Dover water distribution system would be to construct approximately 6,000 feet of water main north along Freshnet Road and northeast along Durham Road, and connect to the Dover water system at Mast Road. Additional investigation would be necessary to determine the ability of Dover's system to handle the additional supply, as well as the treatment plant's ability to pump to the higher hydraulic gradeline in Dover.

The approximate costs associated with installing temporary pipe from the Madbury Water Treatment Plant to Mast Road in Dover would be $180,000. Temporary pumping may also be required based on the pumps at the water treatment plant and the hydraulic gradeline of the Dover system.

Horizontal Directional Drill

A more permanent emergency supply connection could be constructed with horizontal directional drilling (HDD). A new 24" pipeline could be constructed under the Little Bay Bridge through HDD. The pipeline would connect the existing Dover system to the Portsmouth water system. With the HDD additional surface improvements in Newington would still be necessary. Directional drilling would be similar to 24" surface pipe on the Little Bay Bridge scenario (see Table 4). A permanent or temporary 6- or 8-inch surface pipe will need to be installed on Nimble Hill Road in order to overcome the headloss under this emergency condition. Table 6 presents the costs associated with horizontal directional drilling under the Little Bay Bridge.

Table 6 - Summary of HDD Connection to Dover Water System

	Cost
HDD one (1) new 24-inch pipeline	$2,000,000
Connections to existing pipe	$50,000
5,700 ft 8-inch HDPE temporary pipe	$90,000
Contingency (20%)	$428,000
Subtotal Construction	**$2,568,000**
Engineering (20%)	$513,600
TOTAL PROJECT COST	**$3,081,600**

Reference: Newington Transmission Main – Short Term and Long Term Alternatives

Summary of Emergency Supply Alternatives

The emergency supply alternatives all rely on the use of water either from or through the Town of Dover. Meetings should be held with Dover to discuss the various alternatives presented in the memorandum to determine the most feasible option for consideration in the event of an emergency.

Stantec appreciates the opportunity to work with the City on this important evaluation. We look forward to discussing the content of this memorandum at your convenience.

STANTEC CONSULTING SERVICES INC.

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Attachment: A – Madbury-Newington Transmission Main Inspection Report
B – Black Dog Divers, Inc. Subaqueous Water Main Inspection Summary
C – CorrTech Field Report Summary
D – Subaqueous Pipeline Protection Options
E – Town of Dover Hydraulic Model Memorandum
F – SOP for Shutdown of Transmission Line

Attachment A
Madbury-Newington Transmission Main Inspection Report

Madbury-Newington Transmission Main Inspection Report

Findings of field inspections of the external facilities conducted on April 13, 2016 and April 14, 2016

Prepared for:
City of Portsmouth, NH

Prepared by:
John Amato, PE

November 11, 2016

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APPENDICES

1.0 INTRODUCTION

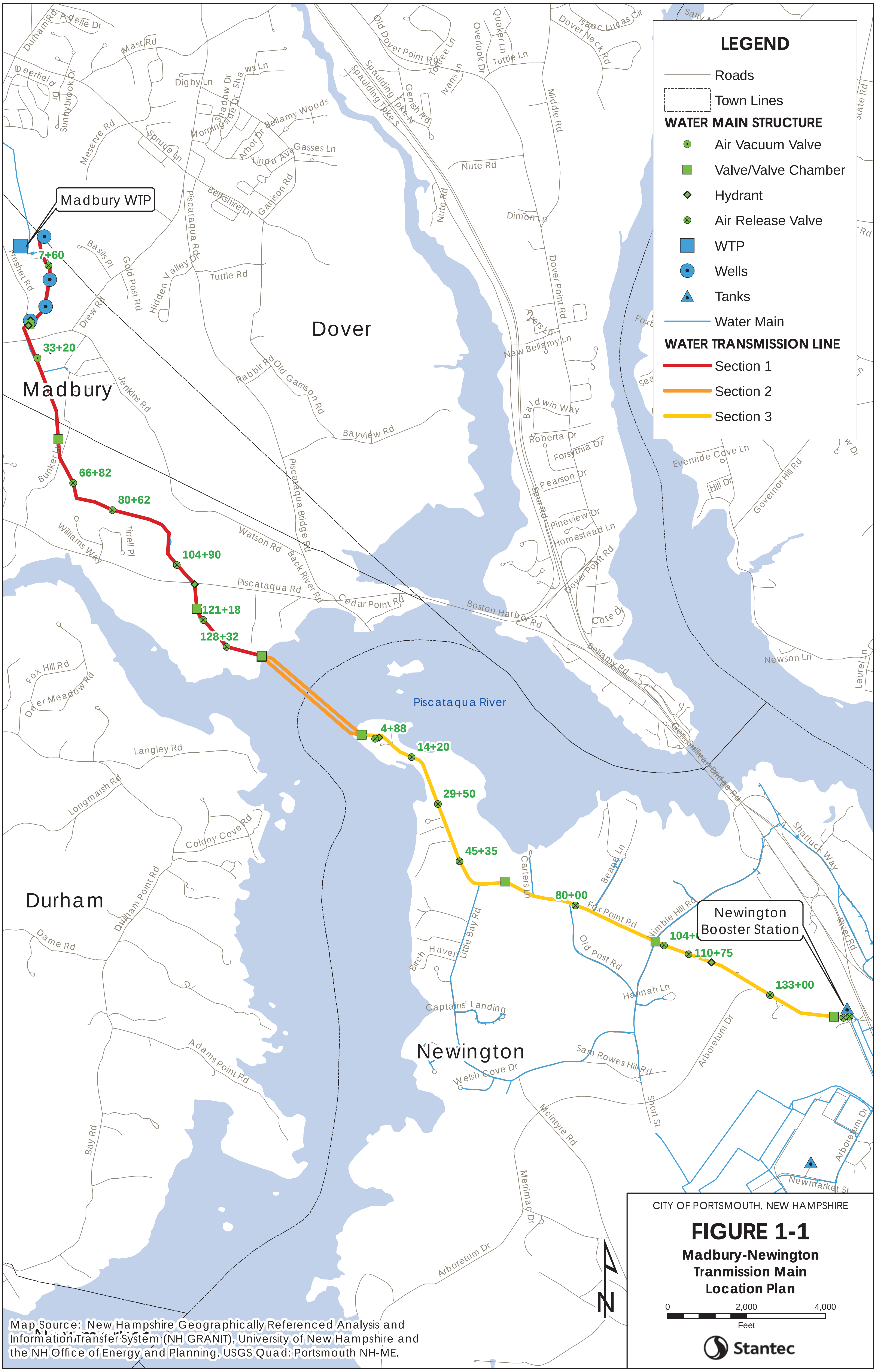
1.1 Background

The Madbury-Newington Transmission Main (MNTM) is a 24-inch diameter, 6-mile pipeline which supplies water from the Madbury Water Treatment Plant to the Newington Booster Pump Station to provide water to the City of Portsmouth, Town of Newington, and Pease Tradeport, formerly Pease Air Force Base. The Corps of Engineers constructed this infrastructure along with four groundwater wells as a water supply source for Pease Air Force Base and the transmission main was placed in service in 1957. This pipeline has provided water supply to these communities for nearly 60 years. On April 13 and 14, 2016 a walkover of the transmission main was conducted by a team of engineers and operators. The walkover was used to document the pipeline route, observe the external facilities of the transmission pipeline, and determine types of rehabilitation needed.

For the purposes of this evaluation, the pipeline route has been separated into three sections. These sections are summarized below and are shown in Figure 1-1.

- Section 1 – Approximately 14,000 feet of 24-inch prestressed concrete cylinder pipe (PCCP) from the Madbury Wells to Little Bay
- Section 2 – Approximately 3,200 feet of cast iron pipe crossing under Little Bay
- Section 3 – Approximately 17,000 feet of 24-inch PCCP from Little Bay to the Newington Water Storage Tank and Booster Pump Station.

Having to rely on the single and aged transmission pipeline, the City of Portsmouth must be able to access and thoroughly inspect the pipeline and its components, and to be able to make the necessary repairs that will ensure the pipeline’s long-term integrity and reliability. In addition to the evaluation of the pipeline condition, a contingency plan should be developed to address the potential loss of the pipeline. The plan should include repairs needed, the procedures for removing the pipeline from service for repairs, providing service to all connections, and the maintenance of adequate flows and pressures to the City of Portsmouth and surrounding communities.



CITY OF PORTSMOUTH, NEW HAMPSHIRE

FIGURE 1-1

Madbury-Newington Tranmission Main Location Plan

Stantec

Map Source: New Hampshire Geographically Referenced Analysis and Information Transfer System (NH GRANIT), University of New Hampshire and the NH Office of Energy and Planning. USGS Quad: Portsmouth NH-ME.

1.2 Description of External Facilities

The various external facilities will be described in detail in later sections of this report. However, since early reference will be made to these facilities, a summary of descriptions of each is provided.

A **Gate Valve Chamber** is a reinforced concrete chamber that has a 30" round access manhole and buried removable concrete roof planks. This hatch provides access into the valve chamber with steel rungs cast into the wall.

An **Air Release/Vacuum Relief Structure** is a brick 4' diameter structure that contains an automatic air release/vacuum relief valve(s). Access to the structure is through a 24" and 30" cast iron frame and cover type access hatch. These structures have one (1), 2" combination air/vacuum valve, or one (1), 2-inch air release valve connection to the PCCP with 2" brass nipple threaded into a coupling on the 24" PCCP and 2" bronze gate valve and 2" bronze nipple connected to the air valve.

Blow-offs (no structure) consists of one gate valve and pipe to allow the MNTM to be drained by gravity or by pumping into an adjacent wetland or stream. Three 6-inch valves are indicated on the record drawings provided to Stantec. None were found or observed operating during the inspection.

A **Culvert** is a reinforced concrete structure or pipe that provides continuity of surface drainage across the pipeline right-of-way. Most culverts cross below the pipeline as depressed pipes (inverted siphons), and some culverts cross over the pipeline. Record Drawings indicate one culvert in Section 1 and five culvert crossings along Section 3.

A **Meter Chamber** is a chamber that contains a flow meter. One type chamber was found. The flow meter is a magnetic insert type flow meter that is contained in a concrete vault on the top of the 24-inch pipeline located across from Well Station No.1. The original meter located in this chamber was a cast iron Venturi Profile meter. When the Venturi meter was replaced with a mag meter, a 24-inch butterfly valve and an additional compartment was added for chemical injection ports. There are three- ¾" injection nozzles in the additional concrete chamber downstream of the flow meter. However, the insertion flow meter is reportedly not measuring the flow accurately or at all at times.

Connections to Community Water Supplies have valves and meters that may be located in chambers along the pipelines that provide water supply from the MNTM to the various communities and individual services. Several connections are made to the MNTM to supply water to a local town distribution network.

2.0 MADBURY – NEWINGTON TRANSMISSION MAIN (MNTM)

The MNTM is a 24-inch pre-stressed concrete cylinder pipe (PCCP) surface pipe, beginning at the Madbury Well Field and a more recent connection to the Madbury Water Treatment Plant, terminating with a connection to the Newington Booster Pump

Station and Water Storage Tank in Newington. The MNTM is comprised of three (3) sections, Madbury to Durham point (24-inch PCCP), Little Bay Crossing (2-20-inch CI pipes) and Fox Point to Newington Pump Station (24-inch PCCP).

Section 1 of the transmission main begins as a 24-inch diameter surface pipe and continues in southeasterly direction to Little Bay where a transition is made from PCCP surface pipe to two 20-inch cast iron sub-aqueous pipes crossing under the bay to Fox Point in Newington. At Fox Point the two 20-inch cast iron pipes go through a horizontal installed double disk gate valve with a 3-inch by-pass gate valve. After the 20-inch mains go through the valve chamber a transition is made to one 24-inch PCCP surface pipe with a special wye fitting. The MNTM continues easterly then northerly and southeasterly along Fox Point Road to the Newington booster pump station and storage tank as a surface conduit. For most of its length, the pipeline is 24-inch in diameter. Record drawings of the MNTM and individual appurtenances including noted observations during walkover are included in Appendix A. Section 1 has two 1-inch domestic services and eight 8-inch connections supplying hydrants and service to a Horse Farm.

Section 2 consists of approximately 3,200 feet of two 20-inch cast iron conduits, separated by about 150 feet beneath Little Bay. The two conduits are connected with a special 24” x 20” x 20” wye fitting on each side of the Bay. The pipeline comes up out of the Bay through two concrete chambers with a 20-inch gate valve in each chamber. The chambers were found full of water and will be pumped out at a later date.

Section 3 which is east of the Bay is a 24–inch PCCP pipeline installed along Fox Point Road for approximately 15,536 feet where it connects to the Newington booster pump station and water storage tank. Section 3 has five connections to 8-inch town water mains and two domestic services.

2.1 Section 1

2.1.1 Sta 0+00, Well Station No. 4 –to Sta 139+32.53 Y Branch west of Little Bay - Horizontal Alignment

Section 1 of the Madbury–Newington Transmission Main (MNTM) starts at the Well Station No. 4 discharge pipe. A connection to the Transmission main, approximately Sta 5+75, was made for the Madbury Water Treatment Plant finished water discharge which now also supplies the Newington booster pump station. During the walkover seven air valves in brick manholes, one mainline gate valve in concrete chamber, and four steel pipe marker pins were found and located with the City’s GPS system.

Section 1 starts along a paved access road through the Madbury Well Field and continues in a south easterly route for about 450 feet to Freshet Road before leaving the right of way into a cross country route. The pipeline continues through a horse farm for about 1400 feet and leaves a grassy field to cross a small brook, then the pipeline runs adjacent to a small water course through heavily wooded and brier overgrowth. Walking over the pipeline became quite difficult and routing was moved left or right where a clear path was found, returning to the pipeline route at air valve chambers and /or gate valve chambers. Not too far into the woods a chamber was discovered. Based on plans, this chamber is a 24” gate valve but the cover could not be opened to verify.

2.1.2 Vertical Alignment

Section 1 follows the local topography and required the installation of seven air valves at the high points along the pipeline.

Diameter: 24-inch

Conduit Materials: Pre-stressed concrete cylinder pipe

Length: 13,933 feet (Station 0+00 to Station 139+43)

Maximum centerline elevation: 80 ft (msl) at Air Valve (Sta 33+20) in horse farm connection

Minimum centerline elevation: 0 ft (msl) at 20-inch gate valve west of Little Bay.

External facilities found in Section 1 include: (Station numbers are approximate based on Record Plans)

Well Stations No. 4, 3, 2 & 1.

- Station 0+00 Well 4
- Station 13+15 Well 3
- Station 18+77 Well 2
- Station 23+60 Well 1

Chambers with 2” Auto Air Release and/or Combination Valves

- Station 7+60 - 2” Air Release Valve (ARV)
- Station 33+20 - 2” Comb. Air/Vacuum Valve
- Station 66+82 - 2” Air Release Valve (ARV)
- Station 80+62 - 2” Air Release Valve (ARV)
- Station 104+90 - 2” Air Release Valve (ARV)
- Station 121+18 - 2” Air Release Valve (ARV)
- *Station 128+32 - 2” ARV

Figure 2-1: Begin MNTM looking at FW PS

Figure 2-2: MNTM installed on left side of paved road

Figure 2-3: Air valve #7 and Brick MH

Figure 2-4: 1” service near Well Station #3

Figure 2-5: MNTM on right side of roadway

Figure 2-6: Well Station #3

Figure 2-7: Well Station #2

Figure 2-8: Paved Roadway #2, MNTM on right side EOP

Figure 2-9: Paved Roadway looking toward Well Station #1

Figure 2-10: Well Station #1

Figure 2-11: Access Gate to Freshet Road near Well Station #1

Figure 2-12: Meter & Chemical Injection Chambers at Well Station #1

Figure 2-13: McCrometer Model 395L Full Profile Insert (FPI) Flow Meter & BFV near Well #1

Figure 2-14: 3 chemical injection nozzles at Well #1

Figure 2-15: Looking up access road toward Well #2

Figure 2-16: Looking at Well #1 and access gate from Freshet road

Figure 2-17: 2-inch Air/Vacuum Valve in Horse farm

Figure 2-18: Pipe marker assumed to be at 8-inch pipe and service connection in Horse farm property

Gate Valve and Chamber

- Station 55+00

Figure 2-19: Heavy CI cover on GV chamber (no access)

Figure 2-20: Overgrowth over GV chamber

04/13/2016 09:56

Figure 2-21: Sta 40+00 Start of Overgrown Wooded and wet route adjacent to pipeline.

04/13/2016 09:58

Figure 2-22: Cart Path adjacent to pipeline easement

Connections to Community and Residential services

- 1 - 1” service near Well #3
- 1 - 1” service Freshet Road
- 1 - 8” pipe connections to 24”
- 1 - Hydrant and horse farm house
- 1 - Hydrant at Route 4

Figure 2-23: Cart Path near pipeline near Sta 50+00

Figure 2-24: Sta 37+00 Looking up open field toward Horse Farm

Figure 2-25: Access near pipeline near Sta 43+00

Figure 2-26: Access near pipeline near Sta 43+00

Figure 2-27: Walkover Route, adjacent to pipeline

Figure 2-28: 24” PCCP pipe found in woods

Figure 2-29: Wooded & overgrown over pipeline

Figure 2-30: Pipe marker found along route

Figure 2-31: Walkover route near pipeline

Figure 2-32: AV #8 chamber and vent pipe

Figure 2-33: Sta 66+82 ARV #8 in Brick manhole

Figure 2-34: Walkover Route along pipeline

Figure 2-35: Numbered Pipe Markers found at various locations

Figure 2-36: Walkover route thru Logging area

Figure 2-37: Sta 80+62 ARV#9 wet and wooded area. No clear path over the pipeline

Figure 2-38: ARV#9 Brick manhole flooded

Figure 2-39: Route through abandoned logging area

Figure 2-40: Route under man made pond

Figure 2-41: Sta 91+00 Route thru water and clear-cut woods

Figure 2-42: Water over Pipe route Emery Farm

Figure 2-43: Sta 104+90 AV #10

Figure 2-44: AV #10 Brick MH full of water

Figure 2-45: Looking across field toward AV #10 Emery Farm

Figure 2-46: Looking across wetland from Route 4

Figure 2-47: Looking easterly across Route 4 & hyd conn.

Figure 2-48: Route thru field at Wagon Hill Farm

Figure 2-49: Sta 118+50 farm house water service

Figure 2-50: Sta 121+18 AV # 11 east of Farm Road

Figure 2-51: Grassy field route between AV #11 & AV #12

Figure 2-52: Wagon Hill Farm

Figure 2-53: Grassy field route between AV #11 & AV #12

Figure 2-54: Grassy field route between AV #11 & AV #12

Figure 2-55: Sta 128+32   AV #12

Figure 2-56: Flooded Chamber and Broken Vent Pipe

Figure 2-57: Grassy Filed along pipeline route to Little Bay

Figure 2-58: Looking east toward Little Bay crossing

Figure 2-59: Looking westerly along route thru gassy and wet field.

Figure 2-60: Looking easterly toward Little Bay Crossing

Figure 2-61: Sta 139+17 +/- Two 20-inch CI Gate Valves in Reinforced concrete chambers

Figure 2-62: Sta 139+17 +/- Two 20-inch CI Gate Valves in Reinforced concrete chambers

Figure 2-63: North Gate Valve chamber full of water

Figure 2-64: South Gate Valve chamber partially full of water


04/13/2016 12:47

Figure 2-65: Little Bay Crossing looking east


04/13/2016 12:59

Figure 2-66: Looking from Durham across Little Bay


04/13/2016 12:55

Figure 2-67: 20-inch GV under water in concrete chamber

Figure 2-68: Pipeline Crossing sign on shore of Bay

2.2 Section 2

2.2.1 *Horizontal Alignment*

Section 2 of the MNTM, the crossing of Little Bay, is approximately 3,200 lf in length. Two 20 –inch mains cross under the Bay and reconnect at Fox Point into a 24-inch pipeline.

2.2.2 *Vertical Alignment*

The transition from surface PCCP conduit to cast iron subaqueous pipe starts on the Durham side of the bay where two 20” gate valves are located; centerline elevation is about 14 feet msl. The low point of the profile indicated on the Record Drawings is -40 feet, a difference of about 55 feet. The two 20-inch pipelines emerge from the Bay and run through two gate valves in concrete chambers. There is a surge relief valve in a chamber on the 24-inch PCCP at Fox Point.

Diameter: Two (2) 20-inch

Conduit Materials: Cast Iron, per Record plans

Length: 3,200 feet (Station 0+00 to Station 32+00)

Maximum centerline elevation: 14.0 ft. at west and east side of Bay valve chambers

Minimum centerline elevation: -40.0 ft. at mid- point of Bay crossing

External facilities found in Section 2 include:

Connections to MNTM

- Bifurcation on each side of the Bay (4-20” Valves) in four concrete chambers

Figure 2-69: Little Bay Crossing

Figure 2-70: Little Bay Crossing

2.3 Section 3

2.3.1 Horizontal Alignment

Section 3 begins at Fox Point in Newington and ends at the Newington Booster Pump Station. At its connection to the bay crossing the MNTM increases in size from twin 20-inch mains back to 24-inch PCCP and follows Fox Point Road to the Newington Pump station. At Fox Point there are two flooded concrete chambers with 20-inch gate valves, a 4-inch surge relief valve in a brick chamber, and two 2-inch ARV #13 and ARV #14. The chambers were flooded and were pumped out to make a visual inspection of the facility. As the pipeline continues along Fox Point Road through the conservation land, the roadway has a gravel surface. When the roadway leaves the conservation area it becomes a paved roadway for the remainder of Fox Point Road. There were nine ARVs in brick chambers, one check valve chamber and two 24-inch gate valves in concrete chambers along this section.

2.3.2 Vertical Alignment

Section 3 begins at Fox Point where the pipe comes up out of the bay at elevation 10 msl, rises to elevation 45 at AV#15, elevation 70 at AV#17, and high point at elevation 95 at AV#21.

Section 3 Facts:

Diameter: 24-inch

Conduit Materials: Pre-cast concrete cylinder pipe

Length: approx. 17,067 feet (Station 1+07 to Station 156+43)

Maximum centerline elevation: 95.0 ft at Station 156+43

Minimum centerline elevation: 14.0 ft at Station 1+07

External facilities found in Section 3 include:

Surge Relief Valve & Chamber

- Station 1+17

4-inch surge relief was found just after the gate structures on Fox Point. The valve was in a brick manhole approximately 8 feet deep. The manhole was full of water and had to be pumped out.

Gate Valves Structures

- Station 1+00 20-inch gate valve in concrete chamber
- Station 1+00 20-inch gate valve in concrete chamber
- Station 60+00 8-inch Check Valve in chamber w/ by-pass
- Station 101+90 24-inch gate valve in concrete chamber
- Station 156+20 24-inch gate valve in concrete chamber

Figure 2-71

- Station 101+90 24-inch gate valve at Nimble Hill Rd.

Air Release Valve & Chamber

- Station 4+88 (#13)
- Station 14+20 (#14)
- Station 29+50 (#15)
- Station 45+95,

Figure 2-72: 2" Air Release Valve, chamber and vent, #21 near Newington BPS

Figure 2-73: Air Release Valve near Newington Town Hall on Fox Point Rd.

Figure 2-74: Looking toward Fox Point on Fox Point Rd. from AV #18

Figure 2-75: 24" GV chamber at Nimble Hill Road and Fox Point Rd.

Figure 2-76: 24" Gate Valve in concrete chamber at Nimble Hill Rd and Fox Point Rd.

Figure 2-77: 24" Gate Valve in concrete chamber at Nimble Hill Rd and Fox Point Rd.

Figure 2-78: Looking south on Fox Point Rd. along MNTM

Figure 2-79: Existing ARV #18

<u>Connections to Community Water Pipelines</u>

- Station 32+50 8-inch Mott Cove
- Station 60+00 8-inch connection to Little Bay Road and Carter Lane
- Station 79+00 8-inch Old Post Road
- Station 85+00 8-inch Beane Lane
- Station 102+00 8-inch Nimble Hill Road

Figure 2-80: MNTM route along Fox Point Rd.

Figure 2-81: MNTM route along Fox Point Rd.

Figure 2-82: Fox Point Road and Old Post Road intersection and community connection

Figure 2-83: Air Release valve # 19

Figure 2-84: MNTM in Bike Path

Figure 2-85: Air Release Valve #20

Figure 2-86: Air Release valve #20

Figure 2-87: Air Release Valve #20

Figure 2-88: MNTM route in Fox Point Rd original alignment

Figure 2-89: Air Release Valve #21

Figure 2-90: 24" Gate Valve at NBPS inlet

Figure 2-91: NBPS Tank Altitude Valve chamber

Figure 2-92: 24" GV chamber access cover

Figure 2-93: Storage Tank and altitude valve chamber

Figure 2-94: Altitude Valve Chamber at NBPS storage tank

2.4 Summary

On April 13 and 14, 2016 Stantec personnel completed a walkover of the MNTM pipeline. This inspection served to obtain an understanding of the location of all structures along the alignment and to make observations of the condition of these structures. Table 2-1 summarizes the structures along the pipeline.

Table 2-1 Summary List of Structures/Facilities by MNTM Section

	Transmission Main Section No.			
Structure/Facility Type	**1**	**2**	**3**	**TOTAL**
Culverts	2	0	8	10
Gate Valve Chambers	3	0	4	7
Surge Relief Valve	1	0	1	2
Auto Air Release/Vacuum Relief Chambers	7	0	9	16
Blow-Off Valves	1	0	2	3
Connections to Community Water Supply	5	0	5	10
Chemical feed Connections	3	0	0	3
Meters	1	0	0	1
TOTAL	23	0	29	52

2.4.1 Section 1

The surface features varied along the MNTM route. In Section 1, at the start of the main the pipeline is located along the left edge of the well field access road from Well #4 to Well #1 and then along Freshet Road after leaving the water department property. After being installed along Freshet road the pipeline starts to go cross country. The initial part of this cross country route is through an active horse farm. Access is limited due to horse corrals over the pipe. Beyond the horse corral area, the pipe heads through a sloping grass field and then proceeds through dense wooded area, crossing some streams and areas of high ground water. Access through the wooded section is quite restricted and inaccessible with most vehicles other than an all-terrain vehicle. The route in this area is marked only by the location of valve chambers and numbered pipe markers.

A gate valve chamber was located at Sta 55+00 but could not be opened. The location was completely overgrown with brier and trees. The route emerges from the woods beyond AV #9 and travels through some private property where the owner has constructed a pond over the pipeline. Leading back into some woods the pipeline enters Emery Farm land and goes under another pond to AV#10. After AV#10 the pipeline continues under a greenhouse and under some wetlands before crossing SR 4 and into the Wagon Hill Farm property. The pipeline route through Wagon Hill Farm property was over grassy fields where some depressions were noticed until reaching the Little Bay crossing where two concrete gate valve chambers are located.

The route of the pipeline from Freshet Road to State Route 4 has limited or no vehicle access and is not marked. Several points along the walkover the team had to wander away from the pipeline easement to continue the walkover on foot.

Sixteen air valve chambers were opened and inspected and found at least eight valves had been replaced since the original construction. The air valves were located in brick manholes as detailed on the record plans. These brick manholes were in fair to good condition. Vent pipes were generally in good condition except for about eight that were broken, leaning, on the ground or had screens missing. Three air valve chambers were found full of water, which is a potential contamination issue. These flooded conditions may be caused by high ground water condition or a leaking pipe connection to the air valve. The pipe at these air valves had between 4'-5' of cover.

One meter chamber was inspected along the pipeline. The original venturi type meter has been replaced with a full profile magnetic insert meter, McCrometer Model 395L. This meter was reported to be not measuring or displaying the flow accurately. Downstream of the meter is a 24-inch butterfly valve. The valve chamber has two compartments to it. Downstream of the butterfly valve there are three (3) chemical injection nozzles. The concrete chamber has two aluminum sidewalk hatches and is in good condition.

Inspection of the various facilities along the transmission main confirmed the construction of the appurtenances and structures were as detailed on the Record Plans provided. The large gate valves reviewed were cast iron with lead caulked joints installed in cast in place concrete chambers. The concrete condition of the chambers appeared to be in fair to good condition.

2.4.2 Section 2

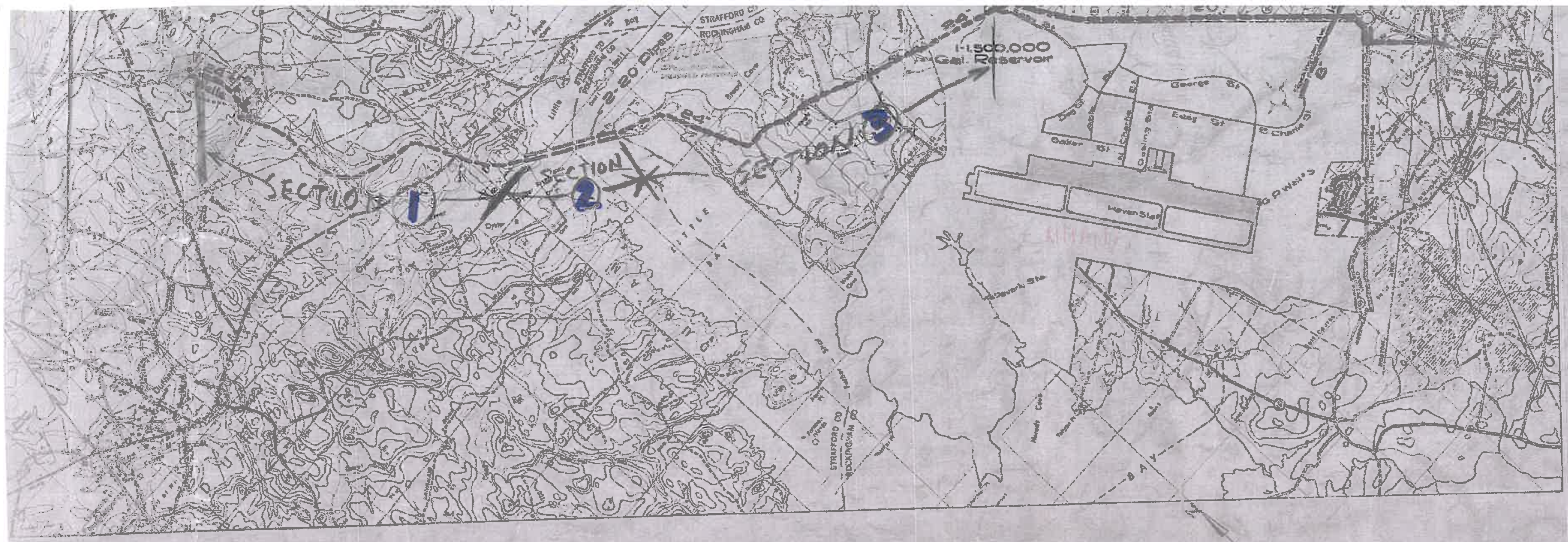
Section 2 of the transmission main bifurcates into two 20-inch cast iron subaqueous pipelines and crossing under Little Bay for about 3,200 feet. The two 20-inch mains have gate valves before and after the pipes cross under the bay.

2.4.3 Section 3

Section 3 begins after the pipeline comes up out of the bay. The pipeline continues across Fox Point, through some community center property and along Fox Point Road to the Newington BPS. Access to the pipeline in Section 3 is good. The pipeline was installed along the edge of the paved roadway for almost the entire length. Other than most of the air valves, which have been replaced in the past, the facilities are of the original 1957 construction. The two 24-inch gate valves found along this section are original and appear to have not been operated for some time. If they had any coatings on the exposed metal bodies, they appeared to have worn off completely.

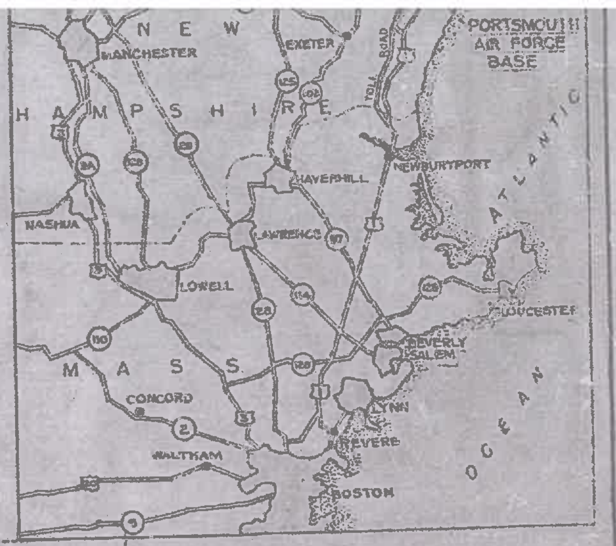
While connections have been made along the pipeline since it was originally installed, Appendix B includes procedures for removal of concrete pipe sections and various pipe connections. This is included as a reference.

Appendix A
Transmission Main Record Plans with Field Comments



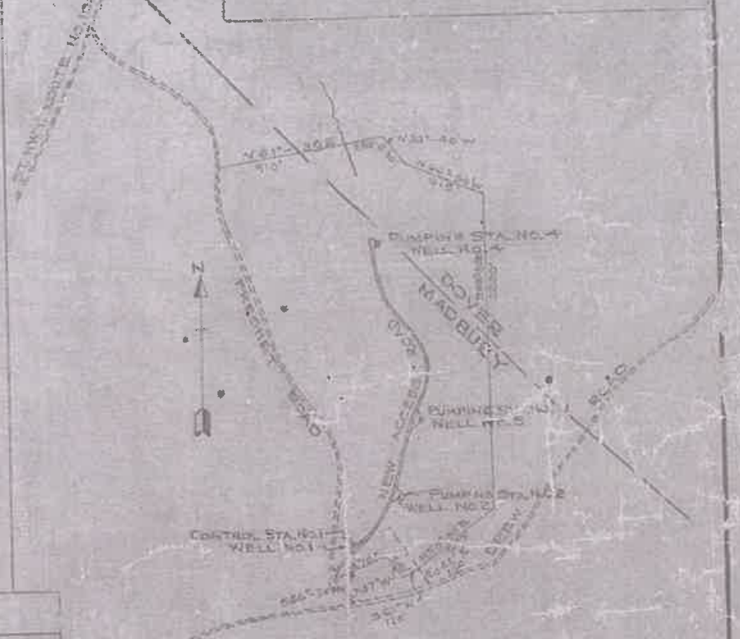
PLAN OF WATER SUPPLY SYSTEM

SCALE: 1 INCH=2000 FEET



LOCATION MAP

SCALE 1 IN=7 MI.



WELL FIELD LOCATION

SCALE 1 IN.=500 FT.

INDEX TO DRAWINGS

SHEET NUMBER	DRAWING NUMBER	DESCRIPTION
[illegible]	71-05-04	GENERAL SITE PLAN & INDEX
[illegible]	71-05-04	WATER MAIN-MADBURY TO DURHAM PT.-PLAN & PROFILE STA. 2+00 TO 54+37
[illegible]	71-05-04	WATER MAIN-MADBURY TO DURHAM PT.-PLAN & PROFILE STA. 54+37 TO 97+45
[illegible]	71-05-04	WATER MAIN-MADBURY TO DURHAM PT.-PLAN & PROFILE STA. 97+45 TO 103+75
[illegible]	71-05-04	WATER MAIN-MADBURY TO DURHAM PT.-PLAN & PROFILE STA. 103+75 TO 128+52
[illegible]	71-05-04	WATER MAIN-DURHAM PT. TO FOX PT.-LITTLE BAY CROSSING-PLAN & PROFILE
6 of 36	71-05-04	WATER MAIN-FOX PT. TO BOOSTER STA.-PLAN & PROFILE-STA. 0+00 TO 25+00
7 of 36	71-05-04	WATER MAIN-FOX PT. TO BOOSTER STA.-PLAN & PROFILE-STA. 25+00 TO 58+00
8 of 36	71-05-04	WATER MAIN-FOX PT. TO BOOSTER STA.-PLAN & PROFILE-STA. 58+00 TO 93+00
9 of 36	71-05-04	WATER MAIN-FOX PT. TO BOOSTER STA.-PLAN & PROFILE-STA. 93+00 TO 126+00
[illegible]	71-05-04	WATER MAIN-FOX PT. TO BOOSTER STA.-PLAN & PROFILE-STA. 126+00 TO 156+00
[illegible]	71-05-04	WATER MAIN {FOX PT. TO BOOSTER STA.-PLAN & PROFILE-STA. 0+00 TO 4+82 BOOSTER STA. TO PORTSMOUTH-PLAN & PROFILE-STA. 4+82 TO 38+00
[illegible]	71-05-04	WATER MAIN-BOOSTER STA. TO PORTSMOUTH-PLAN & PROFILE-STA. 38+00 TO 71+00
[illegible]	71-05-04	WATER MAIN-BOOSTER STA. TO PORTSMOUTH-PLAN & PROFILE-STA. 71+00 TO 104+00
[illegible]	71-05-04	WATER MAIN-BOOSTER STA. TO PORTSMOUTH-PLAN & PROFILE-STA. 104+00 TO 119+00
[illegible]	71-05-04	WATER MAIN-BOOSTER STA. TO PORTSMOUTH-PLAN & PROFILE-STA. 120+00 TO 165+24
[illegible]	71-05-04	WATER MAIN-CONNECTIONS AT ROCKINGHAM AVENUE
[illegible]	71-05-04	MADBURY WELL AREA-ACCESS ROAD-PLAN & PROFILE-STA. 0+50 TO 13+00
19 of 36	71-05-04	MADBURY WELL AREA-ACCESS ROAD-PLAN & PROFILE-STA. 13+00 TO 24+88
20 of 36	71-05-04	MADBURY WELL AREA-GRADING AT ALL PUMPING STATIONS
21 of 36	71-05-04	MADBURY WELL AREA-WELL DETAILS
22 of 36	71-05-04	MADBURY WELL AREA-PLAN, ELEVATIONS & DETAILS-STATIONS NO'S 2, 3 & 4
23 of 36	71-05-04	MADBURY WELL AREA {ELECTRICAL DISTRIBUTION PLAN-ALL STATIONS ELECTRICAL DETAILS-STATIONS NO'S 2, 3 & 4
24 of 36	71-05-04	MADBURY WELL AREA-CONTROL STATION NO.1-ARCHITECTURAL DETAILS
25 of 36	71-05-04	MADBURY WELL AREA-CONTROL STATION NO.1-STRUCTURAL DETAILS
26 of 36	71-05-04	MADBURY WELL AREA-CONTROL STATION NO.1 HEATING, PLUMBING & ELEC. DETAILS
27 of 36	71-05-04	MADBURY WELL AREA-WATER SERVICES
28 of 36	71-05-04	BOOSTER PUMPING STATION-STORAGE TANK LOCATION-SITE PLAN
29 of 36	71-05-04	BOOSTER PUMPING STATION-ARCHITECTURAL ELEVATIONS & DETAILS
30 of 36	71-05-04	BOOSTER PUMPING STATION-STRUCTURAL DETAILS
31 of 36	71-05-04	BOOSTER PUMPING STATION-PIPING AND DETAILS
32 of 36	71-05-04	BOOSTER PUMPING STATION-PLUMBING AND HEATING DETAILS
33 of 36	71-05-04	BOOSTER PUMPING STATION-ELECTRICAL DETAILS
34 of 36	71-05-04	STORAGE TANK AND VALVE CHAMBER DETAILS
35 of 36	71-05-04	METER PITS AND VALVE MANHOLE DETAILS
36 of 36	71-05-04	HEADWALL & CULVERT DETAILS & HYDROSTATIC THRUST BLOCKS

Record Drawing
Contract No. DA-19-016-ENG- 3024

①

REVISION	DATE	DESCRIPTION	BY

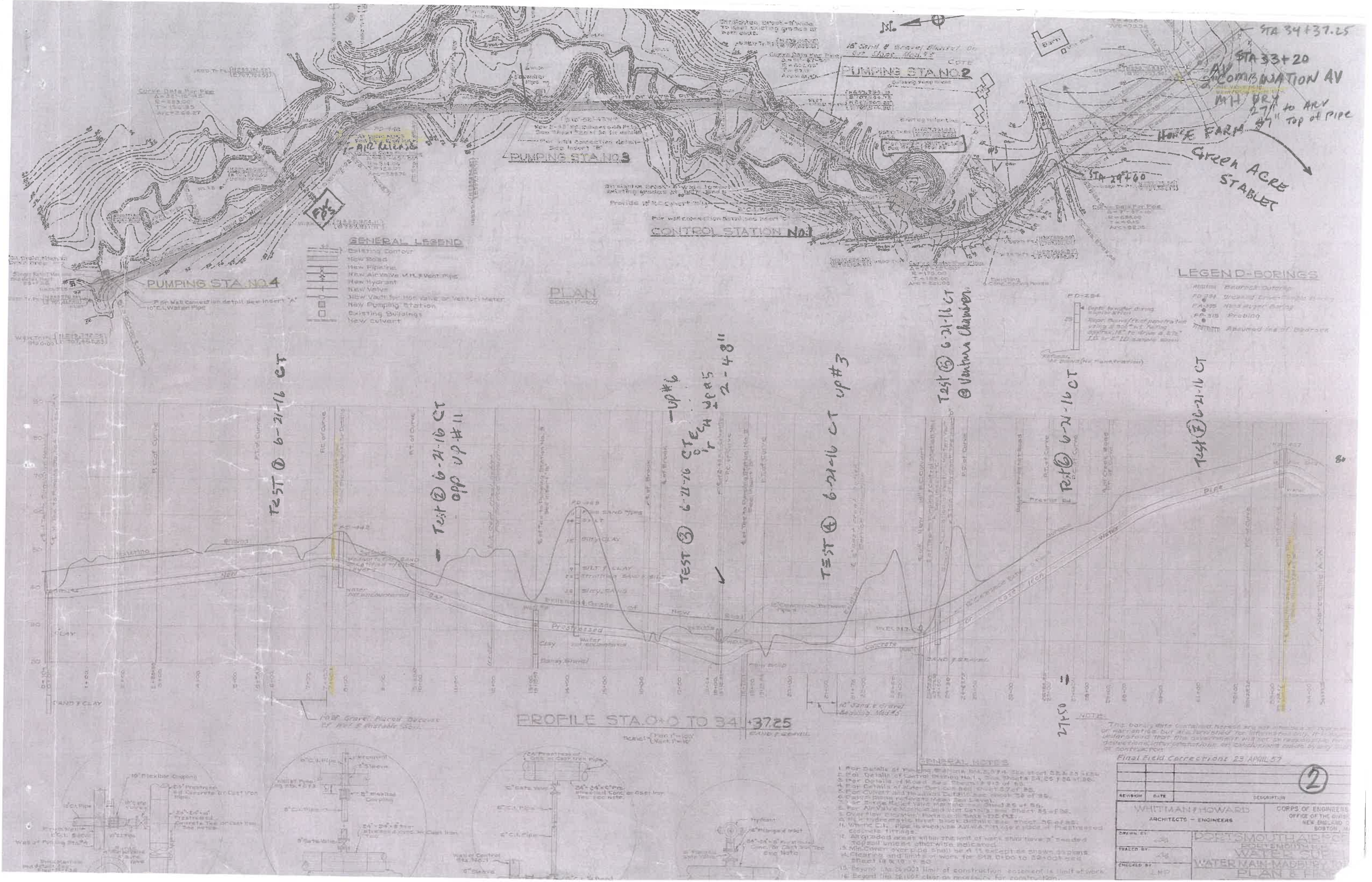
WHITMAN & HOWARD
ARCHITECTS - ENGINEERS

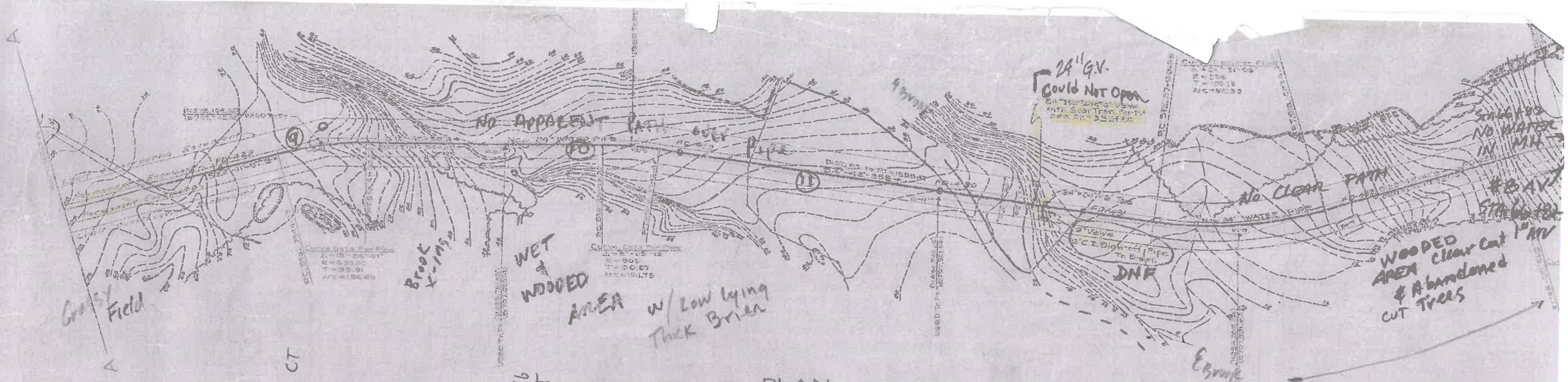
CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DRAWN BY
TRACED BY
CHECKED BY
SUBMITTED E. H. Howard
APPROVED
APPROVED

PORTSMOUTH AIR FORCE BASE
PORTSMOUTH, N.H.
WATER SUPPLY
GENERAL SITE PLAN
AND INDEX

DATE


PUMPING STA. NO. 4
PUMPING STA. NO. 3
PUMPING STA. NO. 2
CONTROL STATION No. 1
1-AIR RELEASE
GENERAL LEGEND
Existing Contour
New Road
New Pipeline
New Air Valve M.H. & Vent Pipe
New Hydrant
New Valve
New Vault for Hor. Valve or Venturi Meter
New Pumping Station
Existing Buildings
New Culvert
PLAN
Scale 1"=100'
LEGEND-BORINGS
STA 34+37.25
STA 33+20
AV
2" COMBINATION AV
MH DRY
27" to ARV
47" Top of Pipe
HORSE FARM
Green ACRE STABLET
STA 29+60
TEST ① 6-21-16 CT
TEST ② 6-21-16 CT
opp up # 11
TEST ③ 6-21-16 CT
up #6
up #5
2-48"
TEST ④ 6-21-16 CT
up #3
Test ⑤ 6-21-16 CT
@ Venturi Chamber
Test ⑥ 6-21-16 CT
Test ⑦ 6-21-16 CT
27+50
Ground
New
Prestressed
Concrete
Water
Pipe
CLAY
SAND & CLAY
PROFILE STA. 0+0 TO 34+37.25
GENERAL NOTES
NOTE:
Final Field Corrections 23 APRIL 57
②
REVISION
DATE
DESCRIPTION
WHITMAN & HOWARD
ARCHITECTS — ENGINEERS
CORPS OF ENGINEERS
OFFICE OF THE DIVIS
NEW ENGLAND
BOSTON, M
DRAWN BY
TRACED BY
CHECKED BY
LHP
PORTSMOUTH AIR FO
PORTSMOUTH
WATER SUPP
WATER MAIN-MADBURY
PLAN & P

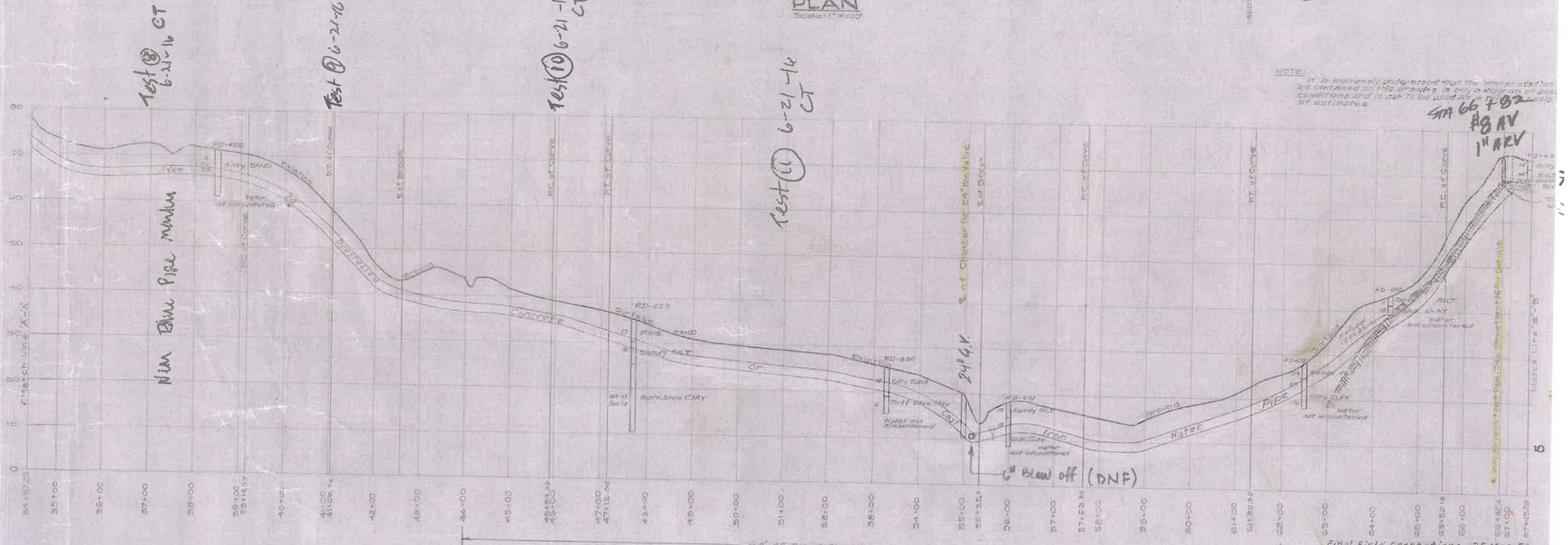


PLAN

Scale: 1"=100'

NOTE:

It is expressly understood that the interpretation as contained on this drawing is only a diagram of poss conditions and is not to be used as a basis of estimates.



PROFILE STA. 34+37.25 TO 67+43.26

Scale: {Hor. 1"=100' / Vert. 1"=10'}

NOTE:

The boring data contained herein are not intended as representations or warranties but are furnished for information only. It is expressly understood that the government will not be responsible for any deductions, interpretations or conclusions made by any bidder or contractor.

GENERAL NOTES

1. Datum Plane refers to Mean Sea Level.
2. For Details of Air valve and Vent Pipe see sheet 35 of 56.
3. Overflow Elevation - Portsmouth Tanks 176.11±
4. For Legend for Borings see sheet 2 of 56.
5. For Hydrostatic thrust block details see sheet 33 of 56.
6. Min. Cover over pipe shall be 4 ft. except as noted.
7. Limit of construction easement is limit of work.
8. Clear as necessary for construction.

Final Field Corrections 25 Mar. 57

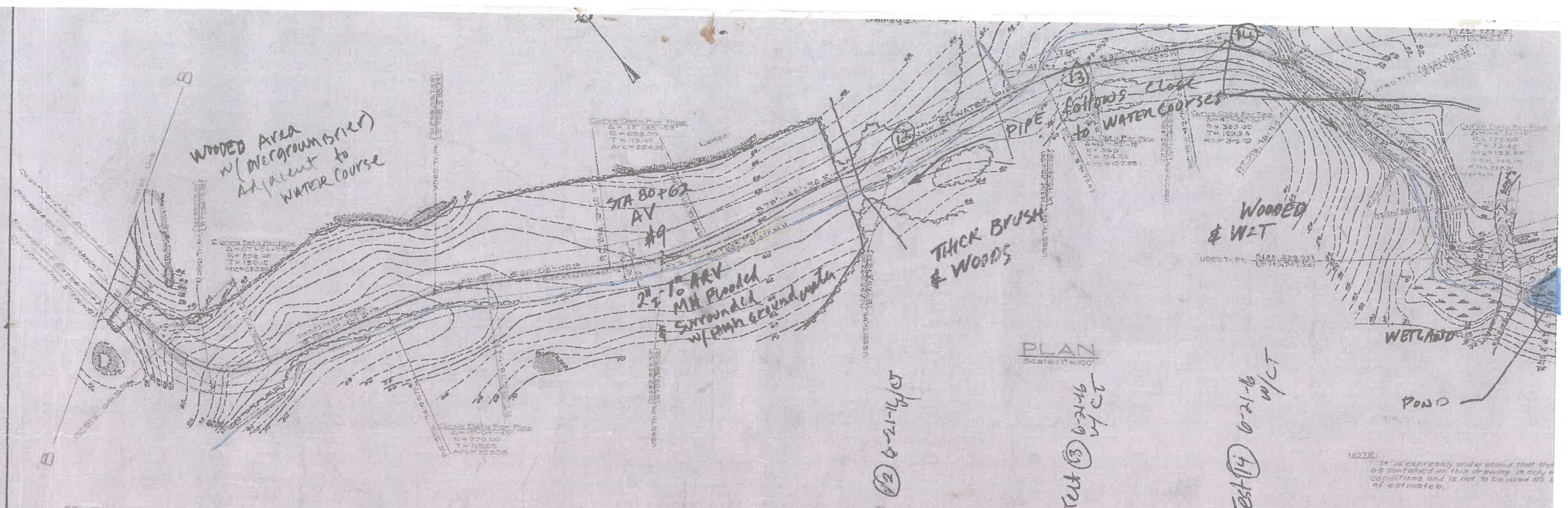
REVISION	DATE	DESCRIPTION
		③

WHITMAN / HOWARD
ARCHITECTS — ENGINEERS

CORPS
OFFI

DRAWN BY: J.K.
TRACED BY: J.K.
CHECKED BY: LMF

PORTSMOUTH
PORTSMOUTH
WATER
WATER MAIN-MADE

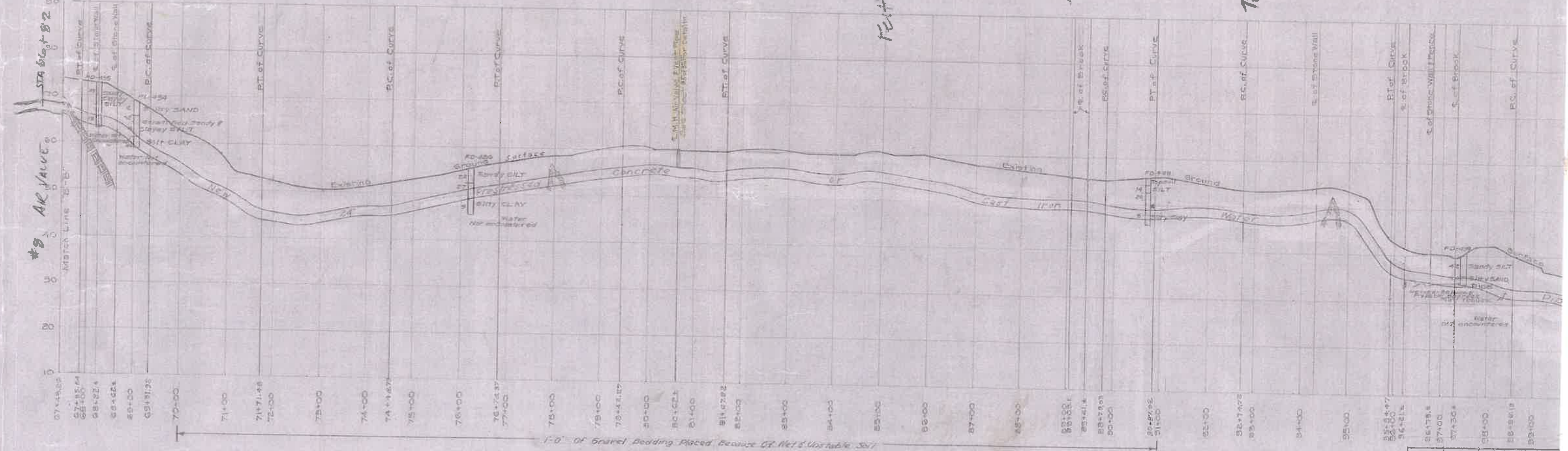


PLAN

Scale 1"=100'

NOTE:

It is expressly understood that the ... as contained on this drawing is only ... conditions and is not to be used as ... of estimates.



1'-0" Of Gravel Bedding Placed Because Of Wet & Unstable Soil

PROFILE STA. 67+43.26 TO 103+76.31

Scale: Hor. 1"=100' / Vert. 1"=10'

NOTE:

The boring data contained herein are not intended as representations or warranties but are furnished for information only. It is expressly understood that the government will not be responsible for any deductions, interpretations or conclusions made by any bidder.

GENERAL NOTES

1. Datum plane refers to Mean Sea Level.
2. For Details of Air Valve and unit Pipe see sheet 35 of 36.
3. Overflow Elevation - Portsmouth Tanks 172 ft.±
4. For Legend for Borings see sheet 2 of 36
5. For Hydrostatic thrust block details see sheet 36 of 36.

6. Min. Cover over pipe shall be 4 ft. except as shown on plan.
7. Limit of Construction Easement is Limit of Work.
8. Clear as necessary for construction.

		Final Field C
		4
REVISION	DATE	

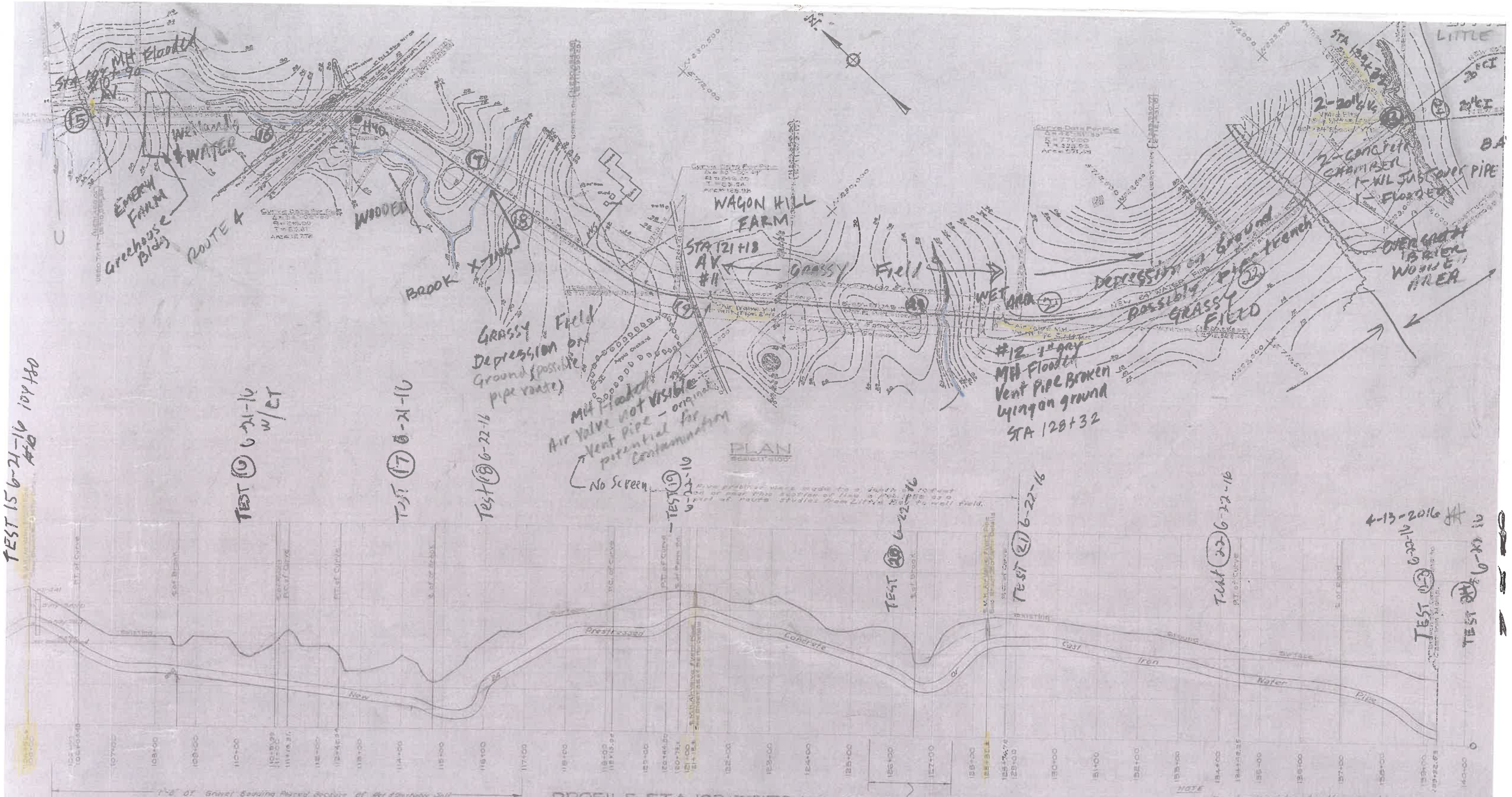
WHITMAN & HOWAR

ARCHITECTS — ENGINEERS

DRAWN BY

TRACED BY

PORTS



PLAN
Scale 1"=100'

PROFILE STA. 103+76.31 TO 139+32.53
Scale:- Hor. 1"=100' Vert. 1"=10'

NOTE
The subsurface data contained herein are not intended as representations or warranties but are furnished for information only. It is expressly understood that the government will not be responsible for any deductions, interpretations or conclusions made by any bidder or contractor.

Final Field Corrections 25 Mar. 57

GENERAL NOTES
1. Datum plane refers to Mean Sea Level.
2. For Bay Crossing Valve Pit Details see sheet 35 of 86.
3. For Details of Air Valve and Vent Pipe see sheet 35 of 86.
4. Overflow Elevation - Portsmouth Tanks 172.4±
5. For Legend for Borings see sheet 2 of 86.
6. For Hydrostatic Thrust Block details see sheet 36 of 86.
7. If Cast Iron Pipe is used, use AWWA fittings in place of prestressed concrete fittings.

8. Min Cover over pipe shall be 4 ft except as shown on plan.
9. Limit of Construction Easement is Limit of Work.
10. Clear as necessary for construction.

REVISION	DATE	DESCRIPTION

5

WHITMAN & HOWARD
ARCHITECTS – ENGINEERS

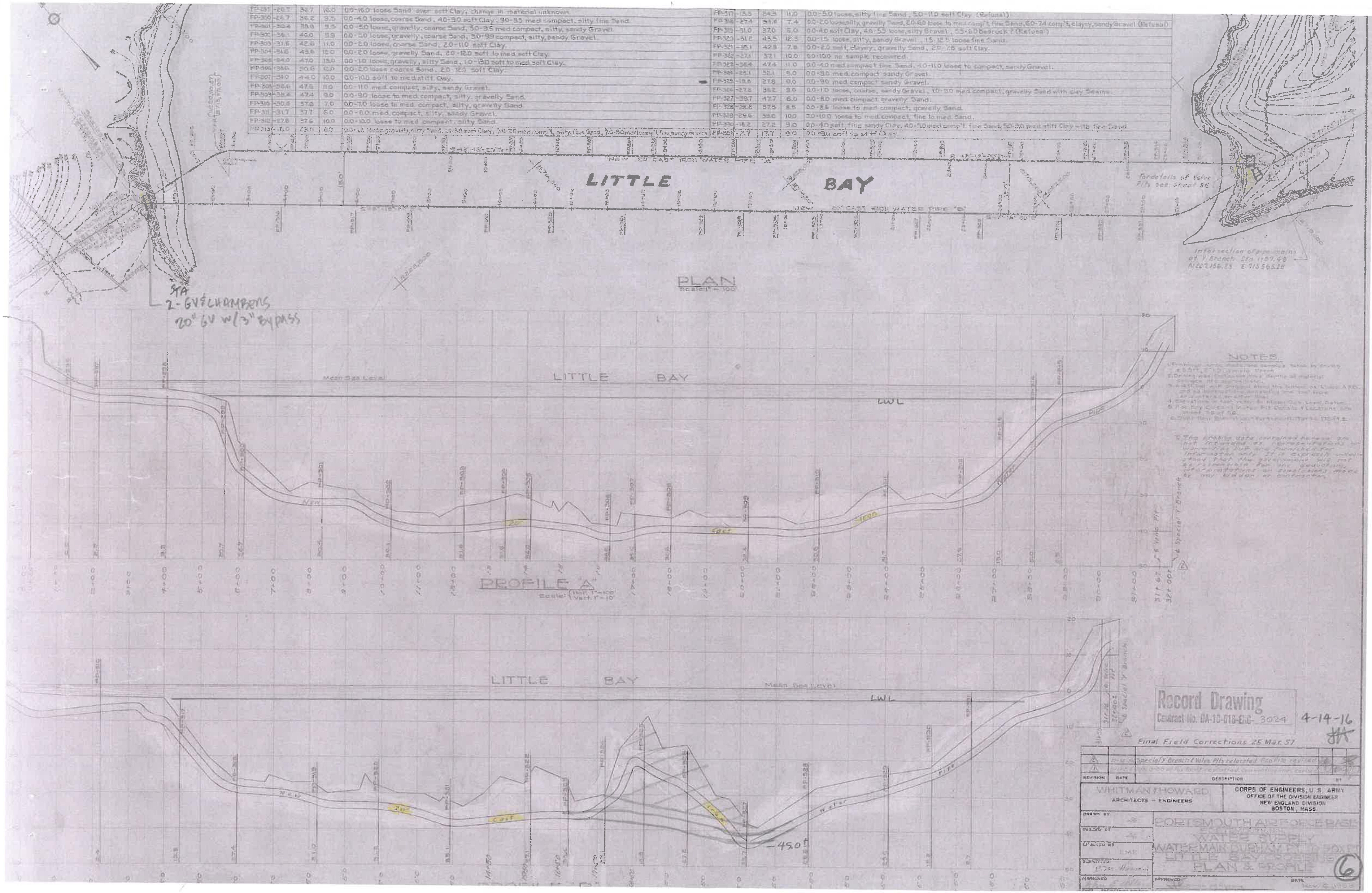
CORPS OF ENGINEERS, U
OFFICE OF THE DIVISION EN
NEW ENGLAND DIVISI
BOSTON, MASS.

DRAWN BY
TRACED BY
CHECKED BY
SUBMITTED

PORTSMOUTH AIR FORCE
WATER SUPPLY
WATER MAIN-MADBURY TO DU
PLAN & PROFILE

FP-299	-20.7	36.7	16.0	0.0-16.0 loose Sand over soft Clay, change in material unknown.
FP-300	-26.7	36.2	9.5	0.0-4.0 loose, coarse Sand, 4.0-9.0 soft Clay, 9.0-9.5 med compact, silty fine Sand.
FP-301	-30.4	39.9	9.5	0.0-5.0 loose, gravelly, coarse Sand, 5.0-9.5 med compact, silty, sandy Gravel.
FP-302	-36.1	46.0	9.9	0.0-5.0 loose, gravelly, coarse Sand, 5.0-9.9 compact, silty, sandy Gravel.
FP-303	-31.6	42.6	11.0	0.0-2.0 loose, coarse Sand, 2.0-11.0 soft Clay.
FP-304	-31.6	43.6	12.0	0.0-2.0 loose, gravelly Sand, 2.0-12.0 soft to med soft Clay.
FP-305	-34.0	47.0	13.0	0.0-1.0 loose, gravelly, silty Sand, 1.0-13.0 soft to med soft Clay.
FP-306	-38.6	50.6	12.0	0.0-2.0 loose coarse Sand, 2.0-12.0 soft Clay.
FP-307	-34.0	44.0	10.0	0.0-10.0 soft to med stiff Clay.
FP-308	-36.6	47.6	11.0	0.0-11.0 med compact, silty, sandy Gravel.
FP-309	-38.4	47.4	9.0	0.0-9.0 loose to med compact, silty, gravelly Sand.
FP-310	-50.6	57.6	7.0	0.0-7.0 loose to med compact, silty, gravelly Sand.
FP-311	-31.7	37.7	6.0	0.0-6.0 med compact, silty, sandy Gravel.
FP-312	-27.6	37.6	10.0	0.0-10.0 loose to med compact, silty Sand.
FP-313	-10.0	23.0	8.0	0.0-1.0 loose, gravelly, silty Sand, 1.0-3.0 soft Clay, 3.0-7.0 med comp't, silty fine Sand, 7.0-8.0 med comp't fine sandy Gravel

FP-317	-13.5	24.3	11.0	0.0-5.0 loose, silty fine Sand, 5.0-11.0 soft Clay (Refusal)
FP-318	-27.4	34.6	7.4	0.0-2.0 loose silty gravelly Sand, 2.0-6.0 loose to med comp't, fine Sand, 6.0-7.4 comp't, clayey, sandy Gravel (Refusal)
FP-319	-31.0	37.0	6.0	0.0-4.0 soft Clay, 4.0-5.5 loose, silty Gravel, 5.5-6.0 bedrock ? (Refusal)
FP-320	-31.2	43.5	12.3	0.0-1.5 loose, silty, sandy Gravel, 1.5-12.5 loose fine Sand.
FP-321	-35.1	42.9	7.8	0.0-2.0 soft, clayey, gravelly Sand, 2.0-7.8 soft Clay.
FP-322	-27.1	37.1	10.0	0.0-10.0 no sample recovered.
FP-323	-36.4	47.4	11.0	0.0-4.0 med compact fine Sand, 4.0-11.0 loose to compact, sandy Gravel.
FP-324	-23.1	32.1	9.0	0.0-9.0 med compact sandy Gravel.
FP-325	-18.8	27.8	9.0	0.0-9.0 med compact sandy Gravel.
FP-326	-27.2	36.2	9.0	0.0-1.0 loose, coarse, sandy Gravel, 1.0-9.0 med compact, gravelly Sand with clay Seams.
FP-327	-39.7	47.7	8.0	0.0-8.0 med compact gravelly Sand.
FP-328	-28.8	37.5	8.5	0.0-8.5 loose to med compact, gravelly Sand.
FP-329	-29.6	38.6	10.0	0.0-10.0 loose to med compact, fine to med Sand.
FP-330	-18.2	27.2	9.0	0.0-4.0 soft, fine sandy Clay, 4.0-5.0 med comp't fine Sand, 5.0-9.0 med stiff Clay with fine Sand
FP-331	-8.7	17.7	9.0	0.0-9.0 soft to stiff Clay.



PLAN
Scale: 1" = 100'

PROFILE "A"
Scale: Horiz. 1" = 100' Vert. 1" = 10'

NOTES.

1. Probings were made and samples taken by driving [illegible]
2. Driving was [illegible]
3. [illegible]
4. Elevations in feet refer to Mean Sea Level Datum.
5. For Bay Crossing Valve Pit Details & Locations see Sheet 56 of 56.
6. [illegible]

7. The profile data contained hereon are not intended as representations or warranties but are furnished for information only. It is expressly understood that the government will not be responsible for any deduction, interpretations or conclusions made by any bidder or contractor.

Record Drawing
Contract No. DA-19-016-ENG- 3024

4-14-16

Final Field Corrections 25 Mar 57

REVISION	DATE	DESCRIPTION	BY
2	[illegible]	Special Y Branch & Valve Pits relocated. Profile revised.	[illegible]
1	[illegible]	[illegible]	[illegible]

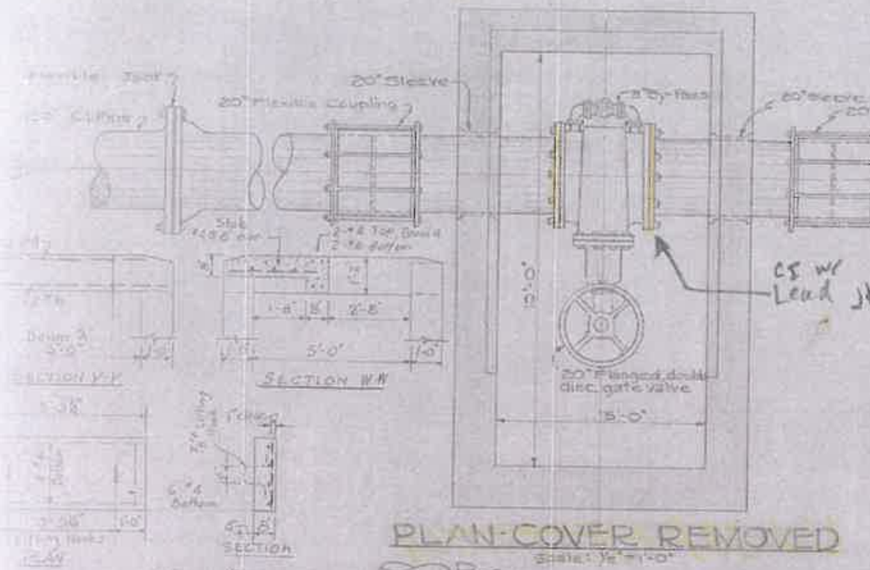
WHITMAN & HOWARD
ARCHITECTS — ENGINEERS

CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DRAWN BY
TRACED BY
CHECKED BY EMP
SUBMITTED
APPROVED
APPROVED
DATE

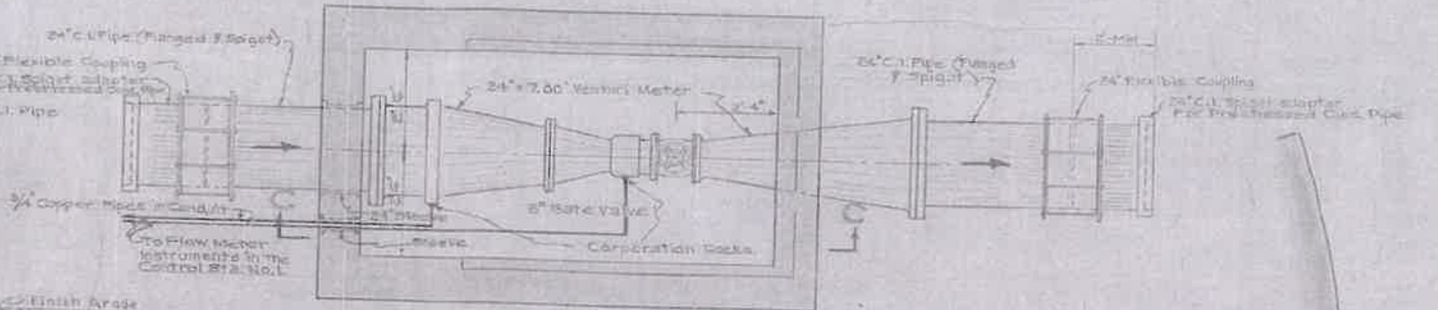
PORTSMOUTH AIR FORCE BASE
WATER SUPPLY
WATERMAIN DURHAM PT. TO FOX PT.
LITTLE BAY CROSSING
PLAN & PROFILE

6



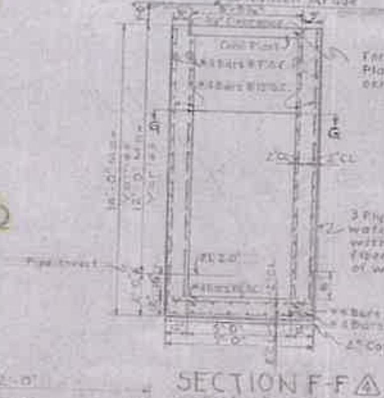
PLAN-COVER REMOVED

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



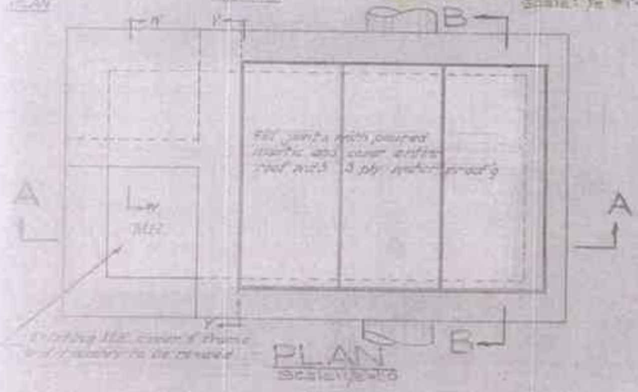
PLAN-COVER REMOVED

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



SECTION F-F ⚠

Scale: 3/8"=1'-0"



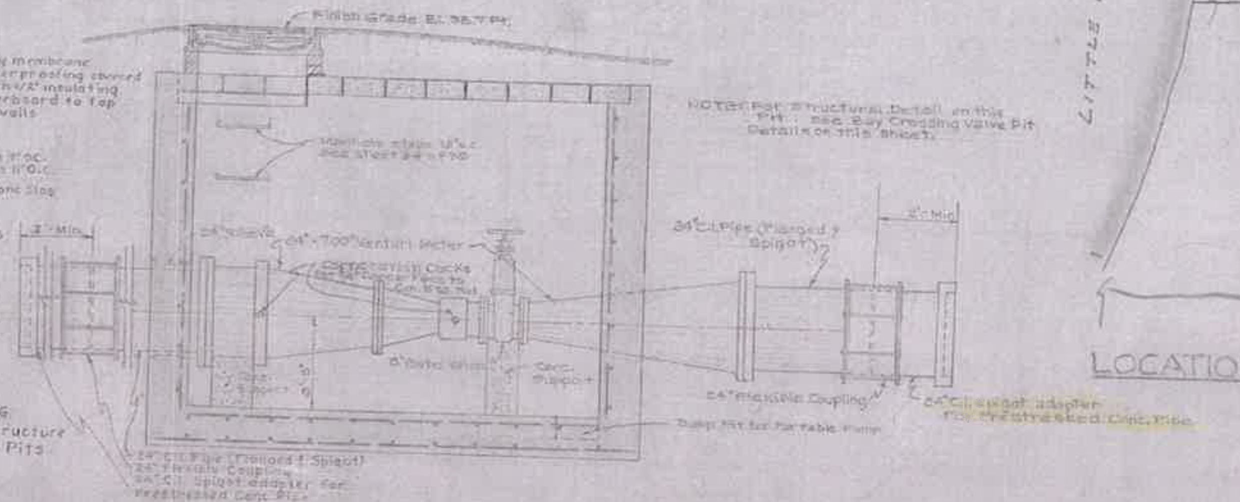
PLAN

Scale: 1/4"=1'-0"

SECTION G-G ⚠

Scale: 3/8"=1'-0"

Note: Sections F-F & G-G ⚠ show details of structure for Durham Valve Pits only

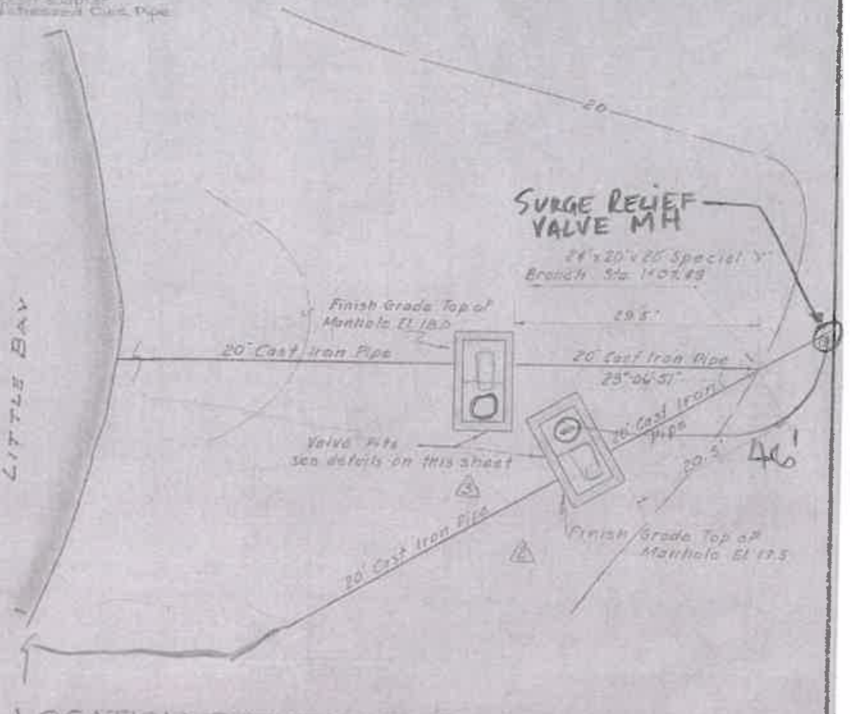


SECTION C-C

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

DETAIL OF VENTURI METER PIT AT CONTROL STATION

Note: For material and dimensions to build pit see detail of Bay Crossing Valve Pit on this sheet.

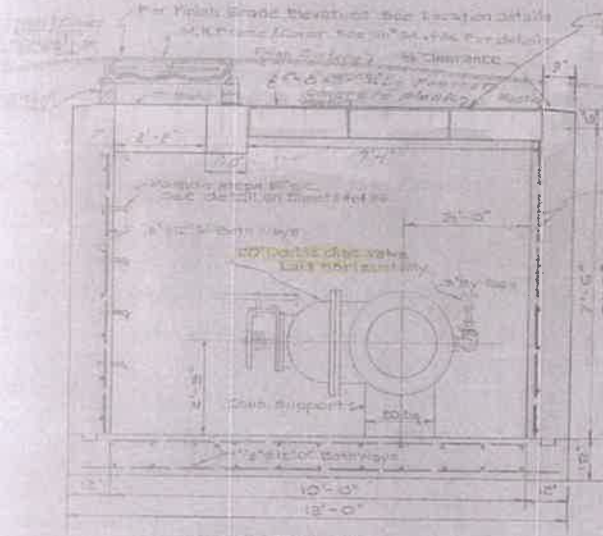


LOCATION - BAY CROSSING VALVE PITS FOX POINT

Scale: 1"=10'

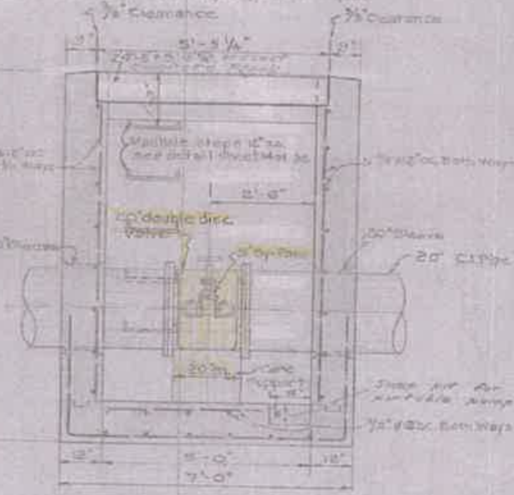
NOTE

In walls over 8" thickness, two #4 bars at top, bottom & sides of openings placed 2" clear from edges of opening extending 1'-6" beyond openings where possible. Two #4 diagonal bars 3'-0" long at 45° across all corners of openings centered on centers. In walls 8" or less thick, one bar each in lieu of the two stipulated above for the thicker walls.



SECTION A-A

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



SECTION B-B

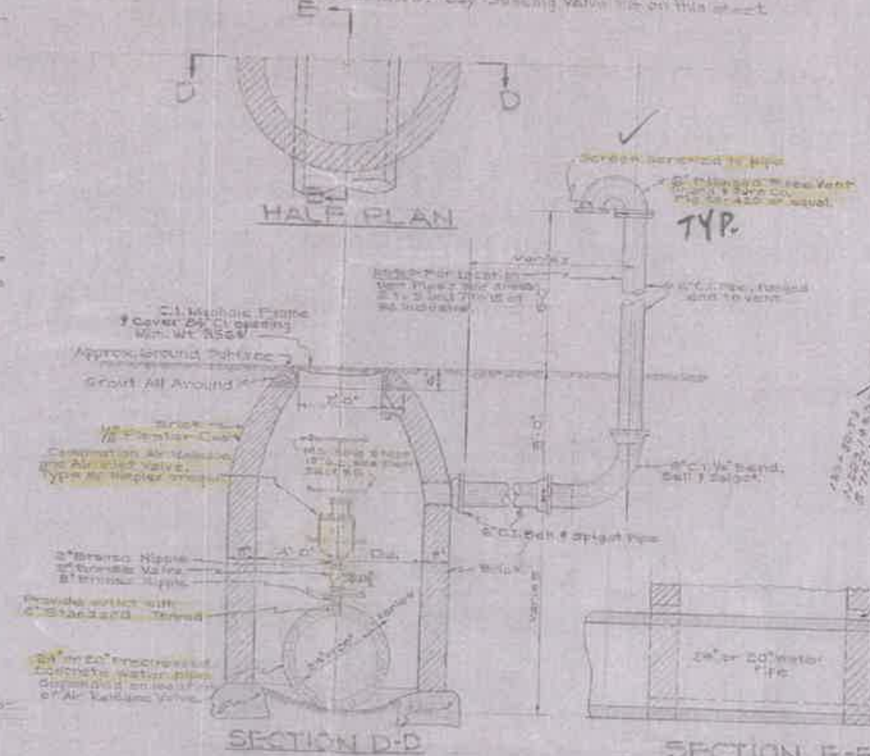
Scale: 1/2"=1'-0"

24" GV @ NIMBLE Rd @ FOX PT. RD

DETAIL OF VALVE PIT ✓

For Bay Crossing & main line valves, size of valve depends on size of main.

Note: (Structures for Fox Point only) ⚠



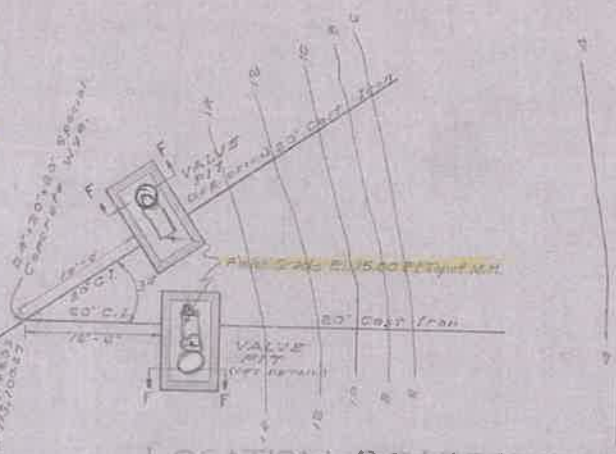
HALF PLAN

SECTION D-D

SECTION E-E

DETAIL OF AIR VALVE MANHOLE & VENT PIPE

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



LOCATION - BAY CROSSING VALVE PITS DURHAM POINT

Record Drawing
Contract No. DA-19-016-ENG- 3024

SURGE RELIEF MH

✓ Fnd on Newington Side of BAY

Final Field Corrections 25 Mar 51

⚠	[illegible]	Fox Point Valve Pits relocated	[illegible]
⚠	[illegible]	Location of valve pits at Fox Point changed	[illegible]
⚠	[illegible]	Note added for [illegible]	[illegible]
REVISION	DATE	DESCRIPTION	BY

WHITMAN & HOWARD
ARCHITECTS - ENGINEERS

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DRAWN BY
TRACED BY
CHECKED BY E.K.P.
SUBMITTED
APPROVED

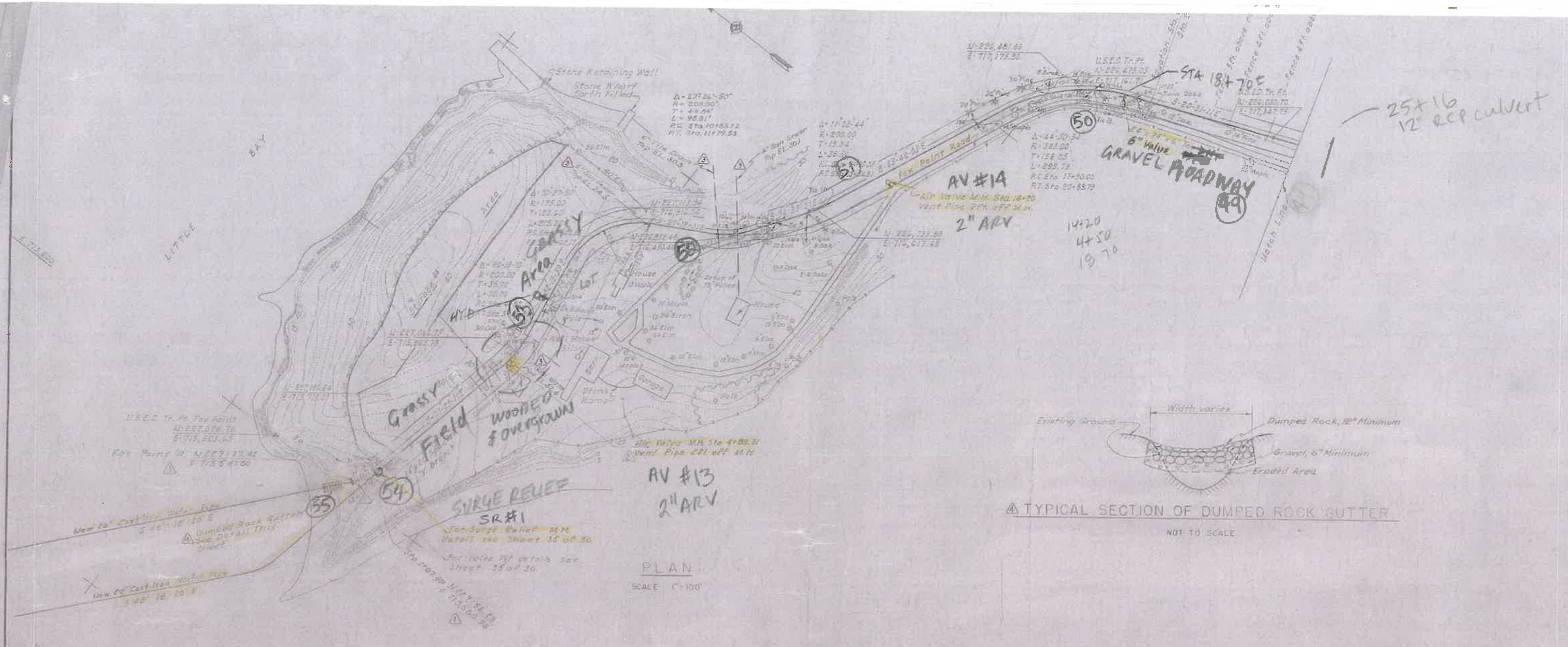
PORTSMOUTH AIR FORCE BASE
WATER SUPPLY
METER PITS & DETAILS
VALVE MANHOLE DETAILS

APPROVED
DATE

⑦

4-14-16

GENERAL NOTES



PLAN

SCALE 1"=100'

Existing Ground

Width varies

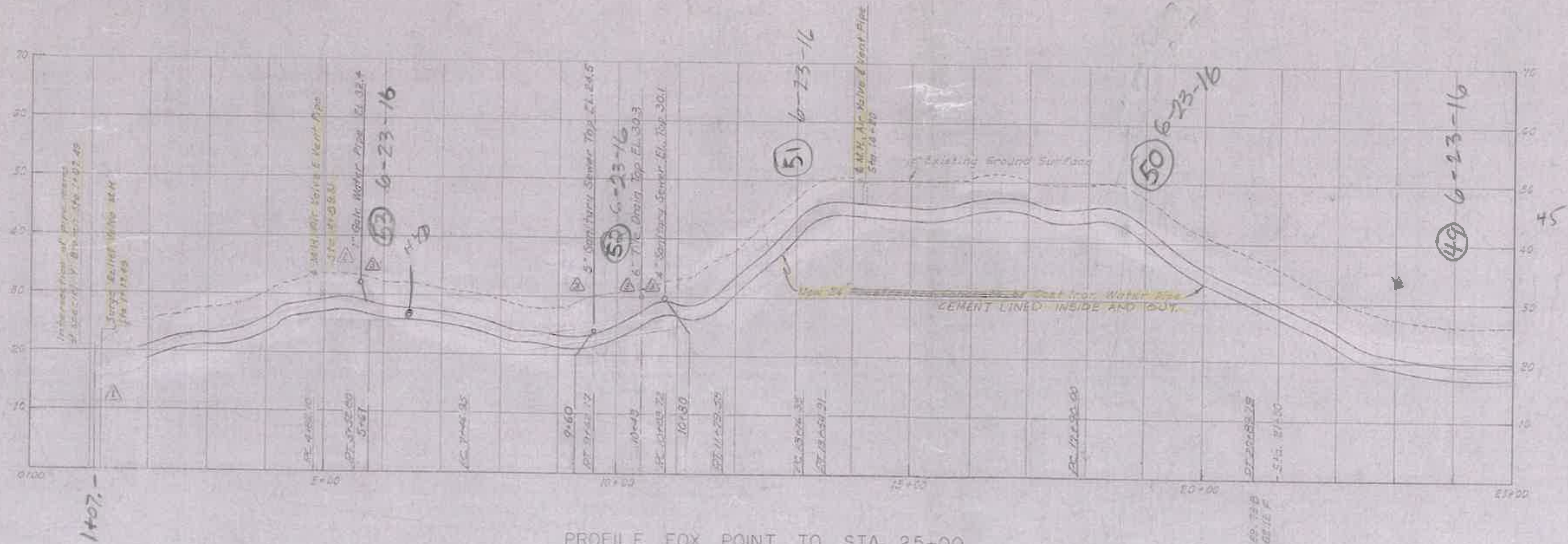
Dumped Rock, 12" Minimum

Gravel, 6" Minimum

Eroded Area

④ TYPICAL SECTION OF DUMPED ROCK GUTTER

NOT TO SCALE



PROFILE FOX POINT TO STA. 25+00

NOTES:

1. Elevations Refer to Mean Sea Level Datu
2. For Bay Crossing Valve Pit Details see She
3. For Details of Air Valve and Vent Pipe s
4. For Detail of Surge Relief Valve M.H. see S
5. Overflow Elevation - Portsmouth Tanks
6. For Legend of Borings see Sheet No. 1 of
7. For Hydrostatic Thrust Block Details see
8. All graded areas within limits of work seeded topsoil unless otherwise shown.
9. Minimum cover over pipe shall be 4 ft shown on Plan.
10. Limit of Construction Easement is

Record Drawin

Contract No. DA-19-010-E 3024

Final Field Corrections 23 APRIL 57

REVISION	DATE	DESCRIPTION
④	4-10-57	Rock Gutter and Section added (F
③	9-21-56	Sewer, Water and Drain Pipes added (F
②	6-26-56	Air Valve Manhole added
①	12-13-55	Special Y Branch and Valve Pit
		Profile revised

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

(8)

DES. BY	DR. BY	CK. BY
	A.G.	

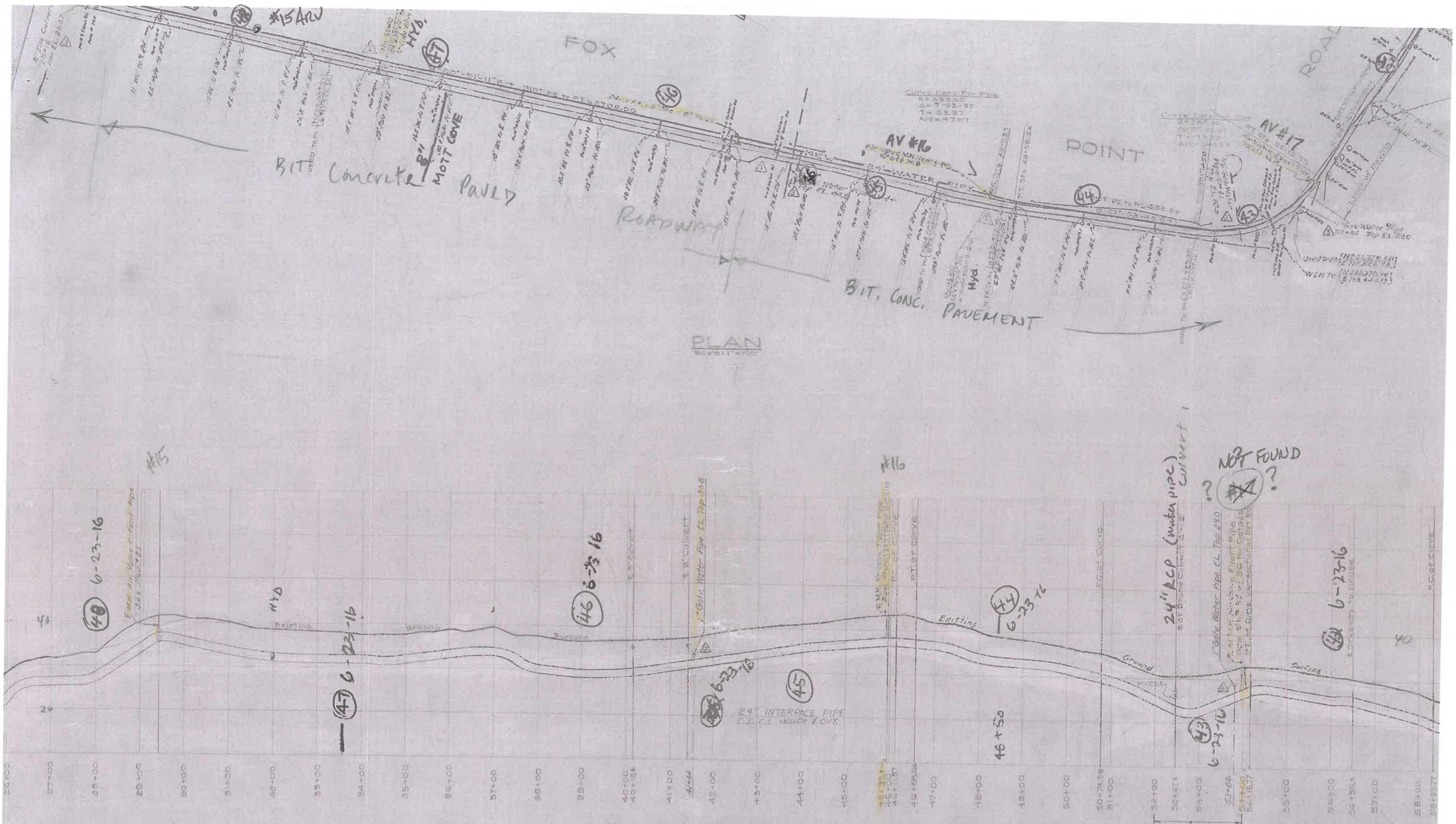
CHIEF, DESIGN BRANCH

PROJECT ENGINEER

SUBMITTED BY

CHIEF, MILITARY BRANCH

PORTSMOUTH AI
PORTSMOUTH
WATER S
WATER MAIN FOX PT
PLAN & PR
STA. 0+00 T



Note:
Increase gradient of the 24" Prestressed Concrete Water Line between Sta. 26+00 and Sta. 37+00 and establish a high point with air vent installation at Sta. 30+25. Minimum cover requirements shall govern limit of gradient increase. Add. #23

1' of Gravel Bedding placed because of wet & Unstable Soil

Final Field Corrections 25 Mar. 57

24" ECI –

REVISION	DATE	DESCRIPTION
3	3-1-56	Water lines added, culvert revise
2	3-16-55	[illegible]
1	8-11-54	24" x 24" x 8" Tees shown on plan. Note

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9

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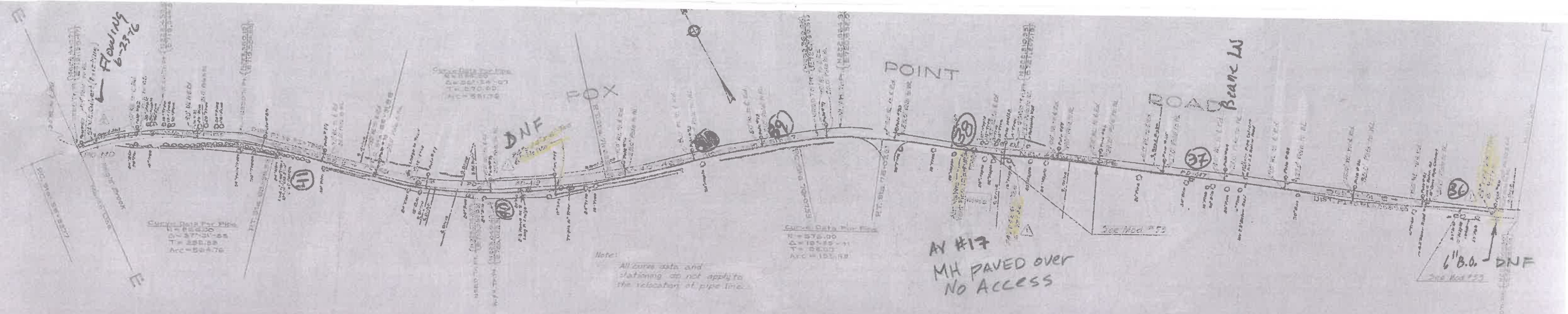
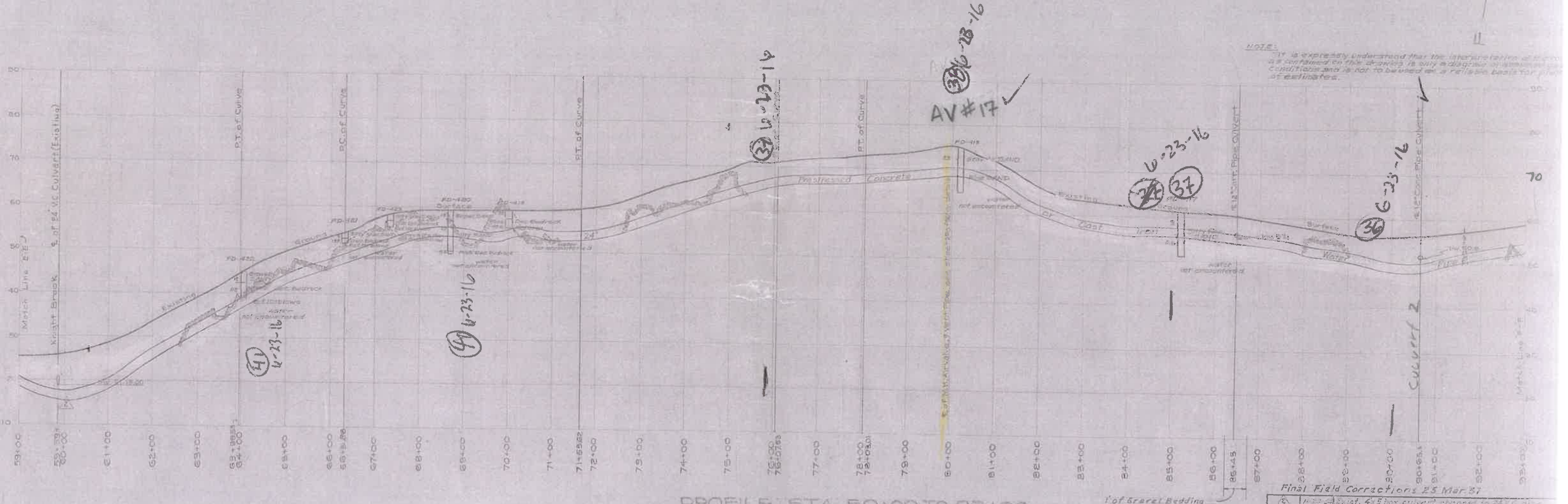
GENERAL NOTES
1. Datum Plane refers to Mean Sea Level.



PLAN
Scale: 1"=100'



NOTE:
"It is expressly understood that the interpretation of ... as contained on this drawing is only a diagram of ... conditions and is not to be used as a reliable basis for ... of estimates.

PROFILE: STA 59+00 TO 93+00
Scale: {Hor. 1"=100' / Ver. 1"=10'

1' of Gravel Bedding Placed because of wet unstable Soil

NOTE:
"The boring data contained herein are not intended as representations or warranties but are furnished for information only. It is expressly understood that the government will not be responsible for any deductions, interpretations or conclusions made by any bidder or contractor.

GENERAL NOTES

1. Datum plane refers to Mean Sea Level.
2. For Air Valve and Vent Pipe Details see Sheet 55 of 56.
3. Over Flow Elevation - Portsmouth Tanks 172.15
4. For Legend for Borings see sheet 2 of 56.
5. For hydrostatic thrust block details see sheet 56 of 56.
6. Min cover over pipe shall be 4'-6" except as shown on plan.
7. Nipples for 6" Valve connections shall have a minimum length of 18"

Final Field Corrections 25 Mar 57

REVISION	DATE	DESCRIPTION
2	[illegible]	Exist. 4x5 box culvert changed to 24" C pipe Inv. El. revised, 24" pipe lowered
1	8-11-[illegible]	[illegible]

10

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NEW ENGLAND DIV
BOSTON, MASS

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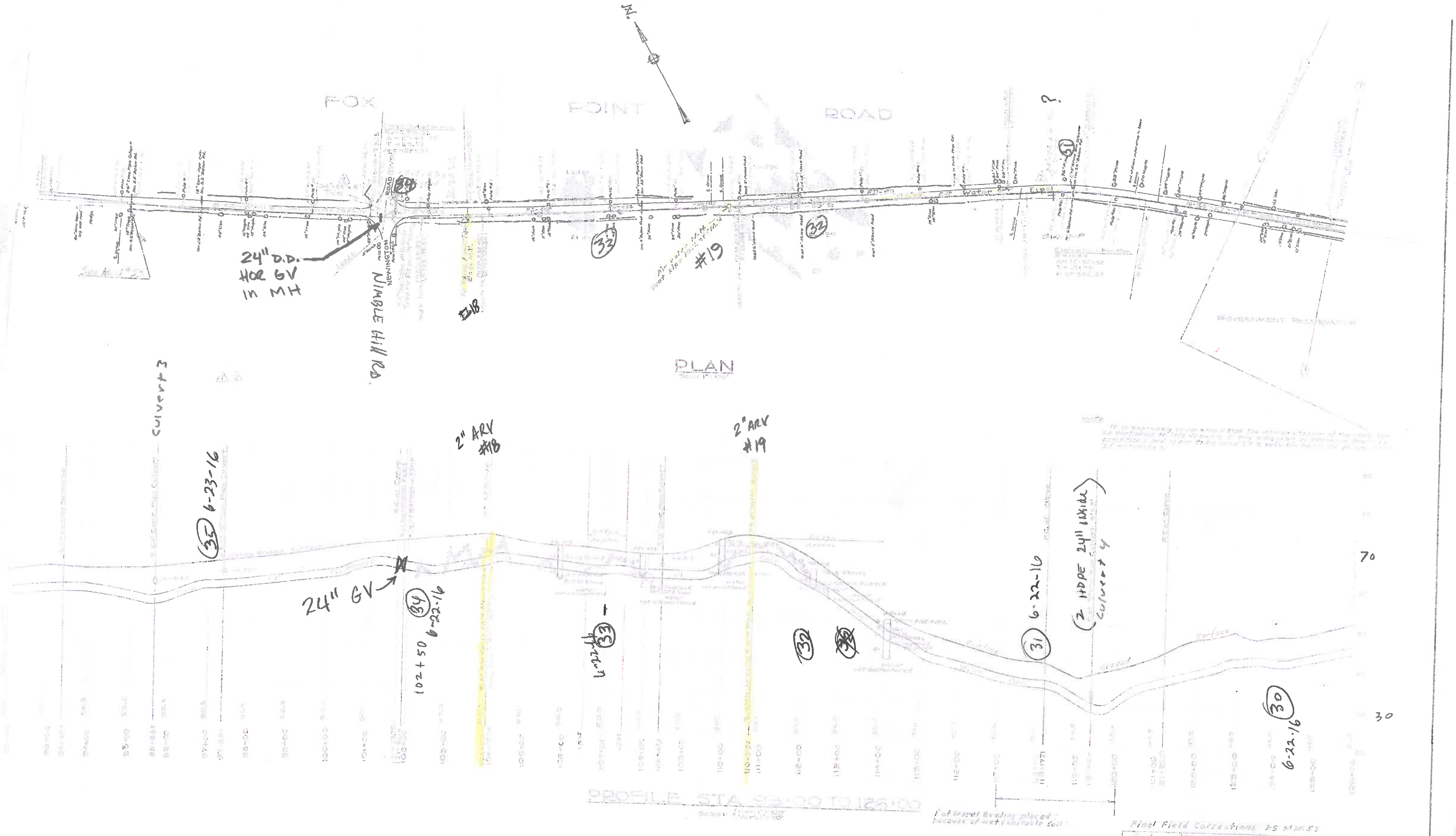
SUBMITTED

PORTSMOUTH AIR FORCE
WATER SUPPLY
WATER MAIN-FOX PT.
PLAN & PROFILE



Final Field Corrections 25 Mar.57

REVISION	DATE	DESCRIPTION	BY
A			

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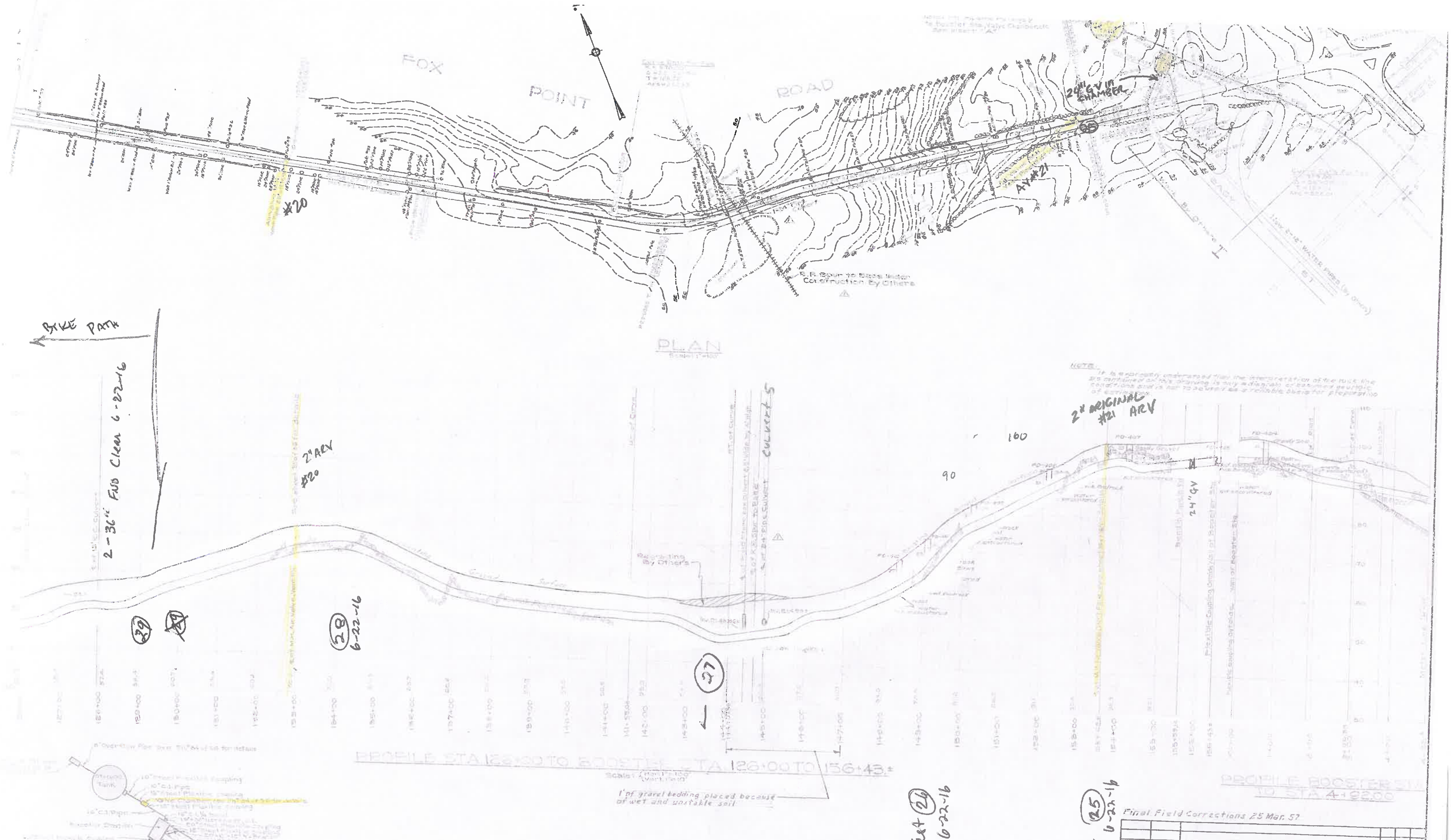
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DRAWN BY
TRACED BY
CHECKED BY

PORTSMOUTH AIR FORCE BASE
WATER SUPPLY

11



Final Field Corrections 25 Mar. 57

△	[illegible]	R.R. Spur & Culvert added (Add. No. 1)	[illegible]
REVISION	DATE	DESCRIPTION	BY

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NEW ENGLAND DIVISION
BOSTON, MASS

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PORTSMOUTH AIR FORCE BASE
WATER SUPPLY

12

Appendix B
Procedures for Removing Concrete Pressure Pipe

PROCEDURE FOR REMOVING A LENGTH OF CONCRETE PRESSURE PIPE

INSTALLATION OF VARIOUS MATERIALS SUCH AS SHORTS, TEES, ADAPTERS, AND CLOSURES

Hanson Pressure Pipe
Grand Prairie, TX
October 2008

INITIAL EXAMINATION

Refer to Figure 1

1. Excavate all around the pipe length to be removed.
2. On the pipe to be removed, continue the excavation along the sides of the pipe in each direction approximately 2 feet past the next pipe joint.
3. Remove the exterior grout at the pipe joints at each end of the length to be removed and determine what type of joints it has. Refer to the table below:

Joint Type	Description	Comments
Standard push-on joint	This joint should pull apart easily once the bond with the exterior joint grout and any "joint set" have been overcome	Unrestrained Joint
Snap-Ring Restrained	The Snap-Ring insert must be cut and removed by pulling it back thru the "window" in the Snap Ring bell ring or the "nose" (front portion) of the Snap Ring bell ring must be cut off.	These joints are restrained-type that must be released before the joint will separate.
Bell-Bolt Restrained	Remove <u>all</u> bolts completely and proceed with disassembly as with the standard push-on joint. These bolts use an interference-type threading requiring more torque than normal to remove them.	
Harness Clamp Restrained	Unbolt and remove the bolts located at each side (ie. springline) of the pipe joints. This will allow the upper and lower halves of the harness clamp rings around the joint to be removed. Then proceed with disassembly as with the standard push-on joint.	
Turnbuckle Bolted Restrained	Cut the turnbuckle bolts in half with a torch or saw and proceed with disassembly as with the standard push-on joint.	
Field Welded Restrained	Carefully burn through the weld causing as little damage as possible to the joint ring to remain. Proceed with disassembly as with the standard push-on joint.	

BREAKING INTO PIPE

Refer to Figure 2

1. Pick a location on the pipe and scribe a line approximately 2' long at each springline (180° apart ±). Connect the ends of these longitudinal lines with circumferential lines marked across the tope of the pipe.

2. Utilizing a standard cut-off saw with a concrete, steel, or combination blade, cut through the mortar coating along the lines described in Step 1 to a depth of 1"-1 ½".

   ❖ NOTE: Cutting to a depth of 1" – 1 ½" will cut through and relax the prestressing wires and break the bond with the mortar coating. The coating and wires are now loose and can be removed with a large sledge hammer. On Lined Cylinder Pipe (LCP), if the saw cut penetrated 1 ½", the steel cylinder inside will be cut and can be removed with a hammer and/or pry bar. On Embedded Cylinder Pipe (ECP), it will be necessary to cut deeper with the saw to reach and remove the steel cylinder.

3. Once the steel cylinder has been removed, the inner concrete core is exposed. It's a good idea at this point to knock a small hole through the core to determine if the pipe is empty. If not, a pump suction hose can be inserted to facilitate dewatering and eliminate an uncontrolled, flooded excavation.

   If the line is empty or the water is controlled, continue removing the top 180° portion of the core with a sledge hammer or jack hammer.

4. The bottom half (180° portion) can now be removed from the inside-out. You can elect to use a sledge hammer, pneumatic jackhammer, or a saw or any combination to dislodge the inner core and cylinder. Slightly undermining the pipe beneath the work area will facilitate removal of this material.

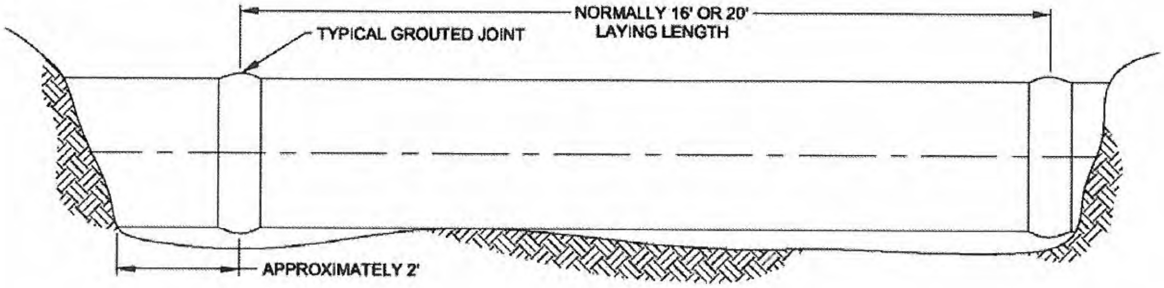


FIGURE 1 INITIAL EXAMINATION

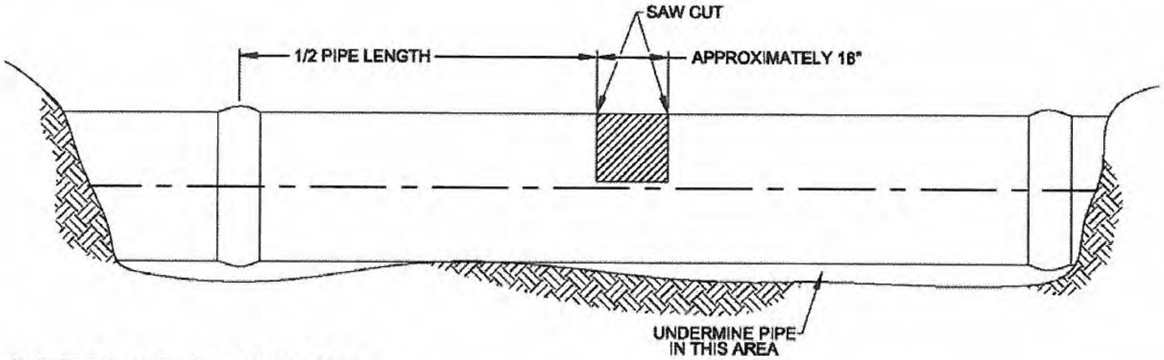


FIGURE 2 BREAKING INTO PIPE

SECTION REMOVAL

Refer to Figure 3

1. Once the center section of pipe has been completely removed, the remaining pipe sections are ready for removal.
2. **Do not** attempt to pull the pipe apart with only an upward lift as this could damage the mating joints to remain and to which the replacement pieces will be connected.
3. Place a choker cable (preferred instead of a link-type chain) near the cut ends of the remaining sections to provide maximum leverage and gently lift upward, then push down, then pull to the right and left. Repeat this "wiggling" action to loosen the joints at each end of the pipe being removed.

Once a separation begins to appear at the joint, the major direction of force when lifting or swinging should be in a direction away from the pipe joint.

PREPARATION OF JOINT ENDS

Refer to Figure 4

After all sections are removed, the excavation and remaining pipe joints should be prepared to accept the new sections.

1. Re-establish proper bedding material to support the new pipe.
2. Leave sufficient room in the bedding under each joint for the tightening of any bolts and for placement of a new grout band. Space will also be required under the closure assembly for the concrete encasement.
3. Remove any remaining or loose joint grout from the inside shoulder of the bell ring and the outside shoulder of the spigot ring. This will eliminate any interference when assembling the new pieces.
4. Clean the steel joint ring surfaces of any old grout material, dirt, or joint lubricant. Use a file, steel brush, wire wheel, or sandpaper to loosen hard material and clean rags to wipe the joint rings. Carefully inspect the joint rings for any damage or corrosion.

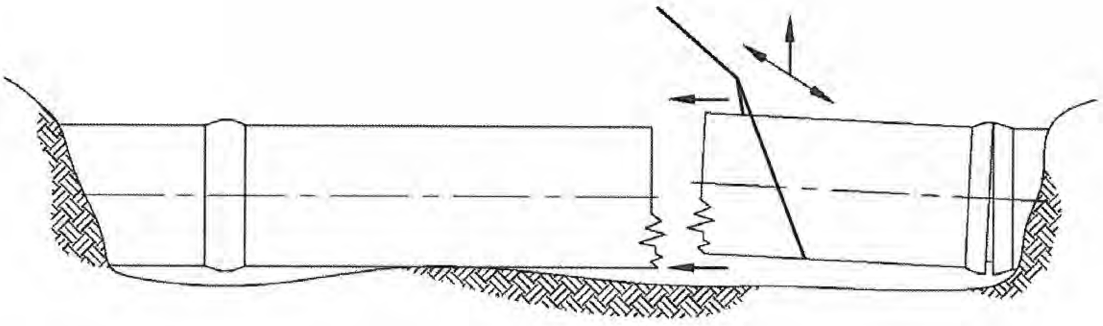


FIGURE 3 SECTION REMOVAL

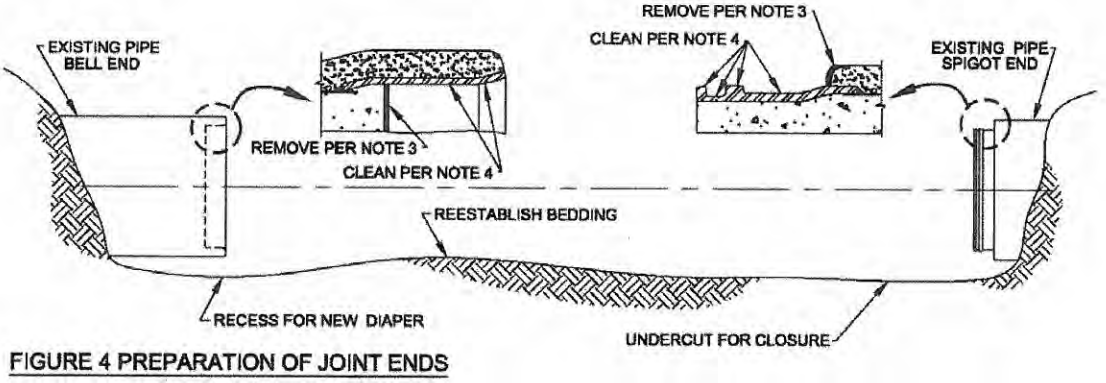


FIGURE 4 PREPARATION OF JOINT ENDS

INSTALLING REPLACEMENT PIECES

Refer to Figures 5, 6, and 7

Replacement pipe may consist of a short prestressed length, a double spigot adapter fitting, and closure assembly (illustrated in Figure 5), or a tee fitting and closure assembly (illustrated in Figure 6), or a valve and closure assembly (illustrated in Figure 7) or a combination of these pieces.

1. Prior to assembly, the flat surfaces of the bell rings and the gasket groove surfaces of the spigot rings as well as the rubber gasket itself, should be coated lightly but thoroughly with joint lubricant to facilitate assembly. Use only joint lubricant supplied by Hanson Pressure Pipe.

2. Use all new rubber o-ring gaskets. Insure that the correct gasket is being used. Gaskets contain markings that identify the pipe diameter and type for which they are designed. Assemble the pipe materials into the existing bells or over the existing spigots. Check gasket position with a feeler gauge.

3. Measure the clear distance between the remaining spigot ends with particular attention paid to the diagonal dimensions in order to assure proper alignment in both the horizontal and vertical planes.

4. Once square alignment is achieved, transfer the clear distance measurement, minus one inch, to the closure cylinder. Check all measurements twice.

5. Cut the closure cylinder, with a cut-off saw, square along the scribed line through the steel cylinder and mortar lining.

6. Lubricate the flat surfaces of the bell closure ring A and push this ring and the follower ring C back far enough onto the closure cylinder to clear the ends of the pipe. Stretch the closure gasket B (larger, unstretched diameter than pipe laying o-ring gaskets) slowly up and over A until it rests between A and C (Also refer to Figure 8 for more detail on the correct position of the closure gasket). The closure is now ready for placement.

    - Assembly of these pipe joints my be accomplished by:

        1. Pulling joints home with wire rope, come-along type hoist, or deadman anchor.
        2. Pushing joints home utilizing excavation equipment (backhoe bucket) being careful to use a wood timber between bucket and pipe joint surfaces for protection.
        3. Pushing and sliding closure rings utilizing hydraulic jacks.

CLOSURE PLACEMENT

Refer to Figure 8

1. Lower the closure cylinder assembly into the clear opening between the spigot rings. Note that a double spigot adapter may be required since a closure must be used with a spigot joint at each end.

2. Push or pull the bell closure ring A as close to the spigot as possible and then pull or push the bell closure ring home until movement bottoms out against internal stops. Check gasket position with feeler gauge.

   A. Pull together with come-alongs attached to the bolt holes in the bell closure ring and to a dead man cable or wire rope cable around the short or existing pipe.

   Or

   B. Push bell closure ring over spigot utilizing a Porta-Power-type hydraulic jack against braces welded to the closure cylinder.

3. Roll the closure gasket B into position behind bell closure ring A.

4. Pull sliding follower ring C up against the closure gasket and install the closure bolts and nuts.

5. Repeat steps 2, 3, and 4, on the joint at the other end of the closure cylinder.

6. Draw follower ring C tight against closure gasket B until approximately ¼" ± gap exists between A and C.

7. Important:

   If the assembly will remain open to inspect for leaks while the line is pressurized, bracing must be placed between the follower rings C at each end to prevent A, B, and C, at each end, from moving under pressure and opening the joint between the bell closure ring A and the spigot of the adjoining pipe. It is usually beneficial to not encase the closure assembly in concrete until the line has been filled and pressurized in order to check for leaks. If the closure gasket is found to be leaking, simply tighten the closure nuts and bolts.

   Upon completion, the entire closure assembly must be encased in Portland cement concrete to prevent corrosion. Ready-mix concrete can be used. Call for minimum 3000 psi concrete and insure that all exposed steel surfaces get at least 3" of coverage. Sandbags or plywood, in conjunction with the trench walls, can be used to create a crude form for the concrete.

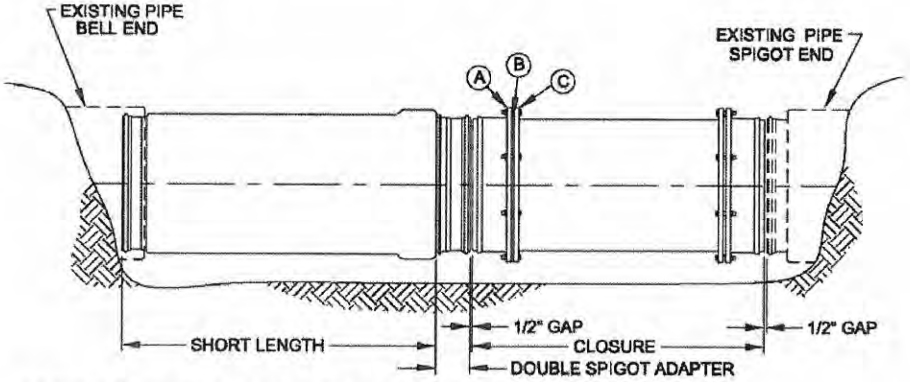


FIGURE 5 INSTALLING REPLACEMENT PIECES SHORT PIPE AND CLOSURE

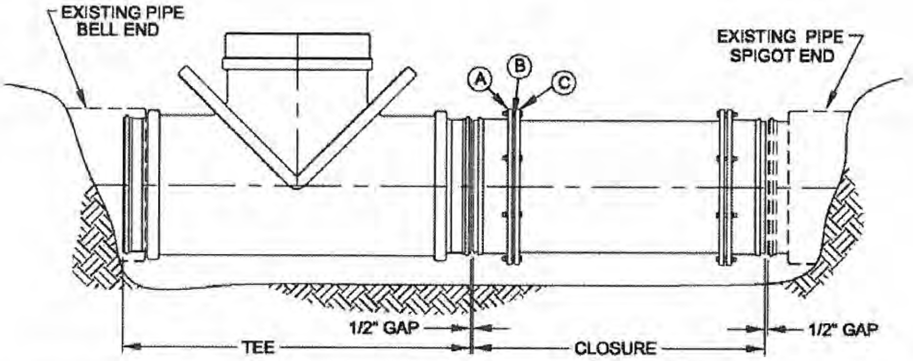


FIGURE 6 INSTALLING REPLACEMENT PIECES TEE AND CLOSURE

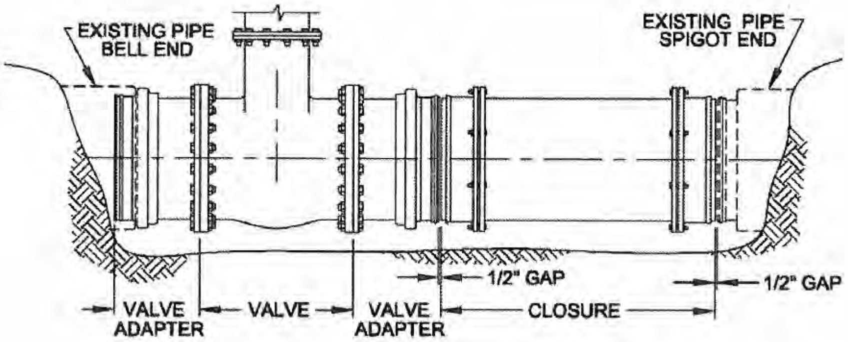


FIGURE 7 INSTALLING REPLACEMENT PIECES VALVE AND CLOSURE

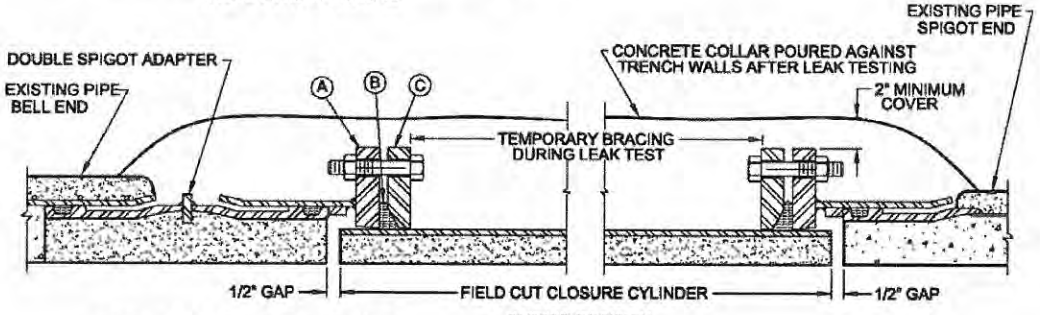
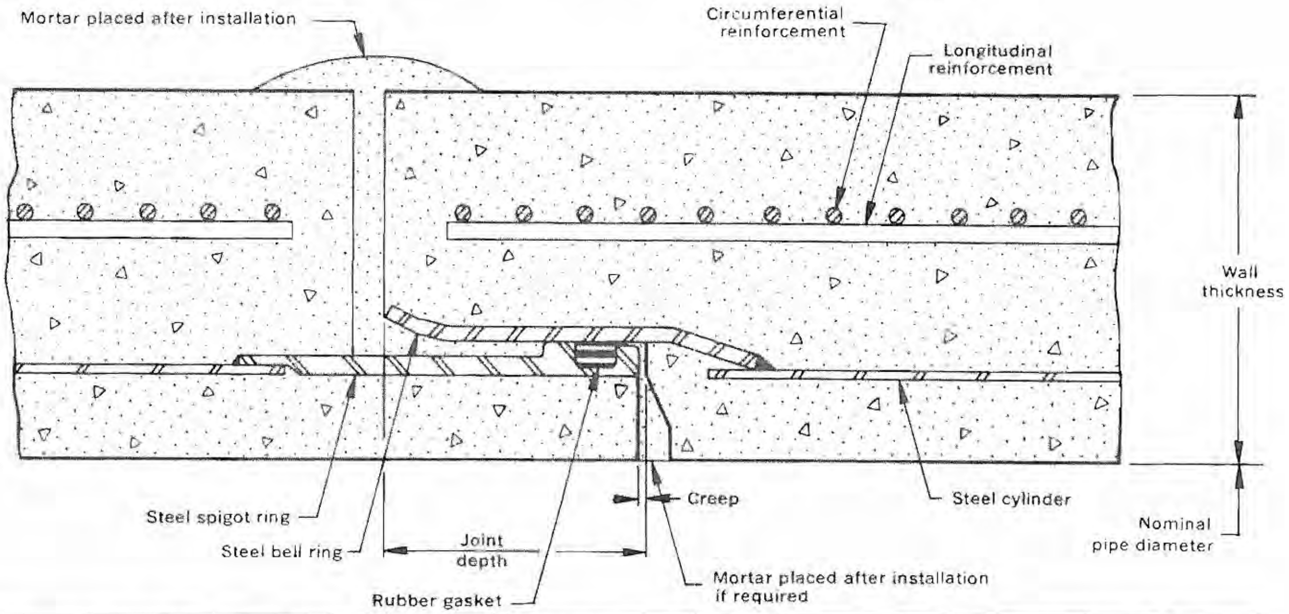


FIGURE 8 CLOSURE PLACEMENT

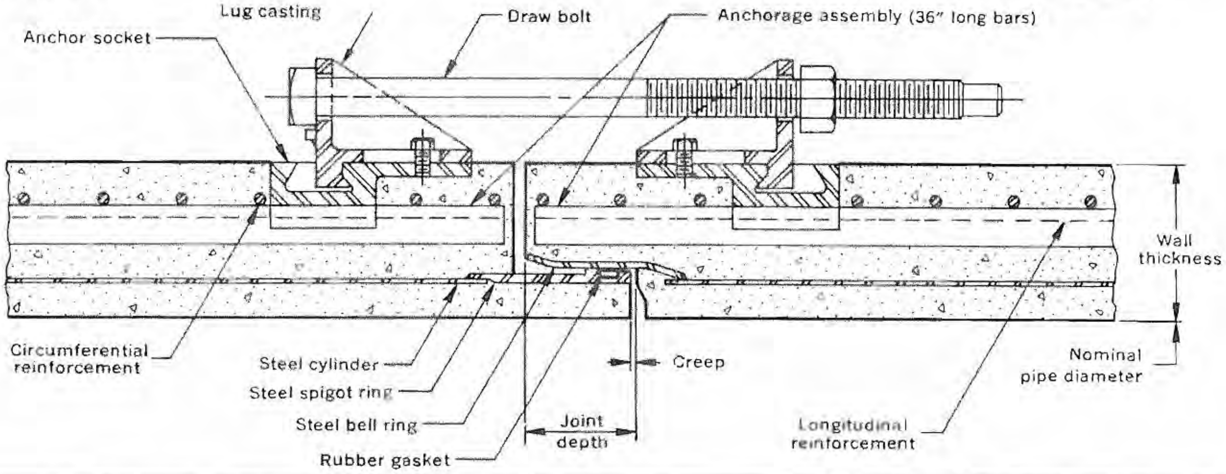
Lock Joint Reinforced Concrete Cylinder Pipe with Rubber and Steel Joint

AWWA C-300 INTERPACE SP-3



Lock Joint Subaqueous Reinforced Concrete Cylinder Pipe with Rubber and Steel Joint

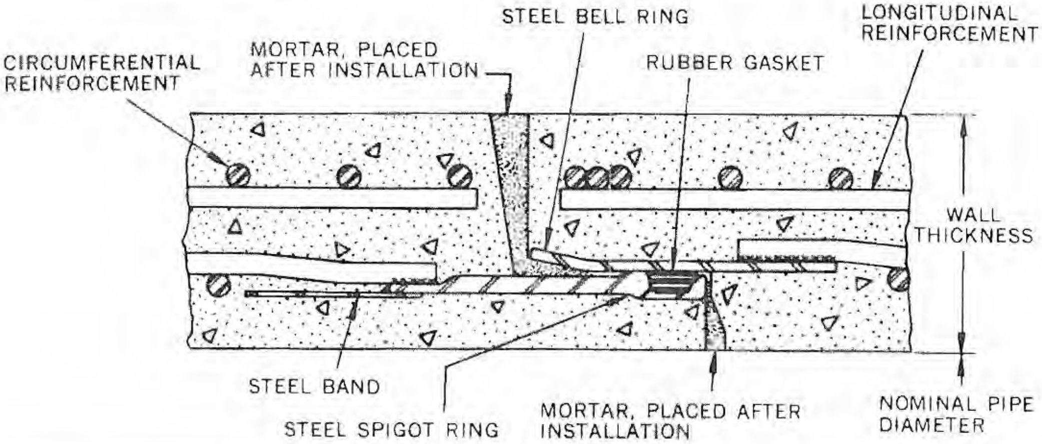
AWWA C-300 INTERPACE SP-7



AWWA C-300 pipe (INTERPACE SP-3 & SP-7) has been largely superseded by AWWA C-301 pipe (INTERPACE SP-5, SP-11, SP-12, SP-18 & SP-35). Where AWWA C-300 pipe is required for special applications, details will be furnished on request.

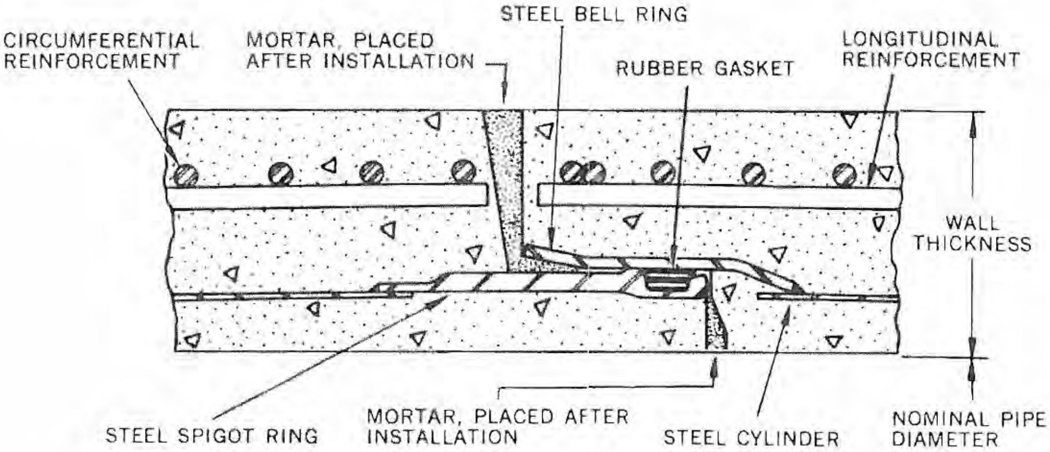
Lock Joint Reinforced Concrete Pressure Pipe with Rubber and Steel Joint

AWWA C-302 INTERPACE SP-1



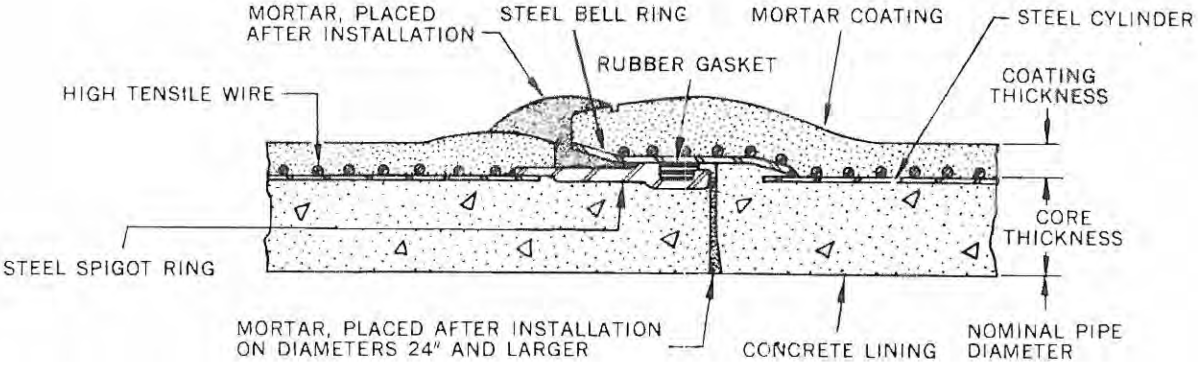
Lock Joint Reinforced Concrete Cylinder Pipe with Rubber and Steel Joint

AWWA C-300 INTERPACE SP-3



Lock Joint Prestressed Concrete Cylinder Pipe with Rubber and Steel Joint

AWWA C-301 INTERPACE SP-5



Attachment B

Black Dog Divers, Inc.

Subaqueous Water Main Inspection Summary

07/14/2016

Black Dog Divers Inc
240 Heritage Ave,
Portsmouth, NH 03802

Survey Report of Pipeline Crossings, Portsmouth, NH

Little Harbor Pipe Crossing

7/8/16

Divers inspected the pipeline crossing at Little Harbor Entrance, running from Odiorne Point to New Castle. Staring from NE of the channel, N43.05600, W070.71997. The diver found a slight impression on bottom, about 6-8" over an 8' length. We followed the trench impression all the way across the channel, through the mooring field and back to the beach. Diver could not find any boils, big holes, or signs of abnormalities. The bottom consisted of sand, small rock, and organics with mud.

Coordinates of staring point; N43.05600, W070.71997

Back Channel Crossing

7/8/16

Diver started the survey on the New Castle Side working back to Portsmouth. About 100' from shore, N43.06069, W070.73558, the diver found a section of pipe exposed about 20' in length. The pipe was in good shape with no leaks. Following that section back in entered the mud-line and continued that way back to Portsmouth. The bottom conditions were sand and small rock. Recommend covering all exposed pipe.

Coordinates of exposed pipe; N43.06069, W070.73558

Little Bay 2-pipe crossing North of Hen and Goat Islands

7/11/16

Starting from the SE side of the crossing, the dive team marked the location of the entrance of the crossing, then went to the NW end and did the same. Do to the longer crossing the team plotted a course with the boats GPS and used side scan sonar to map the bottom and locate the trenches. After, the team jumped a diver and scanned the trench locations the entire length of the crossing. About 200' from shore on the NW side the diver found the north pipe exposed in 3 locations, N43.12088, W070.85940 and N43.12558, W070.86725. One length was about 50' and the other 2 were 100' +. The pipe had heavy pitting and without using a thickness gauge, the pipe appeared to be thin in spots. Some of the pits were about

½” deep. Past these areas moving to the SE, the divers found the trenches covered with rock, about 15’ wide and 4-6’ high. No signs of boils/leaks.
Recommend covering exposed pipe.
Coordinates of exposed pipe; N43.12088, W070.85940 and N43.12558, W070.86725

Video was taking of all the crossings and areas of concern. If you have any questions please call Tap Taylor

Attachment C
CorrTech Field Report Summary

CORRTECH

CORROSION ENGINEERING
INFRASTRUCTURE TECHNOLOGIES

FIELD REPORT

Date(s):	6/21/16 through 6/23/16	**Field Report No.**	8761-4912
Project / Report Title: **Condition Assessment for Portsmouth Water Little Bay Crossing**		**Client:** **Stantec**	
Weather:	Sunny/Clear	**Temperature:**	80s

Background

This report summarizes the soil resistivity evaluation that took place 6/21/16 through 6/23/16. Resistance values were measured approximately every 400-ft along the PCCP pipe route from the Madbury Water Treatment Plant to the Newington Booster Pump Station, with the exception of the Great Bay crossing. Testing was done using a 4-pin setup as well as a collins rod/soil bridge at each location.

Results

Soil resistivity data was measured along approximately 30,000-linear feet of PCCP water main, at the surface, 3-ft, 6-ft, and 9-ft depths. At 54 locations CorrTech conducted the 4 soil resistivity tests for a total of 216 measurements.

Results from this evaluation have determined areas of interest for further investigation.

Recommendations

Based on a layer analysis for the 6 to 9-ft range, areas of interest have been identified and are as follows:

Section 1 (Madbury Water Treatment Plant to Great Bay)
-Sta. No. 85+00
-Sta. No. 114+00
-Sta. No. 130+60
-Sta. No. 134+00
-Sta. No. 139+00 (Transition Location)

Section 3 (Great Bay to Newington Booster Pump Station)
-Sta. No. 1+07 (Transition Location)
-Sta. No. 56+00
-Sta. No. 69+00
-Sta. No. 124+00
-Sta. No. 143+50

For further investigation, direct assessment would be performed at four (4) of the above locations. CorrTech considers the two transition locations to be high priority. To facilitate this evaluation, the entire buried section of pipe under investigation would be exposed. At each location, the hole should be large enough to provide 10 to 15-ft along the pipe, for the entire circumference, with 3-ft of clearance below the invert. A dewatering system may be required. Within the excavation, the pipe surface would be cleaned and divided into 1-ft squares for inspection. Within each square foot the following inspection activities would be completed:

-A prioritization of any defects or conditions found
-An examination of the exposed pipe area, coating, mortar cracking
-Measurement of any corrosion or coating defects, or any damage
-Mortar pH and Schmidt hammer hardness testing
-Mortar sounding
-Wire resistance evaluation

Wire Resistance

CorrTech would evaluate the resistance of the wire to determine areas where the wire has corroded and lost section, hence increasing longitudinal resistance. This involves removing some of the mortar along the exposed section of pipe so that the wire spacing and wire diameter can be determined. Several 3-inch wide by 12-inch windows would be made along the pipe surface based on the length of the excavation. This also allows for inspection of the wires in the window of removed mortar. Where a pipe bell is located in the excavation, electrical continuity between pipe segments would be determined. Following testing, the mortar would be repaired.

Photographs would be taken in each excavation to document the existing conditions. The presence and condition of the coating on the pipe would be evaluated.

Attachments

Employee Name / Time IN and OUT / Hrs:
Jay Paul & Pat Blum were guided by John Amato of Stantec

Prepared By:
CORRTECH, INC.

Jay Paul
Project Foreman
CorrTech, Inc.
25 South St.
Hopkinton, MA. 01748
(508) 435-0090
(774) 276-0221 cell
jpaul@corrtech-inc.com

The above constitutes CorrTech's understanding of all items discussed and/or items noted.

All concerned parties shall review this report and comment within seven days if any of the items require clarification, correction, and/or require additional discussion.

Attachment D
Subaqueous Pipeline Protection Options

SUBMAT

PIPELINE PROTECTION
AND
STABILISATION SYSTEMS

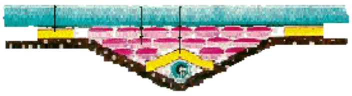
Submat is a trading name of SLP Precast
Limited, Hamilton House, Battery Green Road,
Lowestoft, Suffolk NR32 1DE
First Point Assessment No.10044028

South East Asia contact information:
Telephone No: + (65) 9753 0163
Fascimile No: + (65) 6365 2569
Email: bjlozada@singnet.com.sg
Website:www.slp-eng.com

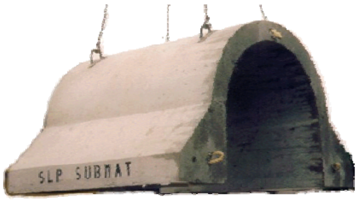
United Kingdom contact information:
Telephone No: +44 (0) 1502 548180
Facsimile No: +44 (0) 1502 548197
Email: albert.russell@slp-eng.com
Website:www.slp-eng.com

SUBMAT

Submat Bitumen Mattresses

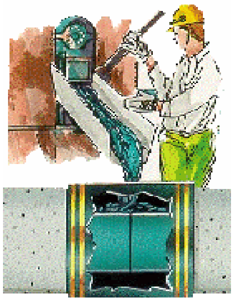


Grout / Ballast Bags



Precast Pipeline Concrete Cover

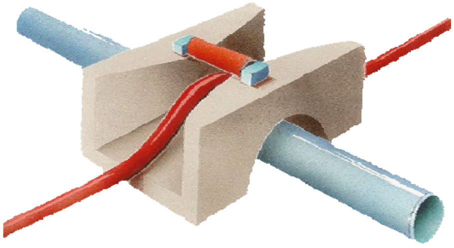
- Submat Bitumen Mattresses
- Submat Flexiform Concrete Mattresses
- Submat Pipeform Concrete Mattresses
- Submat Frond Flexiform Concrete Mattresses
- Impact Resistant Pre-cast Protective Covers
- Pipeline Crossing Supports
- Field Joint Coatings
- Special Projects incorporating Purpose-Built Pre-cast Structures
- River and Coastal Protection Mattresses
- Grout/Ballast Bags
- Technical/Design Services



Field Joint Coatings

Submat Flexiform Concrete Mattresses

Submat’s range of services is aimed at meeting the special requirements associated with the installation of offshore oil and gas pipelines / structures and their related works. Whatsoever your requirements.



Purpose-Built Pre-cast Concrete Structures

4m x 1.5m x 450mm Mattress draped over a 20” pipe.

Submat is a trading name of SLP Precast Limited, Hamilton House, Battery Green Road, Lowestoft, Suffolk NR32 1DE
First Point Assessment No.10044028

South East Asia contact information:
Telephone No: + (65) 9753 0163
Fascimile No: + (65) 6365 2569
Email: bjlozada@singnet.com.sg
Website:www.slp-eng.com

United Kingdom contact information:
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Offshore/Onshore Solutions

SUBMAT FLEXIFORM

Submat Flexiform is a low cost flexible concrete mattress developed as an addition to Submat's proven range of Submat bitumen mattresses which have been successfully utilised for stabilisation / protection of marine pipework for over three decades.

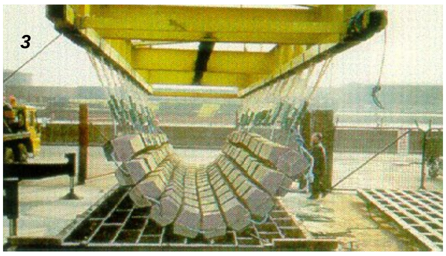
Introduced at the beginning of 1991, Submat flexiform has itself established an impressive track record with various projects successfully completed on time, full details of which are available upon request.

Flexiform consists of high strength concrete segments linked together with a network of high strength polypropylene ropes to form a continuous flexible concrete barrier.

Flexiform by virtue of individually profiled concrete segments is able to provide a high degree of flexibility in two planes and as such allows for complete stabilisation / protection in most applications i.e. straightforward pipeline cover, at pipeline bends intersections on trenched / untrenched pipelines, for counter-action to seabed scouring or where there are pronounced undulations in the seabed profile.

Flexiform can be installed with a simple quick release installation beam / frame which can be provided as an integral part of the order.

Submat Flexiform is designed to provide a high quality, low cost solution for stabilisation / protection of subsea pipelines / structures and conforms to the requirements of BS8110 'The Structural Use of Concrete'.



1. Completed 150mm thick mattress being lifted from mould.
2. Completed 300mm thick mattress being lifted from mould.
3. 150mm thick mattresses storage area.
4. 300mm thick mattresses in storage area.

SUBMAT FLEXIFORM TECHNICAL DATA

STANDARD THICKNESSES

150mm, 300mm, 450mm

STANDARD DENSITY

2.4 Tonnes / Cubic Metre.

Lightweight and Heavy Density options are available from 1.8 - 3.6 Tonnes / Cubic Metre.

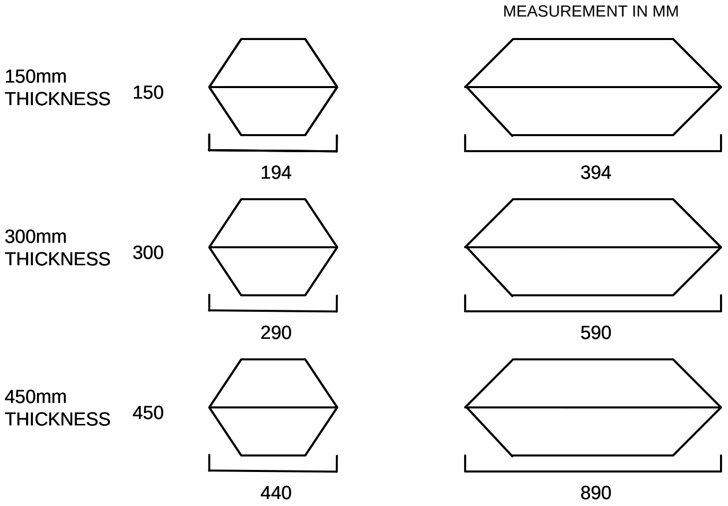
WEIGHTS (Standard Density Approx. Weights / m² Tonnes)

Thickness	In Air	Submerged
150mm	0.275	0.152
300mm	0.510	0.279
450mm	0.770	0.430

STANDARD MATTRESS SIZES

Standard mould sizes are 10m x 3m, plan area. Mattresses may be manufactured in any size within mould dimensions subject to standard block sizes. Mattresses in excess of standard mould sizes may be manufactured to order.

STANDARD BLOCK SIZES (N.T.S)



LIFTING ARRANGEMENT

Integral lifting loops connected to quick release frame as illustrated on front of sheet.

CONCRETE DESIGN SPECIFICATION

C40 / C50 - N/mm² @ 28 days

SUBMAT BITUMEN MATTRESSES

1

2

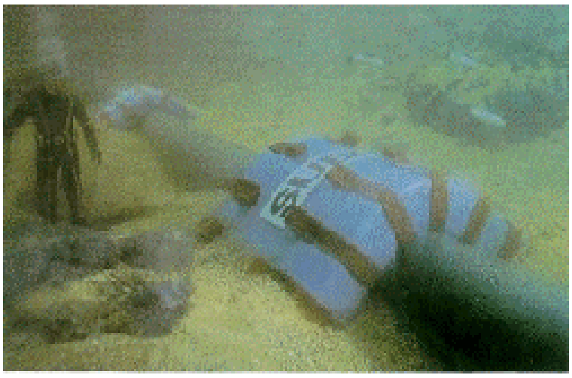
3

Counteraction to scouring the SUBMAT BITUMEN MATTRESSES progressively encourage sand build-up.

1. Installation

2. Partially embedded

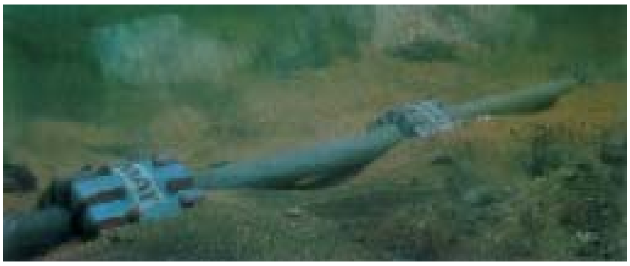
3. Permanent anchorage



Submat Bitumen Mattress the ocean's pipeline stabilisation and protection system.

Protection and stabilisation against erosion at land to sea transition.

Stabilisation and separation padding for pipeline crossovers.



Prevention of pipelift and snaking.

Developed and patented by Submat in 1971, the Submat Bitumen Mattress is the original subsea pipeline stabilisation / protection mattress and is synonymous with the business of subsea pipeline stabilisation and protection.

The Submat Bitumen Mattress has been deployed on numerous projects throughout the world up to the present time, and remains today a proven cost effective solution to many applications associated with subsea pipeline technology.

The Submat Bitumen Mattress consists of a durable outer canvas envelope c/w integral lifting slings which is filled with a dense suitably re-inforced bitu-mastic filler material, all of which combine to produce a flexible mattress that is suited for dealing with all pipeline support, stabilisation and protection requirements. Submat Bitumen Mattress in its solid form retains a flexible nature even in the coldest operational conditions which enables the mattress to respond to ever changing seabed conditions which are particularly attributed to the problems of scour.

The Submat Bitumen Mattress with its relatively void-less mass and size versatility is particularly successful in applications such as pipeline crossovers whereby support piers may be constructed with a minimal number of offshore lifts.

The Submat Bitumen Mattresses is installed with a simple quick release frame which can be supplied as an integral part of each order.

See reverse for Technical Data

SUBMAT BITUMEN MATTRESS

TECHNICAL DATA

SIZE

The Submat Bitumen Mattress, can be manufactured to suit client specification generally up to 10m x 4m in plan area.

STANDARD DENSITY

Approx.. 2.2 Tonnes per cubic metre, may be varied from approx. 1.5 to 3.2 Tonnes per cubic metre.

MIX SPECIFICATION (Standard Density)

48%	14mm down graded stone / crushed rock
30.5%	Sharp sand
11.5%	Limestone Filler
10%	200 penetration bitumen

ENVELOPE COVERS

The envelopes are manufactured from Duradon Extra or Regentex which are man made fibres.

Tensile strength in warp 2409N/50mm
Tensile strength in weft 2628N/50mm

Tear strength in warp 400N
Tear strength in weft 512N

LIFTING SLINGS

Each mattress is fitted with loomstate polyester lifting slings with a combined SWL of at least double the mattress weight in air.

Each sling has a break factor of 7 times the sling SWL, i.e. the combined sling break factor of a 10 Tonne mattress shall not be less than 140 Tonnes.

REINFORCEMENT MESH

Tensar Ar1 - Polyproplyene
Weight 0.24kg/m^3
Tensile strength Transverse 18kN/m
Tensile strength Longitudinal 14kN/m

SUBMAT PIPEFORM

Submat Pipeform is a flexible concrete mattress designed as a stabilisation and protection system for all marine pipework, cables and umbilicals.

Submat Pipeform has been developed as an alternative to the multi-flexible type concrete mattress, where flexibility is specified by the client or is primarily required as being parallel only to the axis of the pipeline.

Pipeform is particularly suited for pipeline stabilisation or pipeline cover.

Pipeform consists of high strength reinforced concrete logs linked together with appropriate strength polypropylene ropes which combine to offer a protective concrete blanket with a high degree of flexibility parallel to the protected pipeline.

Pipeform can be installed with a simple quick release installation beam / frame which can be provided as an integral part of the order.

Pipeform can be manufactured in various sizes / thicknesses and conforms to the requirements of BS 8110 ‘The Structural Use of Concrete’.

See reverse for Technical Data

A demonstration of a 4m x 1.5m x 4.5m mattress being lifted and draped over a 20” pipe. Approx. weight of example shown is 5.1 tonnes.

SUBMAT PIPEFORM

TECHNICAL DATA

STANDARD THICKNESSES

150mm, 300mm, 450mm, 600mm

Other thicknesses may be manufactured to order.

STANDARD DENSITY

2.4 Tonnes / Cubic Metre.

Lightweight and Heavy Density options are available from 1.8 - 3.6 Tonnes / Cubic Metre.

WEIGHTS (Standard Density)

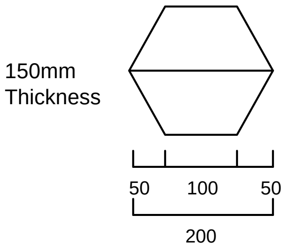
Approx. Weights Per Metre Length of Log (Multiply x Log Length x No Logs for Mat weight)

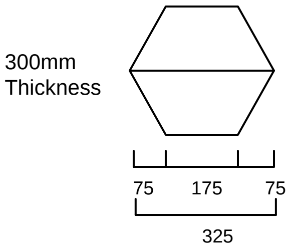
Thickness	In Air	Submerged
150mm	0.054	0.031
300mm	0.180	0.104
450mm	0.379	0.219
600mm	0.648	0.372

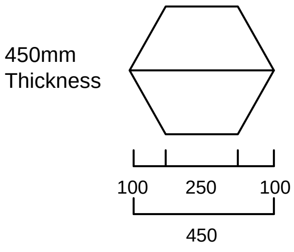
STANDARD MATTRESS SIZES

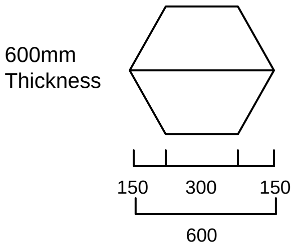
Maximum log length = 10m
Maximum proposed mattress width = 3m
Width / length of mattress may be adjusted subject to adjustment of log length and No. of logs deployed

STANDARD BLOCK SIZES (N.T.S)









LIFTING ARRANGEMENT

Integral lifting loops connected to quick release frame

CONCRETE DESIGN SPECIFICATION

C40 / C50 - N/mm^2 @ 28 days

Submat is a trading name of SLP Precast
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BLOWN GRANULAR MARINE MASTIC

(PATENT NO. GB2372251)

Blown Granular Marine Mastic, Grade D2/S is produced in accordance with our unique quality controlled process. The granular D2/S mastic has the appearance of loose, free flowing powdery granules, delivered in bulk bags ready for use. Bag size can be varied, but is typically around 1.2 to 1.3 tonnes.

ADVANTAGES OF USING BLOWN GRANULAR MASTIC

- Free flowing characteristics
- More rapid melt down
- More convenient transport system (bulk bags) for improved logistics & offshore efficiency
- Less likely to clump and to be tacky

Blown Granular Marine Mastic is designed to include a controlled moisture content to enhance the product's free flowing characteristics. A product, which is user friendly, easy to handle and melts rapidly, speeding up the joint sealing process.

RECOMMENDED STORAGE/POURING TEMPERATURES

Marine Mastic

Working Storage Temperature: **170°C - 210°C**

If due to operational requirements, there is a need to maintain the mastic at working temperature for an extended time, the following recommendations should be followed.

a) Do not hold at a temperature of 200°C for more than 6 hours or 8 hours at 180°C.

b) Pre-plan the storage time and if in excess of those in a) the holding temperature should be reduced to 150°C or lower to be consistent with maintaining movement of the mastic in the Dope Kettle.

c) When storage time is to exceed that in a) fresh material and or 85/25 Bitumen shall be added in sufficient quantity to maintain an acceptable flow characteristic.

d) For extended storage times, lids on the Dope Kettle, where fitted, shall be closed to restrict exposure to the air which may accelerate hardening.

e) After extended storage time at any temperature above melt, the mastic should be inspected and Pure Bitumen added when necessary to bring the mastic to an acceptable consistency.

BLOWN GRANULAR MARINE MASTIC

(PATENT NO. GB2372251)

Blown Granular Marine Mastic in Bags waiting shipment

Hot Pouring of Granular Marine Mastic

PHYSICAL PROPERTIES

D2/S Marine Mastic demonstrates the following key physical properties.

TEST	METHOD	SPECIFICATION	TYPICAL MEAN VALUES
Impact Resistance	A1 – SS7	$0^{o}C \geq 5cm$ $25^{o}C \geq 7cm$	18cm 14cm
Bending Resistance	A1 – SS7	$0^{o}C \geq 25$ s $25^{o}C \geq 30$ s	>35 s >60 s
Tensile Strength	A1 – SS7	$0^{o}C \geq 15$ kg cm $^{-2}$ $25^{o}C \geq 8$ kg cm $^{-2}$	16.5 kg cm $^{-2}$ 8.6 kg cm $^{-2}$
Compressive Strength	ASTM D695 (5mm min $^{-1}$)	$0^{o}C \geq 650$ psi $20^{o}C \geq 220$ psi	779 psi 257 psi
Elasticity Modulus	ASTM D695 (5mm min $^{-1}$)	$20^{o}C \geq 1100$ psi	10,546 psi
Density	BS 594/598 Part 3	2,100 ± 50 kgm^{-3}	2,158 kgm^{-3}
Seawater Absorption	$15^{o}C$ 1 Bar 40 Bar 60 Bar	-	0.040% 0.094% 0.052%
Electric Resistance	BS 903/2044	-	>58.9 GΩ cm

IMPACT RESISTANT COVERS

Submat specialises in the design and manufacture of impact resistant concrete covers against given performance criteria.

A standard semi-circular tunnel shape unit has been developed in addition to bespoke designed units for particular applications.

Submat covers have been designed to accept loading up to 800 kj due to dropped objects and 45 kj due to trawl boards.

Impact resistant covers (trawlboard and dropped object) for expansion spools on the TOTAL Dunbar Project.

The shape of the covers are designed to attract the least hydrodynamic loads and hence reduce scour. However, additional scour prevention systems (fronds) can easily be incorporated where necessary.

Covers can be stacked for economical use of deck space.

Impact resistant covers (trawlboard and dropped object) for expansion spools on the TOTAL Dunbar Project.

Sizes can be designed to facilitate road transportation. Where larger units prohibit logistical movements, covers can be manufacture at a load out quay.

Impact resistant covers (trawlboard and dropped object) for tee piece spools on the Elf Frostpipe Project.

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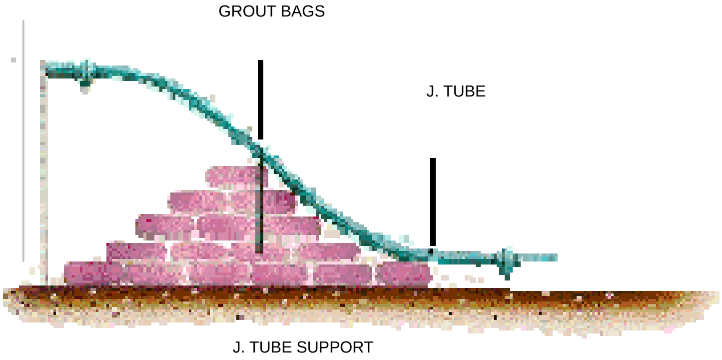
GROUT / BALLAST BAGS

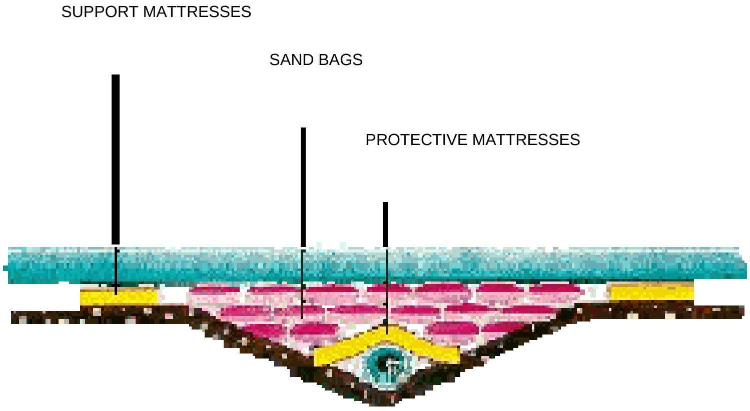
The use of grout and ballast bags when dealing with support / packing operations for subsea pipelines and structures is common place with subsea operators.

Although used independently, in many cases grout and ballast bags are installed to complement the primary method of protection i.e. mattresses / concrete covers etc.

Submat supply grout and ballast bags to complement the Submat protection systems or as an independent item.

See reverse for Technical Data





TRENCH FILL AT CROSSING PRIOR TO PIPE LAY

Illustration of typical applications

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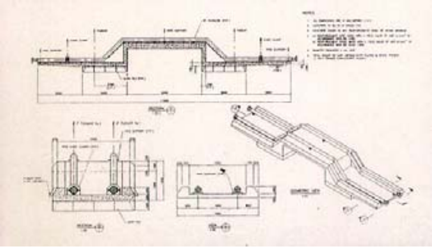
TECHNICAL DATA

GROUT AND BALLAST BAGS CAN BE SUPPLIED TO SUIT INDIVIDUAL CUSTOMER REQUIREMENTS / SPECIFICATIONS AS INDICATED BELOW

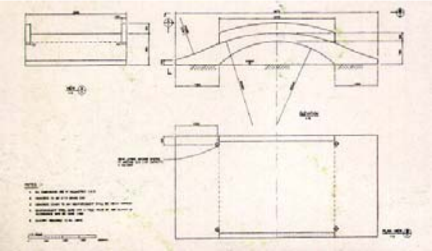
Bags are available in sizes 10kg, 25kg, 30kg, 40kg etc
Bags are provided in either polyprop or bio-degradable hessian
Grout bags have an inner polythene damp-proof liner
Grout mixes / constituents may be varied from neat O.P.C. (Ordinary Portland Cement) to 1:1, 2:1, 3:1, 4:1, 6:1 parts O.P.C to kiln dry sand or as otherwise specified by the client
Materials may be delivered on either pallets shrink - wrapped or in bulk bags of 1 tonne, 2 tonne etc

DESIGN

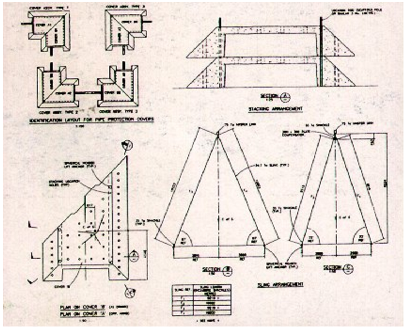
Examples of SLP's Design & Build projects



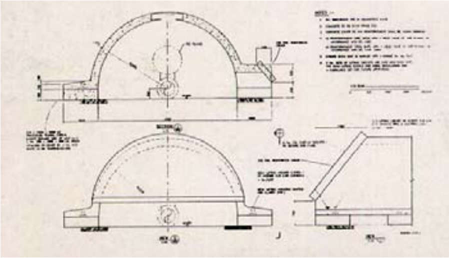
Pre-assembled pipespool bridge



Flowline crossing bridge



Impact resistant covers for expansion spools



Impact resistant Tee Piece cover

Submat personnel can provide all necessary design expertise including all computing and CAD facilities to prepare detailed designs, studies and reports for all aspects of offshore design. In house software has been developed to enable impact data and pipeline stability to be analysed.

The development of concrete for use in a marine environment is well proven and the cost effectiveness of concrete as an alternative to traditional options has been demonstrated many times. Concrete is inherently a cheap material to produce and can be readily adapted. When properly designed the durability of concrete products in a marine environment out performs steel and requires no additional treatments such as cathodic protection or coatings. Used as gravity structures, no additional installation measures such as piling or ballasting are required to provide stability.

It is our policy to provide the client with a complete package by providing cost effective solutions which consider aspects such as lift limitations, ease of positioning on the sea bed, transportation and optimised use of the installation vessel.

Design aspects undertaken include:

- Stability calculations to optimise mattress sizing for site specific environmental loading.
- Calculations and detailed design for trawlboard and dropped object resistance.
- Mattresses, covers, pipe supports, ramps, bridge crossings, anchor blocks etc. can all be designed to site specific requirements.
- Foundation design for pipe support systems.
- Scour prevention and remedial design studies.
- Innovative designs using reinforced and pre-stressed concrete for subsea applications.
- Hazard studies for impact criteria and risk from trawlboard effects.
- Research into the use of alternative concrete mix designs, e.g. lightweight and heavy weight aggregates, fibre reinforcement etc.

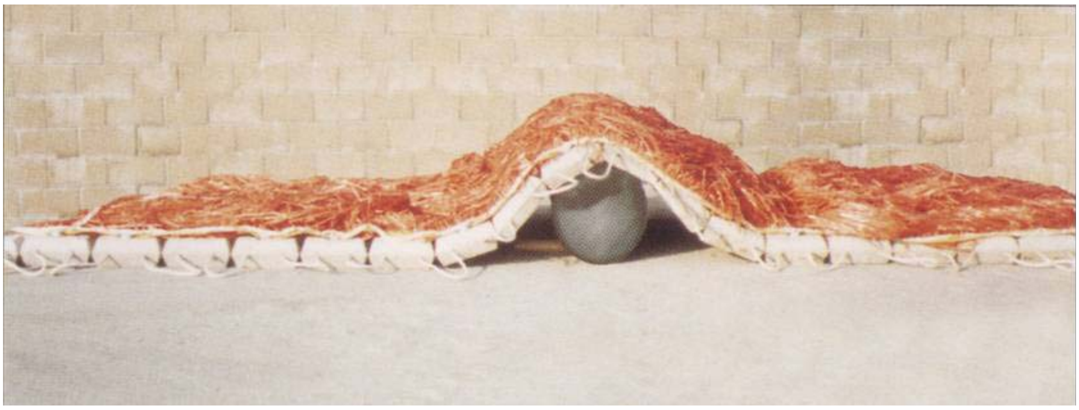
Submat has a proven track record in designing against given performance criteria and is pleased to provide this service as part of an E.P.C contract or on a consultancy basis.

SUBMAT SUBMAT
Offshore/Onshore Solutions

FROND FLEXIFORM CONCRETE MATTRESS

The **"Frond Flexiform"** Mattress, is a combined buoyant frond scour mat and flexible concrete mattress available in several standard variants, all have the same continuous and significantly overlapping parallel lines of buoyant fibrillated polypropylene fronds attached to and aligned with, the lines of the concrete blocks.

No steel members (nor any other metals) are used in the blocks – this avoids dissimilar metal corrosion problems that have arisen in the offshore oil and gas industry from the use of slag in rock dumps. The Frond Line attachment points are moulded into the concrete base blocks.



FROND FLEXIFORM CONCRETE MATTRESS

The **"Frond Flexiform"** Mattress combines all the features of both a flexible concrete mattress and a buoyant frond scour control mat in one: and in particular it offers the following benefits:

- installation is simple and swift, and it provides both instant stabilisation / protection and immediate hold down;
- the creation of long term fibre reinforced, consolidated and vibration compacted sediment bank build up over the mattress substantially adds to the degree of stabilisation / protection afforded and provides an exceptional reduction in scour potential close to structures;
- it provides scour protection for an area somewhat greater than the actual area covered by the mattress:
- the individually profiled concrete segments provide a high degree of flexibility in two planes and allow for a complete stabilisation / protection of subsea structures and pipelines and offer a linked flexible foundation to ensure that load is spread evenly over an area; and
- the fronds prevent edge scour and also halt internecine block (or rock) scour, this eliminates any requirement for the use of geotextile filter screens under a Frond Flexiform mattress.

The submerged weight of the mattress on first installation will increase as the scour control system creates a fibre-reinforced bank over the base mattress. The rate of build up and size of such bank varies from site to site.

The build up of the material bank within the Frond Flexiform mattress is non-linear. The 1.25m high fronds create the greatest viscous drag when first deployed and the initial 200mm to 300mm of mat/mattress infill occurs quickly in normal tidal conditions given the sort of sediment sizes at most offshore sites. As the material bank forms, the exposed frond length is reduced, the mat creates less viscous drag and the rate of formation of the material bank slows until a steady state is reached.

The sediment bank created is considerably more stable and more dense than the natural surrounding seabed: many surveys have confirmed that it is considerably consolidated by the vibratory movement of fronds during the sedimentary period and once in place it is permanently reinforced by the frond material.

Any sediment bank so formed extends out from the frond area to cover the sides of the base mattress extending out in descending curve to seabed level for a distance slightly greater that the height of the formed bank – the final shape of such a "curve" depends upon the coefficient of friction of the seabed particles.

FROND FLEXIFORM CONCRETE MATTRESS

SEDIMENT BANK PROJECTION

For offshore sites after some 20 to 45 days a significant, compacted and solid sediment bed will be in place and a height of not less than 450mm is normal; the final height of bank with a frond height of 1,250mm should should safely exceed 900mm in height after some 40 to 75 days. The formation of such a sediment bank over the Mattress provides submerged weigh or “hold down”. A typical submerged weight of sand particles is 819.5kg/m^3, but the range is large thus the submerged weight of the fibre reinforced material bank can vary. For a 5.0m x 3.0m Frond area this should be:

- after 20 days: in the range 6.67 tonnes to 5.5 tonnes – this is additional to the base mattress' concrete block weight (with 150mm base blocks = 2.28t submerged weight and with 300mm base blocks =4.18t submerged weight).
- after 40 to 75 days: in the range 15.0 tonnes 11.08 tonnes + base mattress' concrete block submerged weight.

BUOYANT FROND MATERIAL

UV stabilised Polypropylene. Fully tested “ Chemically Resistant”. Specific gravity 0.908 and 0.92. Full fibrillated and with profiled film.

FROND LENGTH & ATTACHMENT

Buoyant Fronds are attached to Mattress in successive continuous rows providing substantial and unbroken overlap of fronds to those in the neighbouring rows. Frond clumps are NEVER used. Frond Length (height when deployed) of the lines of buoyant frond material is 1250mm. In riverine (and other special situations) lesser frond heights allied to a proportionate increase in frond density (spacing) in the frond rows may be used. A “Safe Net” frond release is provided for diver and ROV safety.

STANDARD BLOCK THICKNESS

150mm, 300mm, and 450mm.

STANDARD BLOCK DENSITY

2.4 Tonnes / Cubic Metre. Lightweight and Heavy Density options are also available from

1.8 - 3.6 Tonnes / m^3.

WEIGHTS (STANDARD DENSITY)

Approximately Weight / m^2 - at Installation

Thickness (Tonnes)	In Air (Tonnes)	Submerged (Tonnes)
150mm block	0.275	0.152
300mm block	0.510	0.279
450mm block	0.770	0.430

FROND FLEXIFORM CONCRETE MATTRESS
TECHNICAL DATA

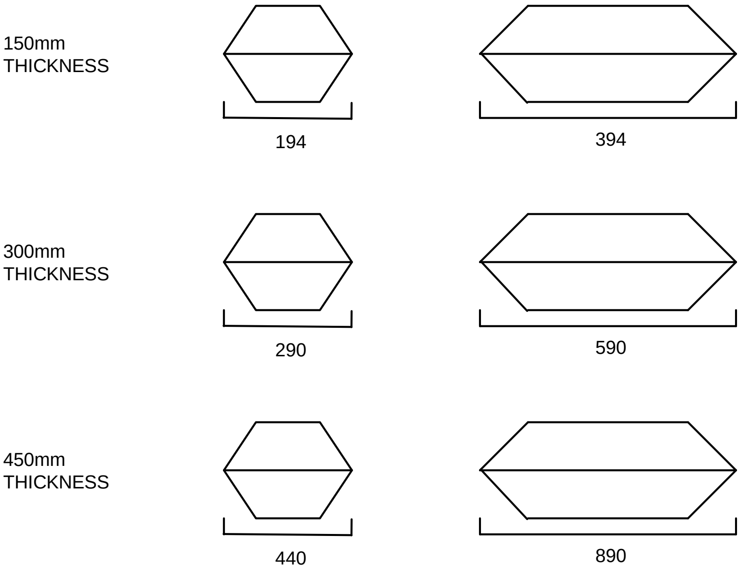
TOTAL SUBMERGED WEIGHT

The submerged weight will increase due to the material bank formed by the fronds: the weight of the bank varies according to the seabed composition. A typical submerged weight of sand particles is 819.5kg / m^3, but the range is large thus the submerged weight of the fibre reinforced material bank can vary. For a 6m x 4m mattress this should be in the range is large thus the submerged weight of the fibre reinforced material bank can vary. For a 6m x 4m mattress this should be in the range 23.9 tonnes to 19.9 tonnes - this is additional to the concrete weight which with a 150mm thick mattress at standard density would be 3.7 tonnes giving a total submerged hold down of 27.6 to 23.6 tonnes.

STANDARD MATTRESS SIZES

Standard mould sizes are 10m x 3m in plan area. Mattress may be manufactured in any size within mould dimensions subject to standard block sizes. For pipeline overlay either 4m or 5m width by 2, 3, 4, 6 or 10m length is preferred to provide cover 2 to 2½m either side of the pipeline as well as over & along the line in a single installation. Mattresses in excess of standard mould sizes may be manufactured to order.

STANDARD BLOCK SIZES (N.T.S.) MEASUREMENT IN MM



CONCRETE DESIGN SPECIFICATION

C40 / C50 - N / mm^2 @ 28 days. Conforms to the requirements of BS8110: The Structural Use of Concrete

ADDITIONAL GROUND ANCHORS

Additional 1 tonne ground anchors certified by ABS and Lloyd’s may be attached at corners or edges to provide the additional edge hold down to increase stability / protection capability (e.g. against trawling).

LIFTING ARRANGEMENT

Integral lifting loops connected to quick release frame.

SUBSEA TECHNOLOGY SOLUTIONS THROUGH EXPERIENCE, EXPERTISE, QUALITY AND INNOVATION

MID WATER ARCHES, GRAVITY BASES
AND
TETHER BASES

Mid Water Arch

SLP has a wealth of experience in the design and build of offshore platforms and subsea structures. SLP has harnessed that experience to add to its portfolio the design and build of Mid Water Arch, Gravity Bases and Subsea Tether Systems.

In conjunction with our partners Keppel, SLP can offer an experienced design team based in London with the ability to fabricate in various locations:

Fabrication	Destination
Lowestoft	UK & Europe
Singapore	Far East & Australia
Brownsville, Texas	Gulf of Mexico & Brazil

Flexible Riser Guide

MID WATER ARCHES, GRAVITY BASES
AND
TETHER BASES

Mid Water Arch

Flexible Riser Guide

Our strongly client orientated approach ensures that projects are executed as efficiently as possible and our world wide fabrication capability ensures that the client gets what they at the most economic rate.

Co-ordination between SLP the client and the installation company is vital to achieve the most economic design which SLP will tailor to match not only the riser and umbilical loading but also methods of the installation contractor.

Submat is independently certified to ISO 9001:2000.

Flexible Riser Guide

Filter Point

Filter Band™

Uniform Section

Enviromat™

Articulating Block

Hydrocast™ Armor Units

HYDROTEX™

Fabric-formed Concrete Erosion Control and Armoring Systems

Product Guide

Filter Point (FP) Linings

Filter Point Linings with filtering points (drains) provide erosion resistant, permeable concrete linings for ditches, channels, canals, streams, rivers, ponds, lakes, reservoirs, marinas, and port and harbor areas. Filter Point Linings have a cobbled surface and a relatively high coefficient of hydraulic friction in order to achieve lower flow velocities and to reduce wave run-up. The filter points provide for the relief of hydrostatic uplift pressures, increasing the system's stability.

Filter Point Linings were the first style of fabric form for concrete. In 1965, a Dutch patent was issued for "fabric-formed slope paving." The form suggested by this patent was later refined to create the first "filter point" lining.

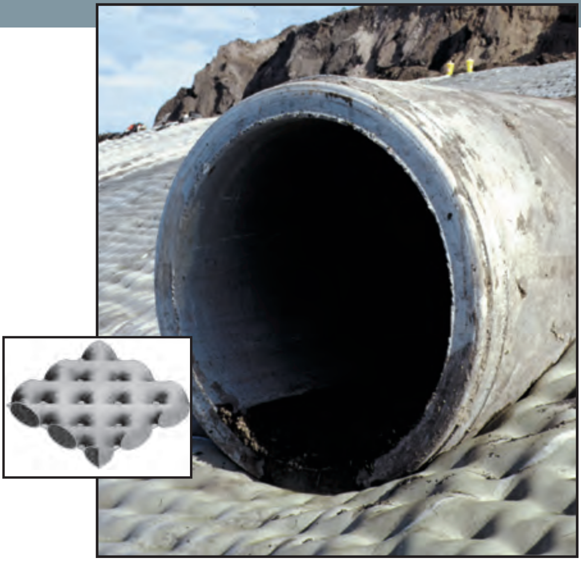
As the use of this technology has spread worldwide, a variety of other forms have been developed to meet specific job requirements.

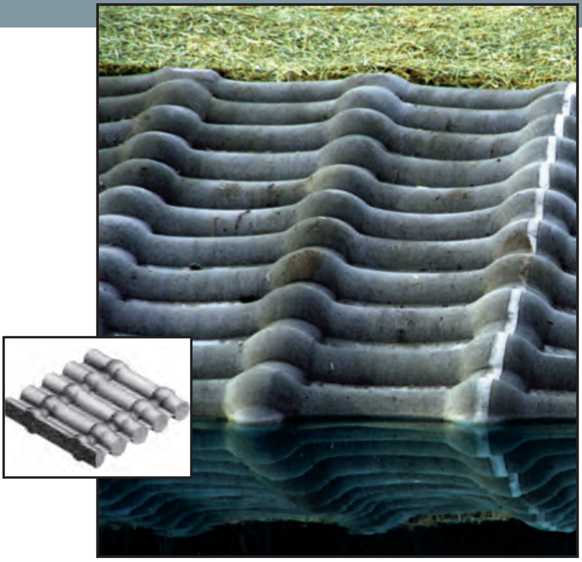
Filter Band™ (FB) Linings

Filter Band Linings are similar to Filter Point Linings, providing an effective and highly permeable concrete lining that resists erosive forces.

Filter Band differs from Filter Point in that the form creates interconnected, tubular concrete elements that are separated by large, interwoven filter bands. The filter bands provide for greater reduction of uplift pressures than filter points. Also, the biaxial alignment of the tubular elements creates two directionally-determined coefficients of hydraulic friction. As a result, Filter Band achieves a greater reduction of flow velocity or wave energy than Filter Point.

Filter Band concrete linings are specified in situations similar to those for which Filter Point might be specified, but which also require greater relief of uplift pressures, higher reduction of flow velocities, or greater reduction of wave run-up.





The Advantages of Hydrotex Linings, Mats, and Armor Units

Stability:

Hydrotex Fabric Forms, manufactured by Synthetex LLC, have been used in millions of square feet of installations worldwide, some in the most severe conditions. In the process they have established a new benchmark in erosion protection by outperforming traditional concrete slope paving, gabions, precast concrete blocks, and rip rap.

Thousands of installations and extensive flume testing have proven that Hydrotex fabric-formed concrete erosion protection systems outperform all alternatives. Hydrotex Linings and Mats, with permissible shear stress in excess of 60 lbs/ft^2 (2.87 kN/m^2), provide the high degree of stability needed to resist the stresses associated with high velocity flows. Hydrotex fabric-formed concrete has greater hydraulic efficiency than rip rap, gabions, precast concrete blocks, and conventional concrete slope paving because of several factors. It can mitigate uplift forces due to outflow and excess pore water pressure, reduce hydraulic uplift by slowing channel velocities, and conform to soil contours to reduce the potential for scour.

Reduced Uplift Pressures:

Many styles of Hydrotex Linings and Mats can accommodate severe uplift pressures. These uplift pressures often cause the failure of conventional concrete slope paving. Unlike traditional methods, fabric forms can be manufactured with built-in filter drains that reduce the mean phreatic level and pore pressures within the underlying soil.

Management of Hydraulic Flow:

Many Hydrotex Fabric Forms construct concrete linings and mats with deeply patterned surfaces. These patterns create a high coefficient of hydraulic friction. The result is reduced

Uniform Section (US) Linings

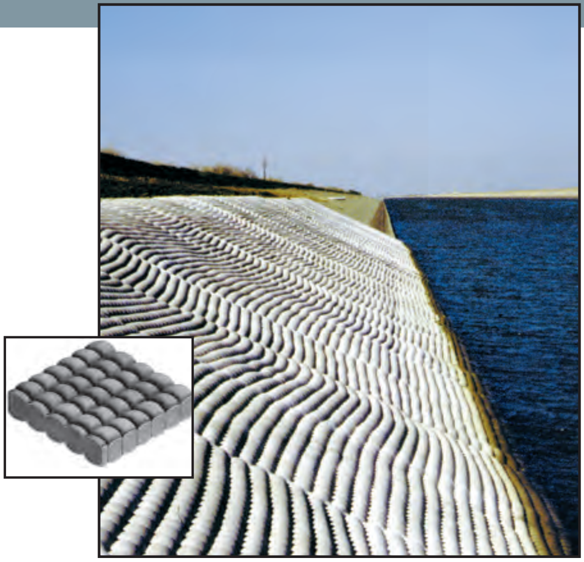
Uniform Section Linings are similar to traditional concrete slope paving. They create a solid, high quality concrete lining with a relatively low coefficient of hydraulic friction and a uniform cross section. Uniform Section Linings are used to reduce the infiltration of aggressive waste and chemical fluids into or out of open channels and basins. They are also used to reduce exfiltration in arid regions where open channels and basins require watertight linings.

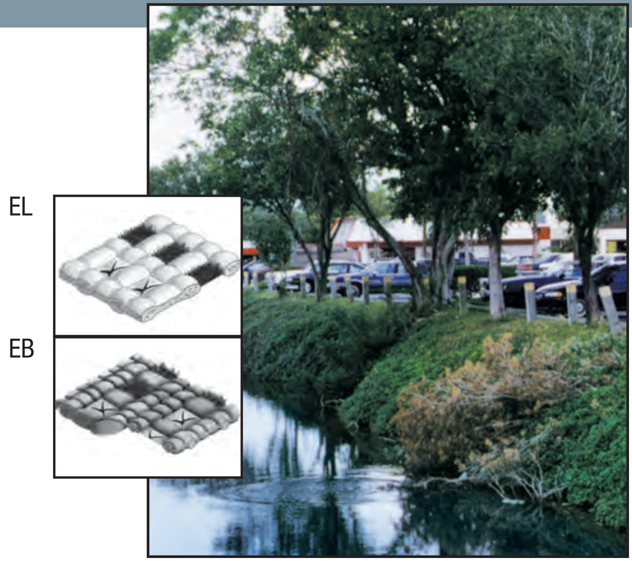
Uniform Section Linings are resistant to most leachates and chemicals. They protect geosynthetic liners from mechanical damage, exposure to UV light, and freeze-thaw cycles and also serve as a ballast layer. These self-supporting, high strength linings permit construction on steep side slopes and replace the use of clay or sand as liner protection. Concrete filling of the forms can be performed with a minimum of traffic on the liner, and the tensile strength and abrasion resistance of the fabric protect the liner from the pumped concrete.

Enviromat™ (EL and EB) Linings

Enviromat Linings are installed to provide protection against periodic high flows. After installation, vegetation can be planted within the open structure of the lining. Enviromat Linings are used in drainage ditches and on the upper slopes of channels, canals, lakes, reservoirs, rivers, and other water courses as well as for embankments subject to heavy run-off.

Enviromat Linings are comprised of concrete-filled elements and unfilled areas that allow for the establishment of vegetation. Once the concrete sets, the unfilled areas are opened by cutting the fabric and are then planted or filled with topsoil and seeded. Within a growing season a vegetated cover will normally extend over the lining, resulting in an erosion control system with the hydraulic, ecological, and aesthetic features desired. EL Linings have a greater open area than EB, so a vegetated cover will be established more rapidly. However, EB Linings are designed to articulate and are more tolerant of uneven settlement after installation.





flow velocity and reduced wave run-up. These surface characteristics impart stability to the system by reducing velocities and also mean that the designer can affect the flow characteristics of a channel, creating the opportunity for an “engineered” hydraulic system. By choosing the correct style of form, in-channel flow can be slowed, reducing downstream velocities and discharge turbulence. Or an hydraulically-efficient, smooth form (such as Uniform Section) can be chosen to maximize drainage from a given area.

Adaptation to Soil Contours:

Filled-in-place fabric forms accommodate uneven contours, curves, and subgrades at the time that they are filled. Consequently, the soil and the concrete protection are in intimate contact, reducing the chance of underscour. Some forms create discrete concrete units, attached to each other with fabric perimeters and/or embedded cables. As a result, the concrete mats can articulate to adapt to uneven settlement.

Ease of Installation:

Hydrotex Fabric Forms are delivered to the job site ready-to-fill and require no additional forming materials. Installation consists of preparing the area, laying out the fabric forms, and filling them with concrete through a small-line concrete pump. Wood or steel forming is not required. The fabric forms themselves assure that the concrete assumes the proper configuration, contours, dimensions, and thickness. Hydrotex Linings and Mats do not require steel reinforcement or concrete finishing. A small crew can handle the installation, and fabric forms can be installed without dewatering the site.

Simple Job Mobilization:

Fabric forms are extremely lightweight, so they can be rapidly shipped anywhere in the world. The “weight” component of a fabric-formed system, the fine aggregate concrete, is readily available from concrete suppliers

Articulating Block (AB) Mats

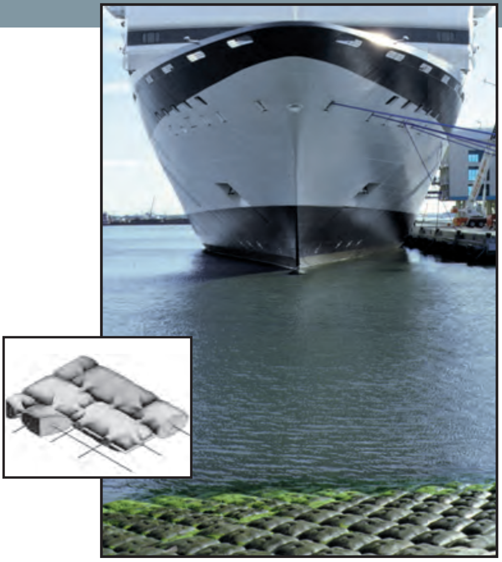
Articulating Block Mats form cable-reinforced concrete block mattresses that resist erosive forces. They are often installed where a revetment is exposed to attack by wave action and are used to protect shorelines, canals, rivers, lakes, reservoirs, underwater pipelines, bridge piers, and other civil and marine structures from propeller wash, ship wakes, waves, currents, and high velocity flows. They are also used in environmental construction for landfill caps, downchutes, and collector channels.

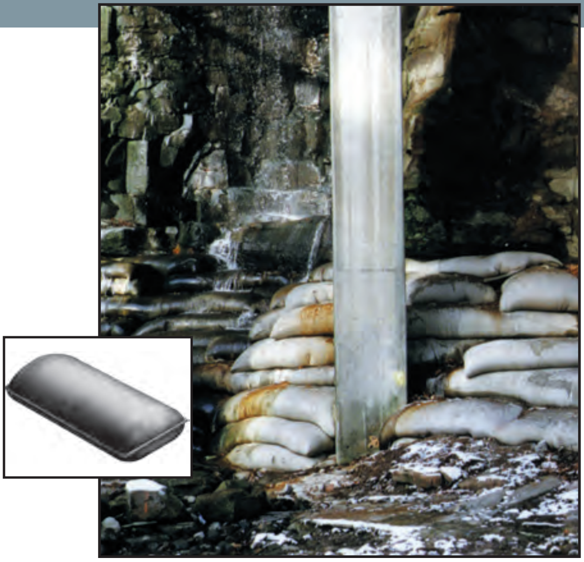
Articulating Block Fabric Forms consist of a series of compartments linked by interwoven perimeters. Grout ducts interconnect the compartments. High strength revetment cables are installed between and through the compartments and grout ducts. Once filled, AB Mat becomes a mattress of pillow-shaped, rectangular concrete blocks. The interwoven perimeters between the blocks serve as hinges to permit articulation. The cables remain embedded in the concrete blocks to link the blocks together and facilitate articulation.

Hydrocast™ Armor Units

Hydrocast Armor Units are monolithic concrete structures which replace heavy rip rap and large precast concrete armor units, such as tetrapods. When the rectangular fabric forms are filled, they assume a flattened cylindrical cross section and range in size from roughly 180 pounds to in excess of 70 tons (80-64,000 kg) per unit. Available in custom sizes and shapes, the dimensions of the form control the concrete armor unit's length, width, height, and weight.

Armor Units have the mass and stability for the construction of gravity seawalls and revetments, groins, levees, dikes, dams, check dams, and other civil and marine structures subject to attack by waves or rapidly flowing water. Since they are filled in place, they adapt to variations in the subgrade and are ideal for preventing or repairing scour at bridge piers and abutments, culvert outfalls, or underwater pipelines. Hydrocast installations do not require dewatering, a crucial advantage in emergency repair situations.





worldwide. Once the site is prepared, simple hand tools and a concrete pump are all that is needed to fill the forms. And in areas with difficult or restricted access, the concrete can be pumped to the forms from as far away as 800 feet (250 meters). Because of the low mobilization costs, it is practical to install fabric forms on jobs as small as a hundred square feet (10 square meters). Regardless of the job size, the ease of mobilization and transportation and the reduced equipment and labor requirements mean that the job goes in faster and at less cost per square unit of protected area.

Environmental Compatibility:

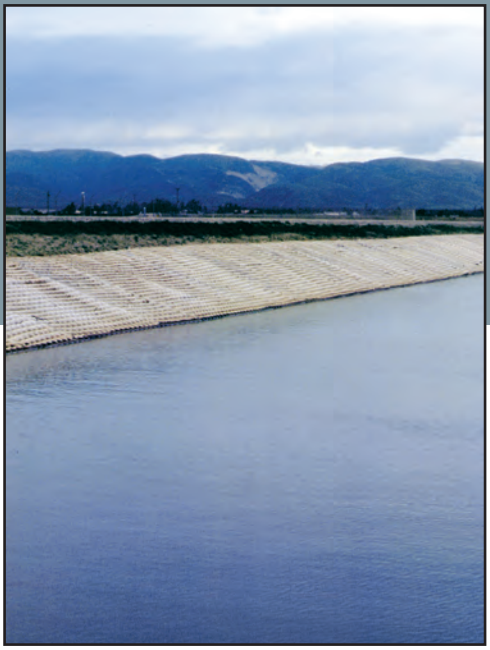
Fabric forms are designed to provide the least possible environmental impact. The fabric used in the forms allows excess mixing water to escape while retaining the cement solids, fine aggregate, and sand. EL and EB Linings have been designed to provide defined areas that can be cut out after installation so that native vegetation can be planted or seeded to create a more natural appearance. And Hydrotex Linings and Mats are free of hazardous projections that could endanger pedestrians, animals, vehicles, or boats.

Hydrotex fabric-formed concrete erosion control systems outperform all traditional solutions and reduce total system cost. The expertise and knowledge that Synthetex has gained from thousands of installations worldwide are incorporated into every form we manufacture. Time and again, in many different types of projects, our erosion control systems have performed "as specified" and delivered predictable erosion control.

Hydrotex™

Fabric-formed Concrete Erosion Control and Armoring Systems

Hydrotex systems outperform rip rap, gabions, precast concrete blocks, and concrete slope paving, yet are less expensive and far easier to install.



Applications:

Drainage Ditches
Channels and Canals
Streams, Rivers, and Bayous
Lakes and Reservoirs
Coastal and Intracoastal Shorelines
Jetties and Groins
Dikes and Levees
Dune Protection
Beach Renourishment
Seawall and Bulkhead Scour Protection
Boat Launching Ramps
Wildlife Crossings
Low-water Stream Crossings
Embankments
Underwater Pipeline Covers
Bridge Abutments and Piers
Check Dams
Dams and Spillways
Ponds and Holding Basins
Landfill Caps
Down Chutes
Water Control Structures

Hydrotex Fabric Forms are filled in place with fine aggregate concrete, delivering the durability and performance of concrete without the costly and difficult installation process of a conventionally-formed concrete slope paving.

Hydrotex systems are not only less expensive than rip rap, gabions, precast concrete blocks, or conventionally-formed concrete slope paving, they also deliver significant stability and performance advantages once installed.

Hydrotex systems can:
- adapt to variable subgrades,
- relieve uplift pressures,
- reduce wave run up, and
- manage channel velocities.

The result is a more cost-effective erosion control system with greater hydraulic efficiency, higher permissible velocities, and improved stability, durability, and performance.

A Wide Range of Solutions

Constructed of high strength, specially woven fabric, Hydrotex™ Fabric Forms come in a variety of form styles. Each style has been engineered to match a certain set of project parameters, allowing you to specify different forms to accommodate differing site conditions. Hydrotex Linings and Mats are used to create erosion and scour prevention systems ranging from ditch linings to coastal revetments. Hydrocast™ Armor Units are monolithic concrete structures that are used for the construction of seawalls and other civil and marine applications.

Proven in the Lab and in the Field

Hydrotex products have been extensively evaluated in an advanced hydraulics laboratory at a leading research facility. Flume testing of Hydrotex Linings and Mats has derived precise design values to assist you in selecting the appropriate fabric form style and mass per unit area to resist the expected hydraulic loading. Hydrotex products have proven their value, quality, and integrity in literally thousands of projects worldwide.

Backed with Technical Expertise

Synthetex's team of technical, manufacturing, and field personnel work closely with engineers, owners, and contractors to derive the best design solutions. Our design philosophy demands solutions that meet strict performance, aesthetic, cost, and construction criteria. You are assured of quality materials, superior technical support, competitive prices, and a commitment to excellence. Our team is able to provide technical and design assistance, system specifications, cost estimates, and construction drawings.

Linings and Mats: Typical Installed Dimensions, Weights and Volumes

Products and Sizes	Average Thickness, in (mm)	Mass per Unit Area, lb/ft^2 (kg/m^2)	Concrete Coverage, ft^2/yd^3 (m^2/m^3)	Varies With Product	
Filter Point Linings					Filter Point Spacing, inches (mm)
FP220	2.2 (55)	25 (120)	136 (16.6)		5 (125)
FP300	3 (75)	34 (165)	100 (12.1)		6.5 (165)
FP400	4 (100)	45 (220)	75 (9.1)		8 (200)
FP600	6 (150)	68 (330)	50 (6.1)		10 (255)
FP800	8 (200)	90 (440)	38 (4.6)		12 (305)
FP1000	10 (250)	113 (550)	30 (3.6)		14 (355)
FP1200	12 (300)	135 (660)	25 (3.0)		16 (405)
Filter Band™ Linings					Filter Band Spacing, inches (mm)
FB400	4 (100)	45 (220)	75 (9.1)		8 (200)
Uniform Section Linings					
US300	3 (75)	34 (165)	100 (12.1)		
US400	4 (100)	45 (220)	75 (9.1)		
US600	6 (150)	68 (330)	50 (6.1)		
US800	8 (200)	90 (440)	38 (4.6)		
US1000	10 (250)	113 (550)	30 (3.6)		
US1200	12 (300)	135 (660)	25 (3)		
US1600	16 (400)	180 (880)	19 (2.3)		
Environ™ Linings					Open Vegetated Area, %
EM250	2.5 (65)	28 (138)	120 (14.6)		20
EM400	4 (100)	45 (220)	75 (9.1)		20
Articulating Block Mats				Mass Per Block, lb (kg)	Nom. Block Dimensions, inches (mm)
AB300	3 (75)	34 (165)	100 (12.1)	52 (23.5)	22 x 10 (560 x 255)
AB400	4 (100)	45 (220)	75 (9.1)	95 (43)	22 x 14 (560 x 355)
AB600	6 (150)	68 (330)	50 (6.1)	205 (93)	22 x 20 (560 x 510)
AB800	8 (200)	90 (440)	38 (4.6)	350 (158)	22 X 26 (560 x 660)
AB1000	10 (250)	113 (550)	30 (3.6)	550 (250)	35 x 20 (890 x 510)
AB1200	12 (300)	135 (660)	25 (3.0)	880 (400)	35 x 27 (890 x 685)

Hydrotex Linings, Mats, and Armor Units are filled in place by pumping fine aggregate concrete into fabric forms. The results are reduced material and equipment costs, faster installation, and dependable erosion and scour prevention.

Whether you're lining a channel; protecting landfill containment systems, underwater pipelines or dams; repairing bridge scour; or armoring a shoreline against storm damage, Synthetex LLC has the form that meets your needs.

For complete specifications and our Construction and Quality Control Manual, please visit our web site at: www.synthetex.com

Note: Values shown are typical and will vary with weight of concrete and field conditions. Custom products of different thicknesses and dimensions can be manufactured.

SYNTHETEX®

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ARMORTEC®
Erosion Control Solutions

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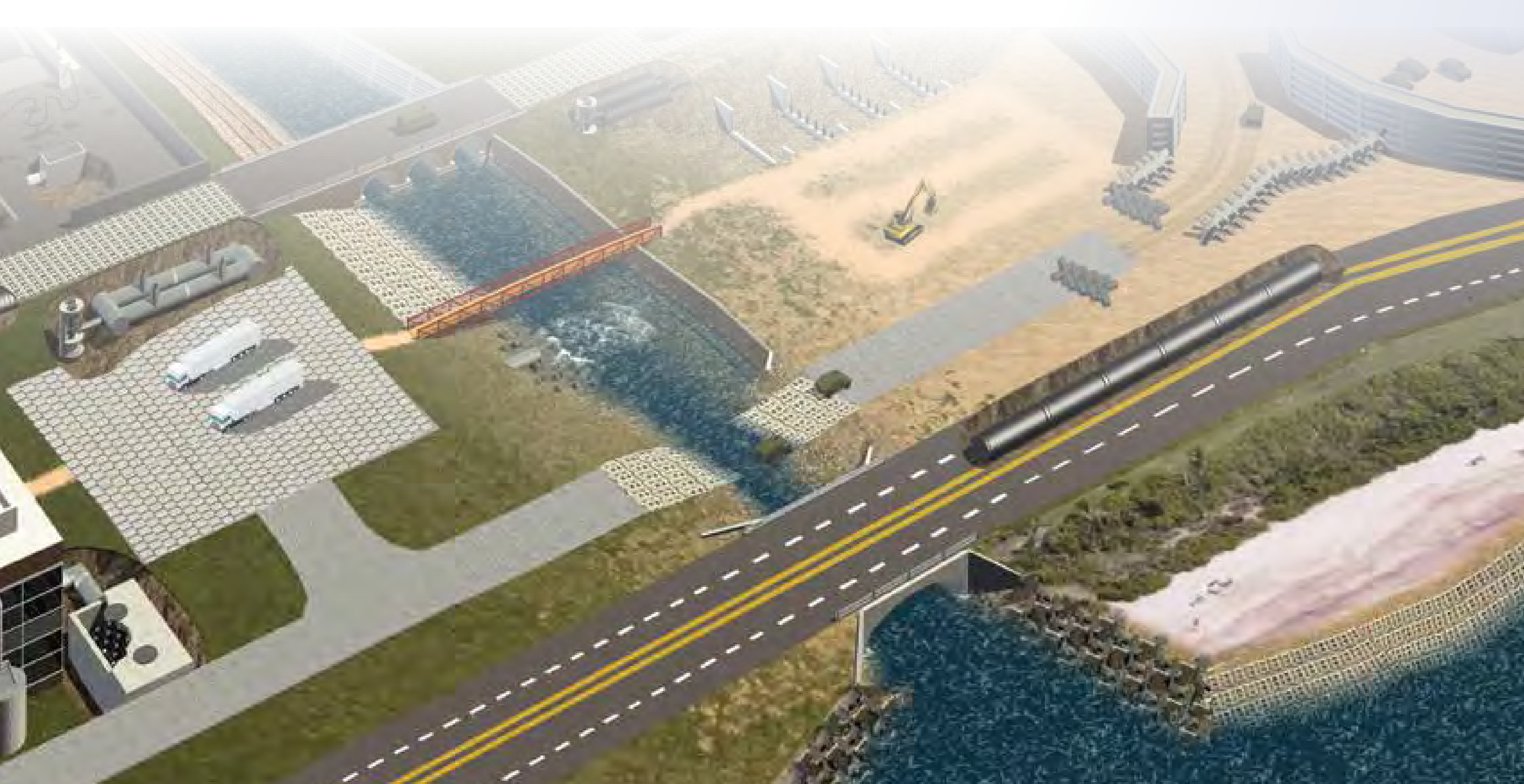
ENGINEERED SOLUTIONS

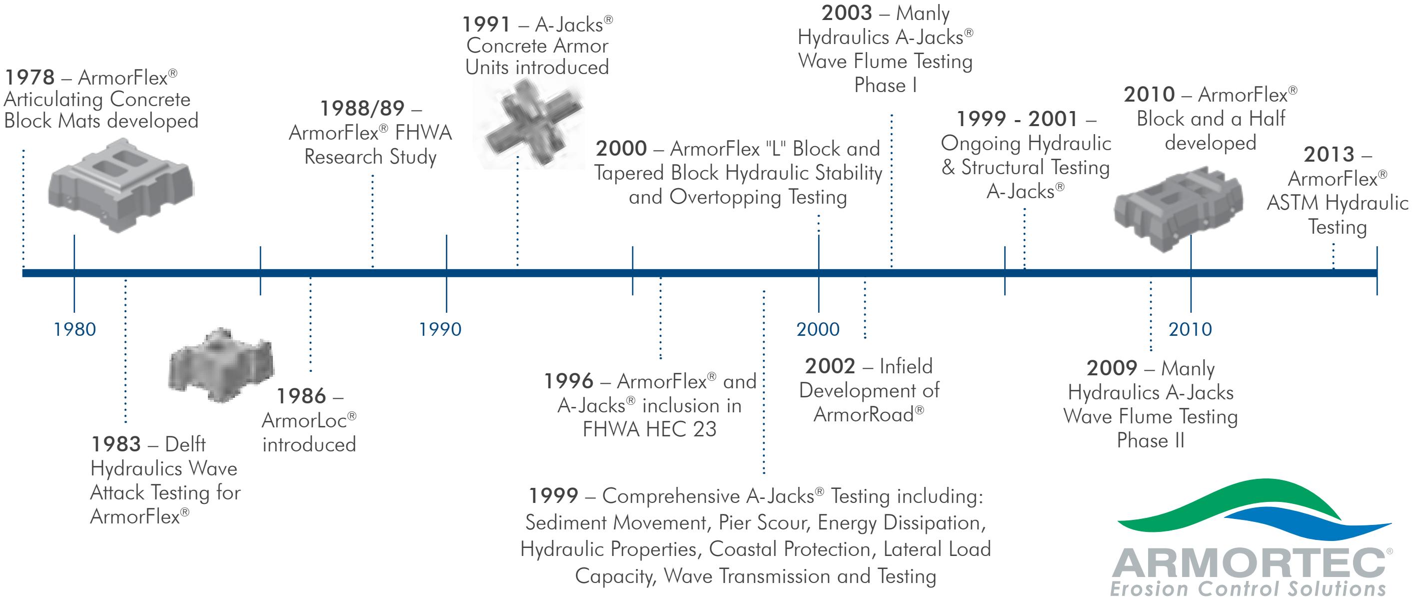
ARMORTEC® HARD ARMOR SOLUTIONS



ARMORTEC HARD ARMOR SOLUTIONS.

A LEGACY OF SUCCESS

Doing the seemingly impossible is an everyday job. With erosion control systems for any need in any application, Contech Engineered Solutions delivers a range of effective, efficient solutions. Our engineered systems provide performance-tested solutions for a wide variety of applications including channel lining, shoreline protection, dam crests and spillways, energy dissipation, pipeline and cable protection, bridge and abutment protection, boat ramps, low water crossings, outfall protection, wave attack protection and more.



1978 – ArmorFlex® Articulating Concrete Block Mats developed

1983 – Delft Hydraulics Wave Attack Testing for ArmorFlex®

1986 – ArmorLoc® introduced

1988/89 – ArmorFlex® FHWA Research Study

1991 – A-Jacks® Concrete Armor Units introduced

1996 – ArmorFlex® and A-Jacks® inclusion in FHWA HEC 23

1999 – Comprehensive A-Jacks® Testing including: Sediment Movement, Pier Scour, Energy Dissipation, Hydraulic Properties, Coastal Protection, Lateral Load Capacity, Wave Transmission and Testing

1999 - 2001 – Ongoing Hydraulic & Structural Testing A-Jacks®

2000 – ArmorFlex "L" Block and Tapered Block Hydraulic Stability and Overtopping Testing

2002 – Infield Development of ArmorRoad®

2003 – Manly Hydraulics A-Jacks® Wave Flume Testing Phase I

2009 – Manly Hydraulics A-Jacks Wave Flume Testing Phase II

2010 – ArmorFlex® Block and a Half developed

2013 – ArmorFlex® ASTM Hydraulic Testing

ARMORTEC®
Erosion Control Solutions

BUILDING CONFIDENCE EVERY STEP OF THE WAY

	ARMORTEC SOLUTIONS	**VS. TRADITIONAL RIP-RAP**
RESEARCH & DEVELOPMENT	ASTM TESTING PROTOCOL COMPLIANT FULL-SCALE TESTING	SCALE MODEL TESTING
DESIGN	CONSISTENT & CONSERVATIVE INDUSTRY DESIGN GUIDELINES	RECOMMENDED GRADATION VARIES WITH METHODOLOGY
QUALITY CONTROL	MANUFACTURED UNDER CONTROLLED CONDITIONS IN COMPLIANCE WITH ASTM ESTABLISHED STANDARDS	RANDOM QUARRIED MATERIAL WITH LIMITED QUALITY CONTROL
CONSTRUCTION	CONFIDENT & SELF-EVIDENT PLACEMENT QUALITY	VARIABLE PARTICLE DISTRIBUTION

INCREASE YOUR CONFIDENCE WITH ARMORTEC

PROCESS – DESIGN, PREFABRICATION, INSTALL.

	ARMORFLEX®	HAND-PLACED	A-JACKS®
PRODUCTION			
TRANSPORTATION			
SITE PREPARATION			
INSTALLATION			
COMPLETION			

ARMORFLEX® ARTICULATING CONCRETE BLOCKS

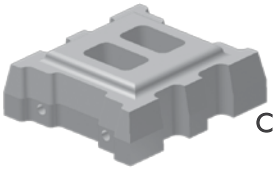
OPEN CELL BLOCK DESIGN ALLOWS FOR REVEGETATION

CLOSED CELL BLOCK DESIGN ALLOWS FOR HEAVY LOADING

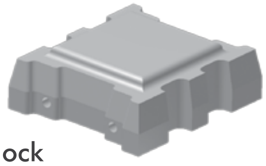
BOTH BLOCKS READILY ADAPT TO COMPLEX SITE GEOMETRIES

BLOCK OPTIONS

Open-Cell Block

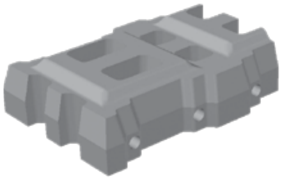


Closed-Cell Block



Tapered Open-Cell Block

Block and a Half®



ARMORFLEX UNIT SPECIFICATION

	Block Class	Nominal Thickness (in)	Length (in)	Width (in)	Gross Area (sf)	Minimum Weight (lbs)	Open Area %	τ_c 0° slope*
OPEN	30-S	4.75	13.0	11.6	0.98	33	20	5.2
	50-S	6.00	13.0	11.6	0.98	42	20	6.1
	40	4.75	17.4	15.5	1.77	59	20	11.2
	50	6.00	17.4	15.5	1.77	76	20	13.6
	70	8.50	17.4	15.5	1.77	107	20	17.7
	40-L	4.75	17.4	23.6	2.58	97	20	14.6
	50-L	6.00	17.4	23.6	2.58	116	20	22.1
	70-L	8.50	17.4	23.6	2.58	164	20	29.5
CLOSED	45-S	4.75	13.0	11.6	0.98	39	10	6.2
	55-S	6.00	13.0	11.6	0.98	50	10	7.3
	45	4.75	17.4	15.5	1.77	71	10	13.5
	55	6.00	17.4	15.5	1.77	91	10	16.3
	85	8.50	17.4	15.5	1.77	126	10	21.1
	45-L	4.75	17.4	23.6	2.58	109	10	21.9
	55-L	6.00	17.4	23.6	2.58	138	10	26.3
	85-L	8.50	17.4	23.6	2.58	195	10	35.1
HIGH VELOCITY APPLICATIONS								
TAPERED	40-T	4.75	17.4	15.5	1.77	58	20	25.0
	50-T	6.00	17.4	15.5	1.77	75	20	30.5
	70-T	8.50	17.4	15.5	1.77	109	20	38.5

** In accordance with ASTM D 7276 – Standard Guide for Analysis and Interpretation of Test Data for ACB Revetment Systems in Open Channel Flow.*

ARMORFLEX® ARTICULATING CONCRETE BLOCKS

APPLICATIONS

- Channel Lining
- Shoreline Protection
- Scour Protection
- Slope Protection
- Outfall Protection
- Pipeline & Cable Protection
- Weirs
- Spillways
- Dam Overtopping
- Emergency Overflows
- Grade Transitions
- Intracoastal Waterways
- Bays
- Lakes
- Reservoirs
- Low Water Crossings
- Boat Ramps
- Down Chutes

Dam Overtopping

SCOUR PROTECTION

SHORELINE PROTECTION

VEGETATED SLOPE

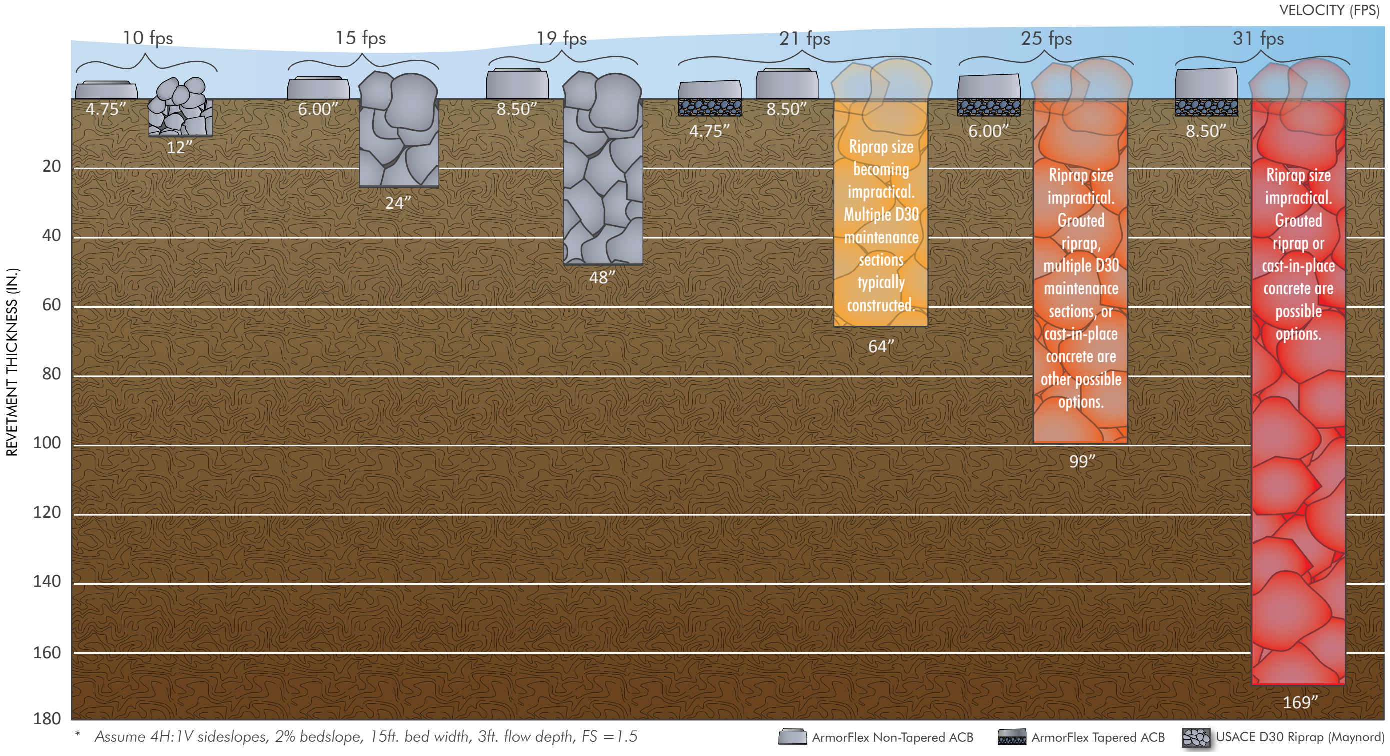
CHANNEL LINING

SUBMERGED ARMORING

ARMORFLEX® DESIGN CONSIDERATIONS

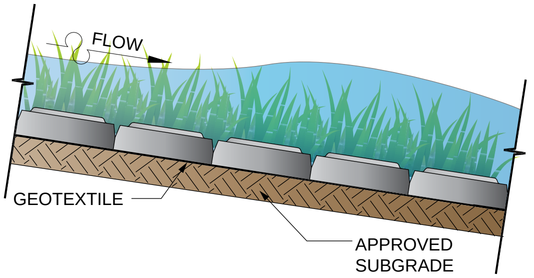
SIZING

ArmorFlex® ACB vs Traditional Riprap*

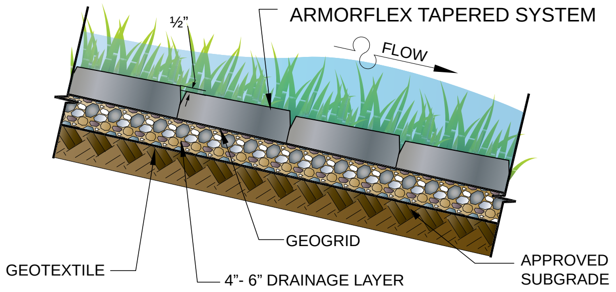


* *Assume 4H:1V sideslopes, 2% bedslope, 15ft. bed width, 3ft. flow depth, FS =1.5*

TYPICAL CROSS SECTIONS (not to scale)



Standard Cross Section



Tapered Series - Cross Section

REFERENCES AND STANDARDS

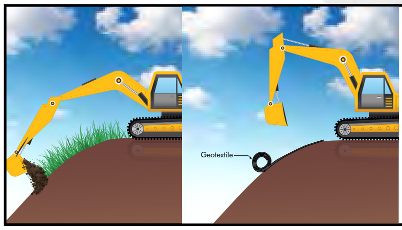
- National Concrete Masonry Association (2010), "Design Manual for Articulating Concrete Block (ACB) Revetment Systems", NCMA Publication TR 220A
- ASTM D 7276 – Standard Guide for Analysis and Interpretation of Test Data for ACB Revetment Systems in Open Channel Flow
- ASTM D 7277 – Standard Test Method for Performance Testing of ACB Revetment Systems for Hydraulic Stability in Open Channel Flow
- ASTM D 6684 – Standard Specification for Materials and Manufacture of Articulating Concrete Block (ACB) Revetment Systems
- ASTM D 6884 – Standard Practice for Installation of Articulating Concrete Block (ACB) Revetment Systems
- FHWA Hydraulic Engineering Circular NO. 23: Bridge Scour and Stream Instability Countermeasures: Experience, Selection and Design Guidance – Third Edition, Volume II, Design Guideline 8.
- USDOT Federal Highway Administration Hydraulic Engineering Circular NO. 15, Third Edition (2005) "Design of Roadside Channels with Flexible Linings" National Highway Institute.
- Julien, Pierre Y. (2010) "Erosion and Sedimentation", 2nd Edition, Cambridge University Press

ARMORFLEX® INSTALLATION

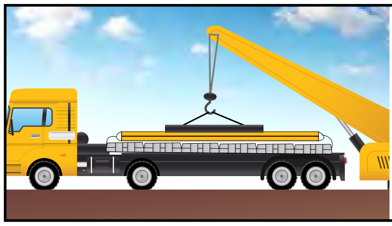
THE ARMORTEC® HARD ARMOR ADVANTAGE

EASE OF INSTALLATION

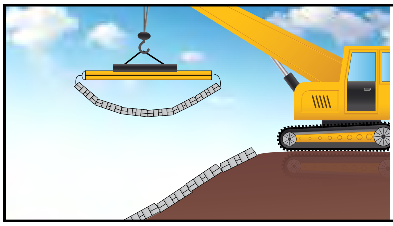
PROCESS



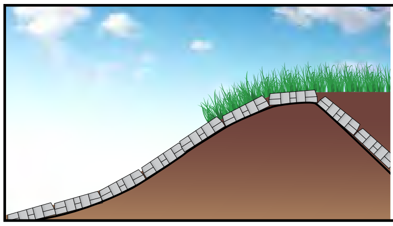
Step 1:
ArmorFlex arrives on-site as a system of factory-assembled mats. ArmorFlex is placed on a site specific geotextile which has been placed on a prepared subgrade using conventional construction equipment.



Step 2:
Mats are supplied on flat bed trailers. Mats can be handled with a spreader bar which can be rented from Contech.



Step 3:
ArmorFlex Mats are placed according to the site plans with appropriately sized equipment. Above normal waterline mats may be topsoiled and seeded to give a vegetated effect.



Step 4:
Proper toe trench requires a minimum of two rows of block buried below predicated soil depth. Tapered series block or mats subject to wave attack are required to have a bedding layer of crushed stone or gravel.

* *See ArmorFlex Installation Guide for additional information.*

ARMORROAD® CONCRETE UNITS

APPLICATIONS

- Industrial Yards
- Durable Driving Surface
- Temporary Road
- Lay Down Yard
- Heaving and Expanding Subgrades

ARMORROAD UNIT SPECIFICATION

Block	L	W	H	Minimum Weight (lbs / sf)	SF per Truck load
Mat	18.00	15.60	6.00	60	750

A-JACKS® CONCRETE ARMORING UNITS (CAU)

APPLICATIONS

- Bridge/Pier Scour
- Energy Dissipation
- Streambank/Toe Stabilization
- Shoreline
- Drop Structure
- Weirs
- Coastal Breakwater (Jetty)
- Habitat Creation

A-Jacks® provided bridge pier foundation scour protection to withstand Hurricane Sandy.

INSTALLATION

- Hand-placed and Bundled Unit Methods
- Field Technicians Available for Pre-con and Installation
- Construction Versatility

A-JACKS® DESIGN CONSIDERATIONS

DESIGN

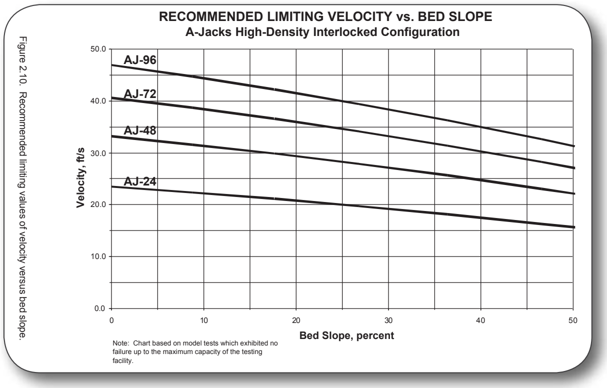
- A-Jacks® are recommended in FHWA HEC 23 with further guidance in Design Guideline 19.

September 2009
Publication No. FHWA-NHI-09-111

Hydraulic Engineering Circular No. 23

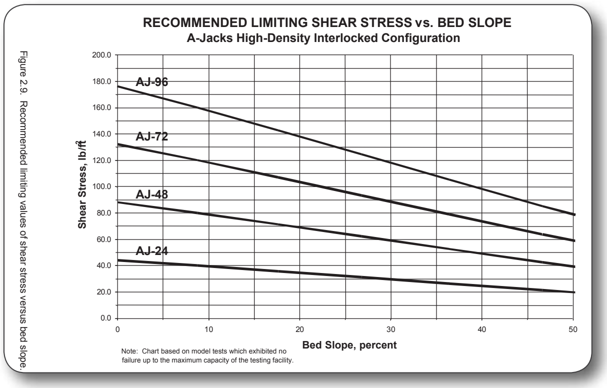
Bridge Scour and Stream Instability Countermeasures: Experience, Selection, and Design Guidance-Third Edition

Volume 1



Note: Chart based on model tests which exhibited no failure up to the maximum capacity of the testing facility.

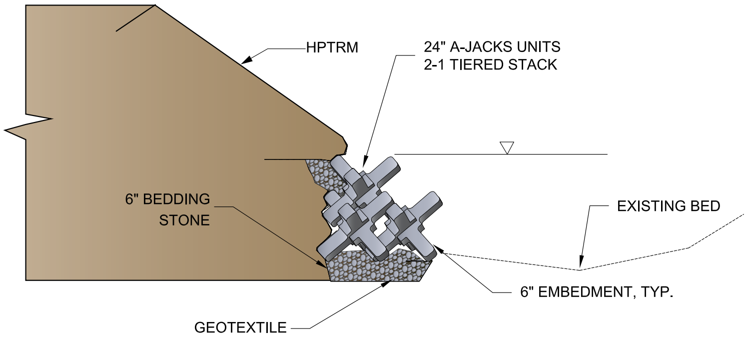
Figure 2.10. Recommended limiting values of velocity versus bed slope.



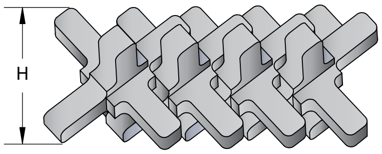
Note: Chart based on model tests which exhibited no failure up to the maximum capacity of the testing facility.

Figure 2.9. Recommended limiting values of shear stress versus bed slope.

STANDARD DETAILS



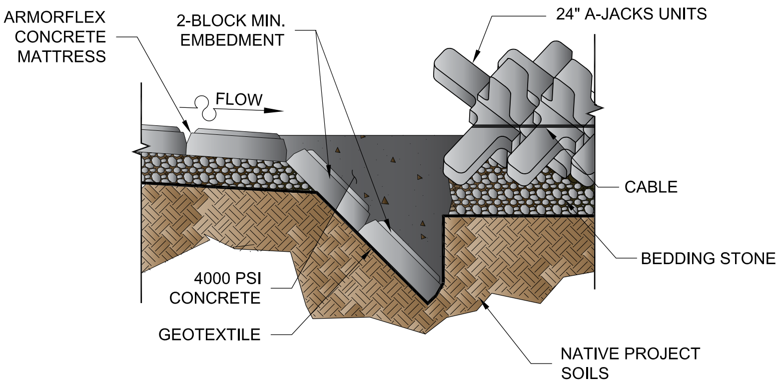
A-Jacks Toe Stabilization Detail



A-Jacks Placement Profile

A-JACKS UNIT SPECIFICATION

A-Jacks	Coverage (SF)	Weight (lbs)	Standing Height (H) (ft)
AJ-24	1.0	78	1.5
AJ-48	4.0	629	3.0
AJ-72	9.0	2,120	4.5
AJ-96	16.0	5,022	6.0
AJ-120	25.0	9,699	7.5

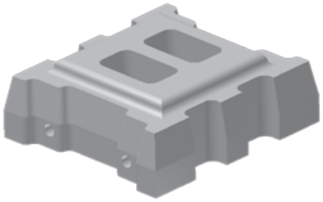


A-Jacks Energy Dissipation Detail

ADDITIONAL HAND-PLACED ACB SOLUTIONS

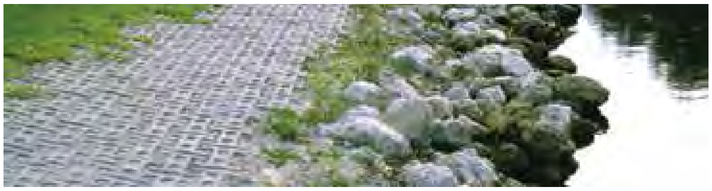
ARMORFLEX®

- Dam Overtopping
- Auxiliary Spillways
- Emergency Overflow
- Grade Transitions
- Retention Basins
- Shoreline Protection
- Drainage Ditch Lining
- Outfall Protection
- Bridge Abutment Protection



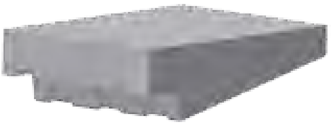
ARMORLOC®

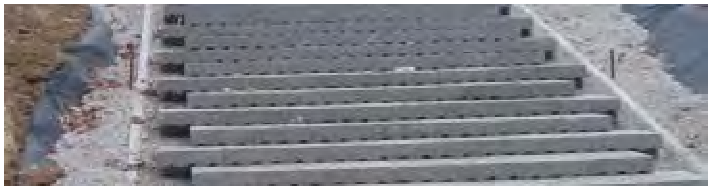
- Auxiliary Spillways
- Emergency Overflow
- Grade Transitions
- Retention Basins
- Shoreline Protection
- Drainage Ditch Lining
- Outfall Protection
- Bridge Abutment Protection
- Walking Paths
- Auxiliary Parking
- Slope Paving



ARMORWEDGE®

- Dam Overtopping
- High Velocity Channels
- Primary and Secondary Spillways
- Down Chutes





PROJECT PARTNER. CONTECH.

OPTIONS & SUPPORT SPECIFIC TO YOUR PROJECT NEEDS

CONSIDERATIONS FOR ENGINEER OF RECORD

- Site Design
- Soil Borings
- Hydraulic Analysis
- Scour Analysis
- Scour Countermeasures
- Permitting
- Inspections

✺	Contech Support Available
☑	Engineer of Record May Provide

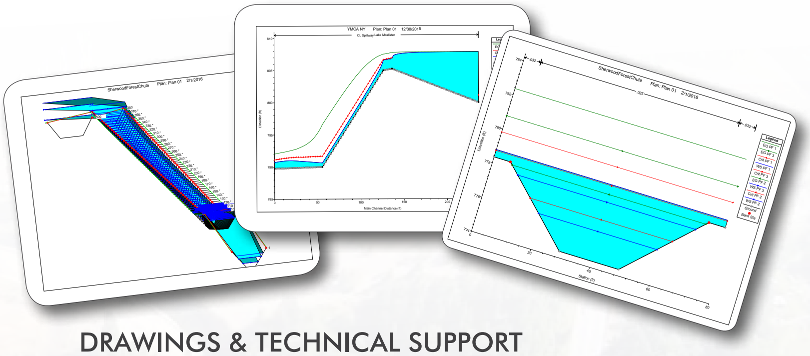
SOLUTION DEVELOPMENT & DESIGN SUPPORT

Limit Assessment	✺	☑
Hydraulic Analysis	✺	☑
HEC RAS Review	✺	
Factor of Safety Analysis	✺	
Block Selection	✺	
Engineer's Estimate	✺	
Proposal Drawings	✺	☑
Contract Drawings	✺	☑
Specifications	✺	☑
Approval Assistance	✺	☑
Staging and Layout	✺	☑
Fabrication Drawings	✺	

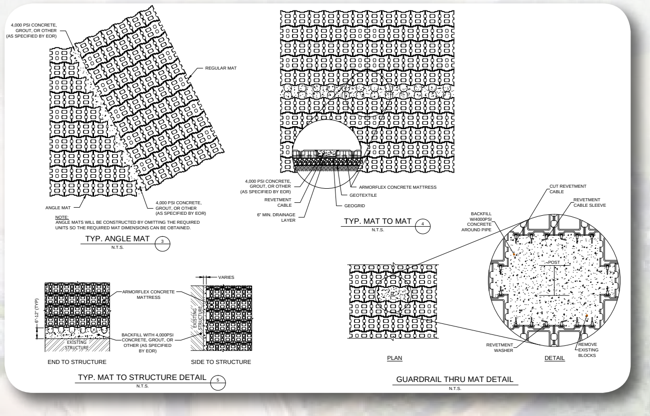
INSTALLATION SUPPORT

Preconstruction Meeting	✺
Logistics Coordination	✺
Onsite Installation Assistance	✺

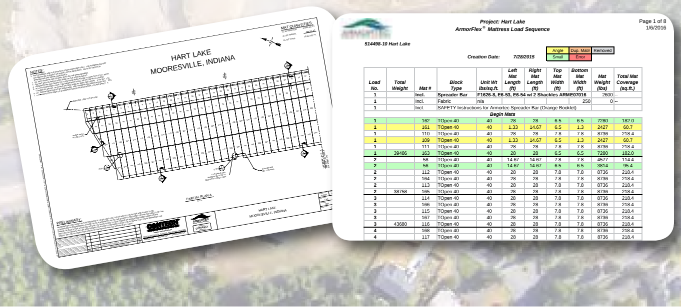
HEC RAS REVIEW



DRAWINGS & TECHNICAL SUPPORT

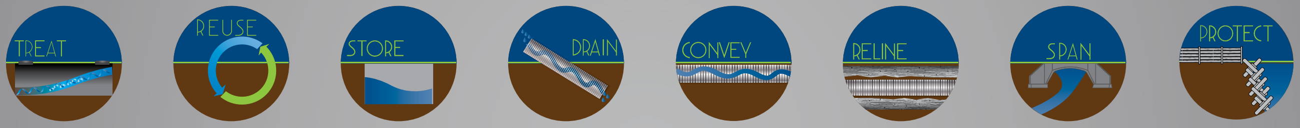


STAGING & LAYOUT



CONTECH® ENGINEERED SOLUTIONS

COMPLETE SITE SOLUTIONS



STORMWATER SOLUTIONS

Helping to satisfy stormwater management requirements on land development projects

- Stormwater Treatment
- Detention/Infiltration
- Rainwater Harvesting
- Biofiltration/Bioretention

PIPE SOLUTIONS

Meeting project needs for durability, hydraulics, corrosion resistance, and stiffness

- Corrugated Metal Pipe (CMP)
- Steel Reinforced Polyethylene (SRPE)
- High Density Polyethylene (HDPE)
- Polyvinyl Chloride (PVC)

STRUCTURES SOLUTIONS

Providing innovative options and support for crossings, culverts, and bridges

- Plate, Precast & Truss bridges
- Hard Armor
- Retaining Walls
- Tunnel Liner Plate

ADDITIONAL SPECIALTY PRODUCTS

TURF REINFORCEMENT MATS

BIN WALL

LIGHT GAGE METRIC SHEETING

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Armortec-Brochure 10/16 7.5M

Attachment E
Town of Dover Hydraulic Model Memorandum

UNDERWOOD
engineers

25 Vaughan Mall, Unit 1
Portsmouth, NH, 03801-4012
Tel: 603-436-6192 Fax: 603-431-4733

Technical Memorandum

To: Bill Boulanger, Superintendent of Utilities and Public Works
Cc: Douglas Steele, II, Deputy City Manager; Dave White, P.E., City Engineer
From: Michael C. Unger, P.E., Project Manager
Date: May 6, 2016
Subject: Potential Water Interconnection Between Portsmouth and Dover

Introduction / Background

We understand the Cities of Dover and Portsmouth are considering a water interconnection at Dover Point (Figure 1).

Discussion

UE used Dover's existing hydraulic distribution system model to predict available flow and pressure at a proposed interconnection point at the end of the existing 12-inch main near the Dover DMV.

The model was run with all supplies on assuming that in an emergency condition with Dover supplying water to Portsmouth Dover will need to produce as much water as possible.

The model predicted the following at the analysis point:

- Static Pressure = 120 psi
- Static Hydraulic Grade Line = 302 feet AMSL
- Available Flow = 2,590 gpm at 20 psi residual

Note: A connection point at the end of the existing 8-inch main at the end of Dover Point Road was also analyzed but could supply significantly less flow (1,080 gpm at 20 psi residual).

Limitations and Recommendations

The results presented here are model predictions under a specific set of operating parameters. They have not been verified in the field.

We suggest the City of Dover consider evaluating the following if this concept is advanced:

- Change in available instantaneous flow over time during diurnal demand shifts.
- Available excess supply capacity accounting for demand within Dover system.
- Potential interconnection at Portsmouth's finished water main near the Madbury Water Treatment Plant.
- Options for Portsmouth to delivery water to Dover in an emergency.

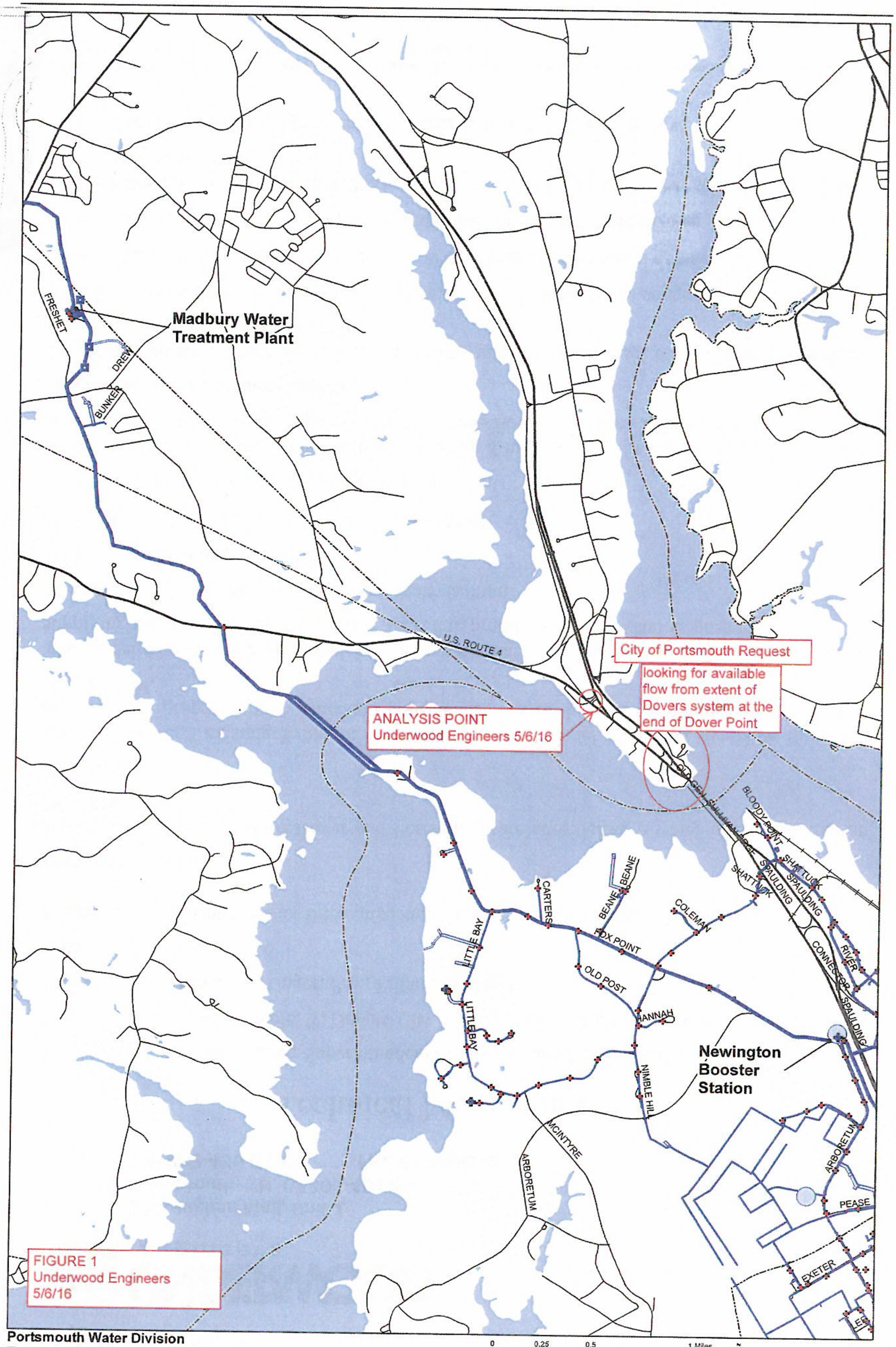

FIGURE 1
Underwood Engineers
5/6/16

City of Portsmouth Request

looking for available flow from extent of Dovers system at the end of Dover Point

ANALYSIS POINT
Underwood Engineers 5/6/16

Portsmouth Water Division
Transmission Line
Map prepared by Portsmouth Department of Public Works

DATE: 11/10/2015

Attachment F

SOP for Shutdown of Madbury-Newington Transmission Line

Standard Operating Procedure (SOP)

for Shutdown Procedures

for the Madbury-Newington Transmission Main

Date Prepared: September 5, 2017

Date Revised: ________________

Shutdown Procedures

1. Locate valve chamber to isolate work area
2. Check area for potential hazards and implement needed safety controls (cones, traffic control)
3. **Confirm Madbury WTP Finished Water Pumps are off**
4. Open vault cover
5. Follow City of Portsmouth procedures for testing and accessing **Confined Space**
6. Operate Valve
    - Verify the turning direction of the valve
    - Assume valve is in the full **Open** position
    - Begin **Closing Valve Slowly**, increasing torque as necessary to achieve movement (without exceeding the pre-determined Maximum Torque)
    - Count the number of turns necessary to achieve the full **Closed Position**.
    - Minimum closure speed is 2 minutes
7. Repeat previous steps at second valve chamber location to isolate work area

Reactivation Procedures

8. **Open** by-pass on gate valve to equalize pressure on upstream and downstream side of the valve
9. Operate Valve
    - Begin **Opening Valve Slowly**, increasing torque as necessary to achieve movement (without exceeding the pre-determined Maximum Torque)
    - Count the number of turns necessary to achieve the full **Open Position**.
    - Minimum open speed is 2 minutes
10. Repeat at second valve chamber
11. Replace vault cover
12. Restore pump operation at Madbury WTP Finished Water Pumps