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DEWATERING AND STORMWATER POLLUTION PREVENTION PLAN

REVISION NO. 02

Boulevard Street Forcemain and Watermain
Jacksonville, Florida

CSI Geo Project No.: 71-19-329-10
Client Project No.: 09302-055-01
JEA Contract No.: 153003

Prepared By

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Prepared For

Jones Edmunds & Associates, Inc.

March 26, 2020

In accordance with the provisions of Florida Statutes, Chapter 471, CSI Geo's work for the above referenced report was prepared under the direct supervision of a Professional Engineer registered in the State of Florida. This report has been determined to be in accordance with good professional engineering practices pursuant to Chapter 471 of the Florida Statutes as it applies to the work described herein. The data, findings, recommendations, specifications or professional opinions were prepared solely for the use of Jones Edmunds & Associates, JEA, and the Florida Department of Transportation. CSI Geo makes no other warranty either expressed or implied and is not responsible for the interpretation of this data by others.

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March 26, 2020

Dr. Harold Bridges, Ph.D, P.E.
Jones Edmunds & Associates, Inc.
8657 Baypine Road, Suite 300
Jacksonville, Florida 32256-8634

RE: Boulevard Street Forcemain and Watermain
Jacksonville, Florida

Subject: Dewatering Plan
CSI Geo Project No.: 71-19-329-10
Client Project No.: 09302-055-01
JEA Contract No.: 153003
Purchase Order: 179335

Dr. Bridges:

CSI Geo, Inc. (CSI Geo) is pleased to present this dewatering plan for the subject infrastructure project. Our services were provided in general accordance with CSI Geo's proposal. This dewatering plan includes:

1) a discussion of the project background information and dewatering requirements;
2) a summary of subsurface soil and groundwater conditions in the project area;
3) the results of hydraulic conductivity testing of the subsurface soils;
4) a description of the nature, location and depths of subsurface dewatering systems;
5) estimated groundwater extraction and discharge rates for the system; and
6) a description of the type, location and size of the associated pumps;
7) a description of the type, location of conveyance systems and discharge points;
8) a discussion of the FDEP permitting requirements; and
9) Best Management Practices (BMP) to control erosion and sedimentation at the discharge locations.

This plan has been prepared to meet the Florida Department of Transportation's general dewatering plan requirements. CSI Geo, Inc. appreciates the opportunity to be of service to you on this project. We are available to answer any questions you may have concerning this dewatering plan and to provide any other services that may be needed.

Sincerely
CSI Geo, Inc.

John A. Iya, P.E.
Senior Geotechnical Engineer

TIMOTHY DUANE SMITH
LICENSE
No. 59506
STATE OF FLORIDA
PROFESSIONAL ENGINEER

Tim Smith, P.E.
Project Engineer
Registered, Florida No 59506

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APPENDICES

1.0 BACKGROUND AND DESIGN CONSIDERATIONS

General project information was provided by Dr. Harold Bridges, Ph.D., P.E. and Mr. Kenneth A. Fraser, P.E. of Jones Edmunds & Associates, Inc. We have been provided with: (1) a general description of the infrastructure improvement project and (2) Electronic plans showing the proposed Boulevard Street Forcemain and Watermain project.

As shown in a subset of the project figure set provided in Appendix A, the Boulevard Forcemain and Watermain project is located along Boulevard Street in Jacksonville, Florida and extends north from West 7th Street to West 16th Street.

Specifically, the infrastructure improvement project will include construction of:

- Replacement of 1,400 linear feet of existing 12-inch diameter and 8-inch diameter watermain pipe along Boulevard Street from West 7th Street to West 11th Street
- Replacement of 3,100 linear feet of existing 16-inch diameter forcemain pipe along Boulevard Street from West 7th Street to West 16th Street

Design and construction considerations for the various planned infrastructure improvements are discussed in the following sections of this report. Currently, this project is in the design phase. Construction contractors and subcontractors have yet to be selected. However, all construction contractors and subcontractors will be required to review and sign this dewatering and storm water pollution prevention plan (SWPPP).

Existing Conditions and Project Description

This project includes the replacement of water mains and force main piping along Boulevard Street between 8th Street West and 16th Street West. With the exception of utilizing jack and bore to replace the force main under the CSX rail line that intersects Boulevard Street, the new pipe will be connected to existing piping at all intersecting roadways.

The groundwater will be dewatered using a dewatering pump during shallow or open cut construction and dewatered using well points for the jacking and receiving pits that will be installed for the jack and bore construction. Recovered groundwater will be discharged into storm water drains at roadway intersections along Boulevard Street and into the storm water ditch located on the south side of the CSX rail line south of 16th Street West. The groundwater will be discharged following best management practices for erosion and sedimentation control (Section 8.0).

1.1 Segment A – Open Cut: Shallow Installation

Segment A consists of the shallow installation/replacement of 8-inch and 12-inch water main piping from West 7th Street to West 11th Street as well as the shallow installation of a 16-inch force main piping from West 7th Street to West 16th Street in Jacksonville, Florida. The water main invert elevations are shown on the attached Plan and Profile Sheets (See Appendix A). As shown, the drill entry pit invert elevations will be approximately 4.0 to 6.0 feet below the top of pavement and/or ground surface. At locations where the replacement piping will intersect a roadway, the watermain and forcemains will be connected to existing pipe under the roadway. Watermain and forcemain construction will be conducted using open cut trenching techniques due to the anticipated shallow depth of excavation along Boulevard Street. Due to the groundwater levels (depth to water measured at the time of the geotechnical exploration was 4 to 6 feet below the existing ground surface), minimal dewatering will be required along the majority of the watermain and forcemain alignment.

Any recovered groundwater and surface water can be controlled using sump pumps. The collected groundwater/surface water will be discharged into roadside stormwater drains along intersecting cross streets (West 7th Street through West 16th Street) along Boulevard Street. Any discharged groundwater / surface water should be discharged per the obtained NPDES permit following best management practices for erosion and sedimentation control (Section 8.0).

1.2 Segment B – Jack and Bore Installation

Segment B consists of the installation of nearly 140 linear feet of 16 inch diameter PVC pipe under a CSX right of way south of 16th Street West in Jacksonville, Florida using Jack and Bore. The Jack and Bore details are shown on the included Plan and Profile Sheets (Appendix A). As shown a nearly 140 foot run of 30” diameter steel casing that will house a 16 inch PVC force main pipe will be advanced under the CSX right of way. The force main crossing will tie into the shallow force main construction which runs along the east side of Boulevard Street immediately south of 16th Street West. The casing invert elevation has been set at a EI. +10.0 feet. The proposed jacking pit (located on the east side of Boulevard Street) will have plan dimensions of 40 feet by 12 feet. The jacking pit depth will be approximately 15 feet below land surface (estimated jacking pit bottom elevation is EI. +9.0 feet). The proposed Receiving Pit (located on the east side of Boulevard Street) will have plan dimensions of 12 feet by 12 feet. The Receiving Pit depth will be approximately 14 feet below land surface (estimated receiving pit bottom elevation is EI. +9.0 feet). Vertical steel sheet piles will be constructed in a horse shoe shape around the edges of the planed pits to maintain excavation stability and to prevent undermining existing utilities and the Boulevard Street pavement. The sheet pile locations and tip elevations will be determined by others.

To accommodate the proposed construction, the groundwater levels in the jacking and receiving pits will need to be drawn down using a combination of vertical well points and horizontal dewatering socks. Groundwater levels should be lowered to a minimum of 2.0 feet below the bottom of the jacking and receiving pits (minimum drawdown elevation is EI. +7.0 feet). The FDOT requires that the groundwater level be lowered at least 2 feet below the steel casing invert elevation (the minimum groundwater elevation for the steel casing is EI. +7.0 feet).

Based upon the results of the geotechnical investigation (Appendix B), it is estimated that the groundwater level in the vicinity of the jack and bore construction will be EI. +19.0 feet (i.e. 4 to 5 feet below land surface. Therefore, 12 feet of drawdown will be required in the jacking and receiving pits, as well as the horizontal bore and steel casing installation.

The project schedule has not been determined at this time. For purposes of the extraction rate and drawdown analyses and dewatering plan development, it has been assumed that (1) the jack and bore related dewatering system will be installed and activated a minimum of 2 days before the commencement of the excavation and jack and bore installation; (2) the groundwater control system will operate continuously until the tie-ins are completed and the jacking and receiving pits are backfilled; and (3) the estimated construction duration will be 8 to 10 calendar days.

The collected groundwater/surface water will be discharged into roadside stormwater drains along the intersections of Boulevard Street and 15th Street West and 16th Street West. Any discharged groundwater / surface water should be discharged per an obtained NPDES permit following best management practices for erosion and sedimentation control (Section 8.0).

2.0 SUBSURFACE CONDITIONS

CSI Geo conducted a geotechnical exploration at the subject site. A geotechnical report entitled "Geotechnical Exploration and Evaluation Report, Boulevard Street Forcemain and Watermain, Jacksonville, Florida, CSI Geo Project No. 71-19-329-10, dated March 11, 2019 was submitted under a separate cover. The copy of this report is included in Appendix B.

In summary, a total of five (5) standard penetration test (SPT) borings were installed to a depth of 15 feet below the existing grades each along the project route. A review of these test borings indicated that the force main alignment is generally underlain by loose to dense sands, slightly silty sands, silty sands and clayey sands until the boring termination depths of 15 feet below the existing grade. In addition, four (4) SPT borings were drilled to a depth of 30 feet below the existing grades and performed at West 8th Street and near the CSX Railroad Crossing. A review of these test borings indicated that the alignment is generally underlain by very loose to medium dense sands, slightly silty sands, silty sands and clayey sands until the boring termination depths of 30 feet below the existing grade.

Groundwater level measurements at the time of the drilling were encountered at approximately 4 to 6 feet below the existing land surface. It is anticipated that the groundwater level will fluctuate due to seasonal changes. For purposes of dewatering plan development, it is estimated that the groundwater level will be 5.0 feet below the existing land surface.

3.0 HYDROGEOLOGIC CHARACTERIZATION OF SURFACE AQUIFER

The following hydrogeologic characterization is based upon the soil data collected as part of the geotechnical exploration and the results of in-situ hydraulic conductivity testing. The soil and hydraulic conductivity data suggest that the unconfined surface aquifer consists of very loose to medium dense silty sands and clayey sands for the shallow installation portions of the project.

The area surrounding the jack and bore installation consists of loose to medium dense sands and slightly silty sands to depths of 4 to 8 feet below land surface. The overburden sands are followed by very loose to medium dense silty sands and firm clayey sands to depths of 12 to 22 feet below land surface. The aquifer is assumed to be homogeneous and isotropic. The effective aquifer thickness is estimated to be 50 feet. The fillable porosity of the aquifer is estimated to be 0.3 due to the sandy/silty sandy nature of the encountered soils. The average horizontal hydraulic conductivity was estimated to be approximately 15 gallons per day per square foot.

4.0 SUBSURFACE INSTALLATIONS FOR DEWATERING SYSTEM

The following sections of this report outlines the recommended de-watering system configuration.

4.1 Segment A – Open Cut: Shallow Installation

The open cut excavation will include installing 8-inch and12-inch PVC water main pipe, as well as, 16-inch force main pipe, a specified 4 to 6 feet below the existing land surface to the bottom of the pipe. As a result, dewatering may not be necessary and will likely be minimal for the majority of the force main and water main installation. If groundwater is encountered, it can be controlled using a dewatering/sump pump specified in Section 6 of this plan (Appendix C).

If dewatering is necessary, **100 micron filtration socks shall be used** at the discharge pump and hay bales should be staged around the discharge point to minimize turbidity to the storm water drainage system. The collected groundwater/surface water will be discharged to storm water drains located at the cross streets along Boulevard Street that traverse the project area. Because groundwater may be encountered at various intervals, CSI Geo recommends that the force main and water main installation be conducted in no greater than 200 foot increments.

4.2 Segment B – Jack and Bore Installation

In order to dewater the area needed for the proposed jacking pit located south of the CSX rail line along Boulevard Street (40 x 12 x 15 feet deep), CSI Geo recommends using 20 vertical well points. It is recommended that the well points be two inch diameter and installed every four to five feet in a horseshoe shape surrounding the jacking pit. Vertical sheet piling will be required to maintain the integrity of the excavation. These dewatering points are to be installed to a depth of 19 feet below land surface with two feet of 0.010" slotted screen at the bottom of the dewatering point with solid riser to the surface. These dewatering well points are to then be connected to dewatering piping (using a 6-inch or 8-inch diameter header pipe) and suction hoses prior to a dewatering pump to allow for dewatering to a depth of 17 feet below land surface. Specifications for the pump are provided in Appendix C. The selected contractor should stabilize all trenching and excavations and provide shoring as required by OSHA and the Florida Safe Trench Act.

The recovered groundwater is then to be discharged to a storm water ditch on the south side of the CSX Rail intersection. The discharge should be approximately 100 feet east of the jacking pit to avoid re-infiltration into the jacking pit using discharge hose. The discharge hose can be run along the ditch. **Filtration socks (100 micron) shall be used** at the discharge pump and hay bales should be staged around the discharge point to minimize turbidity to the storm water drainage system. The proposed location of the jacking pit is illustrated in the figures contained in Appendix A. Please note that is anticipated that the dewatering system will have to be operated for approximately 1 to 2 days prior to excavation to allow the water to begin to be removed from the jacking pit.

In order to dewater the area needed for the proposed receiving pit located north of the CSX rail line along Boulevard Street (12 x 12 x 15 feet deep), CSI Geo recommends using 9 vertical well points. It is recommended that the well points be two inch diameter and installed every four to five feet in a horseshoe shape surrounding the receiving pit. Vertical sheet piling will be required to maintain the integrity of the excavation. These dewatering points are to be installed to a depth of 18 feet below land surface with two feet of 0.010" slotted screen at the bottom of the dewatering point with solid riser to the surface. These dewatering well points are to then be connected to dewatering piping (using a 6-inch or 8-inch diameter header pipe) and suction hoses prior to a dewatering pump to allow for dewatering to a depth of 16 feet below land surface. Specifications for the pump are provided in Appendix C. The selected contractor should stabilize all trenching and excavations and provide shoring as required by OSHA and the Florida Safe Trench Act.

The recovered groundwater is then to be discharged to a storm water drain located at the intersection of Boulevard Street and 16th Street West approximately 150 feet north of the receiving pit using discharge hose. The discharge hose can be run along the Boulevard Street right-of-way. **Filtration socks (100 micron) shall be used** at the discharge pump and hay bales should be staged around the discharge point to minimize turbidity to the storm water drainage system. The proposed location of the receiving pit is illustrated in the figures contained in Appendix A. Please note that is anticipated that the dewatering system will have to be operated for approximately 1 to 2 days prior to excavation to allow the water to begin to be removed from the jacking pit.

5.0 EXTRACTION RATES

The extraction rates necessary to achieve the required drawdown for the de-watering system described above for the force main and water main construction were estimated using Theis equations for unconfined aquifers. Both well point yield and infiltration rates were calculated. The extraction (well point yield) and infiltrations rates are discussed below. For the Boulevard Street force main and water main construction, the extraction rates necessary to achieve the removal of any groundwater that may infiltrate into the construction area is taken from the extraction rate of the dewatering well points and dewatering pump (maximum of 1,450 gpm). The infiltration rates are discussed below. The spreadsheet calculation is provided in Appendix D.

5.1 Segment A – Open Cut: Shallow Installation

For the open cut shallow reclaimed water main construction, the extraction rates necessary to achieve the removal of any groundwater that may infiltrate into the construction area is taken strictly from the extraction rate of the dewatering pump (maximum of 1,450 gpm). The infiltration rate was calculated assuming a working dewatering area of 200 feet by 5 feet and a dewatering depth of 2 feet. The spreadsheet calculation is provided in Appendix D. As seen in the spreadsheet, the pumping rate far exceeds the infiltration rate which will allow for adequate dewatering if necessary.

5.2 Segment B – Jack and Bore Installation

The results of the analyses for the jacking pit pit located south of the CSX rail line along Boulevard Street indicate that the steady state extraction rate that can be achieved by the specified dewatering system of 20 well points discussed in Section 4 is 15.7 gallons per minute (gpm) or approximately 23,000 gallons per day (GPD). The existing groundwater volume of the jacking pit is estimated to be 50,000 gallons. The infiltration rate of the jacking pit utilizing a 12 ft drawdown is 6,000 GPD. Therefore, specified extraction rate of the dewatering system is above the capacity required to dewater the volume of the jacking pit.

The results of the analyses for the receiving pit located north of the CSX rail line along Boulevard Street indicate that the steady state extraction rate that can be achieved by the specified dewatering system of 9 well points discussed in section 4 is approximately 7 gpm or 10,000 GPD. The existing groundwater volume of the jacking pit is estimated to be 4,500 gallons. The infiltration rate of the jacking pit utilizing a 12 ft drawdown is 2,500 GPD. Therefore, specified extraction rate of the dewatering system is above the capacity required to dewater the volume of the jacking pit.

The extraction rate discharge velocity will be less than 0.1 ft/sec. The calculations of the extraction and infiltration rates of the jacking and receiving pits at the intersection of the CSX rail line along Boulevard Street utilizing the Theis equations for unconfined aquifers are presented in Appendix D.

6.0 PUMP TYPE, LOCATION,& DISCHARGE POINTS

A Thompson Pump model 6VW (or equivalent) is recommended to conduct dewatering. This pump is specified to handle moderate heads and maximum flows to 1,450 gallons per minute. Manufacture Information and specifications for the recommended pump is provided in Appendix C. One pump would be sufficient to connect to a series of portable vertical well points that could be installed in any necessary area.

7.0 PERMITTING REQUIREMENTS

Dewatering system discharges require coverage under a Notice of Intent (NOI) to discharge if the groundwater is discharged to a storm water drain or on to property that is not the subject property. A Notice of Intent/temporary permit to discharge will be filed and approved of by the Florida Department of Environmental Protection (FDEP). Based on the anticipated terms of the Notice of Intent, groundwater sampling will be conducted at the start of the dewatering process and then on a weekly basis to verify that no groundwater contamination will be discharged during the dewatering process

The groundwater sampling results have been tabulated and are provided in Appendix E. The temporary wells test locations (TW-1, TW-2, and TW-3) are shown on the Groundwater Sampling Plan included in Appendix E. As noted in Appendix E, lead, zinc and mercury exceeded their respective state standards at various sampling points. It should also be noted that while the cadmium analytical results were below the laboratory detection limit in all three wells, the laboratory detection limit was below the calculated state standard given the water hardness results. Based on the analytical results which demonstrate that these exceedances were not present after the samples were filtered, it appears that these results were due to the undissolved particulate that can be removed using 100 micron filter socks/media. It is also recommended that hay bales or silt fence be used to polish the groundwater at the point of discharge to further minimize turbidity and the likelihood of the groundwater discharge contaminant concentrations exceeding state standards.

Also, though the benzene and naphthalene analytical results were below state standards for all three temporary wells, the project location is within 500 feet of several properties that are listed as FDEP contaminated sites. Because of this, it will be necessary to sample for benzene and naphthalene during dewatering activities. It is not expected that the benzene and naphthalene results will be above state standards. However, the contractor must anticipate the contingency of treating the groundwater discharge with either carbon absorption or air stripping in order to reduce benzene and/or naphthalene concentrations should the sampled concentrations of benzene and/or naphthalene exceed state standards.

Based on these results, dewatering activities will require a discharge water sample to be collected at each discharge location for lead, cadmium, zinc, mercury, benzene, naphthalene, pH and hardness at the beginning of the dewatering effort prior to discharge to the storm water drain to confirm that the groundwater discharge meets state standards. The metals lead, cadmium and zinc are to be analyzed using EPA method 200.8 (this method should provide a lower detection limit to meet the state standard) and mercury is to be analyzed using EPA method 1631 E. The benzene and naphthalene are to be sampled using EPA method 624. FDEP will likely require a discharge groundwater sample be collected regularly on a weekly basis over the course of the dewatering effort. An initial sample from each location must be collected and then the dewatering process stopped until the laboratory results are received and demonstrate that the discharge is meeting the permit requirements. Once the initial sample results have verified that the discharge meets state requirements, the dewatering effort can proceed.

As mentioned, the groundwater is to be discharged through a 100 micron filter sock. The groundwater discharge may also have to be treated with carbon or an air stripper if project analytical results indicate this is necessary. Contingency preparations for carbon or air stripper treatment should be prepared.

8.0 BEST MANAGEMENT PRACTICES FOR EROSION AND SEDIMENTATION CONTROL

During specified dewatering activities, the specified pump is expected to create a maximum discharge velocity of approximately 0.2 feet per second or less. Even though the anticipated discharge velocity is low, measures will be taken to minimize erosion and sedimentation from the discharge.

All erosion and sedimentation control devices will adhere to the requirements of Chapter 4 of The Florida Stormwater, Erosion, and Sedimentation Control Inspectors Manual. Storm water inlet protection (i.e. filter sock/media, hay bales) will be placed at the storm water inlets. Silt fences, or equivalent structural controls, will be used for all side slope and down slope boundaries of the construction area. A copy of the BMP 1.08 for storm water inlet protection has been provided as Appendix F.

During dewatering, a filter sock of 100 microns or finer will be secured to the discharge hose. It is anticipated that the dewatering discharge will be to storm water drains and stormwater ditches located along Boulevard Street. At the point of discharge, a silt basin of hay bales and/or silt fence will be constructed and discharge velocities will not exceed 0.1 feet/sec in order to control erosion and sediment at the point of discharge. Inspections will be conducted within 24 hours after rain events to ensure that all sedimentation controls are performing properly.

Dewatering inspections will be conducted every seven (7) days and within 24 hours of a storm event (greater than 0.5 inches of rain) by the primary contractor. This inspection will evaluate the structural devices mentioned for the control of discharged groundwater and runoff created by any storm water. If any discrepancies are found, erosion and sedimentation control devices will be adjusted to adhere to the aforementioned control and BMP practices.

9.0 SUMMARY

The details of the Dewatering Plan as outlined above are summarized in the following table:

Item	Description
Static Groundwater Depth (Elevation)	Estimated Groundwater Level is 5.0 feet below existing land surface.
Required Dewatering Drawdown	Segment A – Open Cut: Dewatering will be minimal. Any required dewatering will be 2 feet below the existing land surface. Segment B – Jack and Bore at CSX rail line intersection of Boulevard Street: Required drawdown is 14 feet below the existing land surface.
Duration of Dewatering	Dewatering system should be activated one to two days prior to beginning construction activities. The dewatering system operation is not expected to exceed a 25 day duration.
Dewatering Points	Segment A – Open Cut: No dewatering points are needed. Segment B – Jack and Bore at CSX rail line intersection of Boulevard Street: Jacking Pit: 20 well points, 2 inches in diameter, 19 feet deep with 2 feet of 0.01" screen and 17 feet riser Receiving Pit: 9 well points, 2 inches in diameter, 18 feet deep with 2 feet of 0.01" screen and 16 feet of riser
Average Daily Extraction Rates(GPD)	Segment A – Open Cut: 1,450 gpm using pump specification Segment B – Jack and Bore at CSX rail line intersection of Boulevard Street: Jacking Pit: 15.7 gpm / 23,000 gpd Receiving Pit: 7 gpm / 10,000 gpd
Discharge Locations	Storm water drains at the intersections of Boulevard Street and the south stormwater ditch adjacent to the CSX rail line.
Hydrogeologic Characterization	The surface lithology and aquifer consist predominantly of loose to medium dense sands and slightly silty sands to depths of 4 to 8 feet below land surface. The overburden sands are followed by very loose to medium dense silty sands and firm clayey sands to depths of 12 to 22 feet below land surface.
Maximum Pump Discharge Velocity (ft/min)	All discharge velocities will average less than 0.1 feet/sec (6 feet/min) and will not exceed 0.2 ft/sec (12 ft/min).

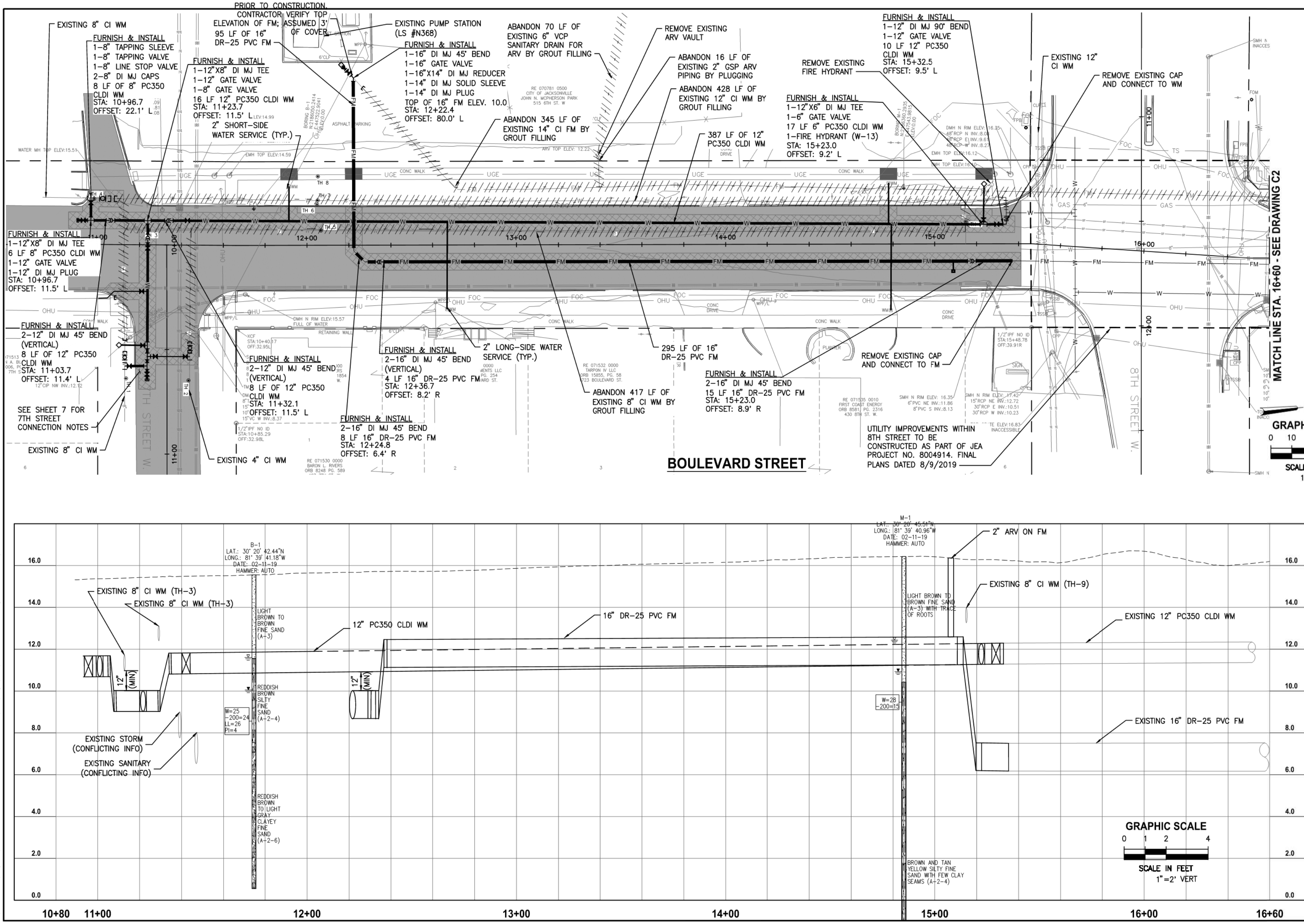
BMPs For Erosion & Sedimentation Control	The specified pump will discharge into storm water drains, ditches and swales. A copy of the BMP 1.08 for storm water inlet protection has been provided as Appendix F. Groundwater will be initially discharged through a 100 micron filter sock/media prior to discharge to a storm water drain. Storm water inlet protection (i.e. filter fabric, hay bales) will be placed at the discharge locations. Silt fences, or equivalent structural controls, will be used for all side slope and down slope boundaries of the construction area.

10.0 LIMITATIONS

The recommendations and design details contained in this report are based on our understanding of the project as presented above. Should conditions differing from those presented herein become evident during construction or if the dewatering system is modified in any material way, the degree of difference(s) should be assessed; the relevant analyses repeated using the appropriately modified assumptions and parameters, and the recommendations and design details modified accordingly. This dewatering plan should cover all requirements if the scale of the system is decreased. Any increases to the scale of the system may require additional permitting. The selected contractor should stabilize the pit bottoms and provide shoring as required by OSHA and the Florida Safe Trench Act. Maintenance of Traffic Plans and Shoring Plans are not included with this Dewatering Plan and were beyond the scope of our services.

APPENDIX A:

Construction Drawings
Figure Set



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CERTIFICATE OF AUTHORIZATION #1841

NO.	BY	DATE	REVISIONS

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DESIGNED:	KFRASER	
DRAWN BY:	RWADE	
DATE:	AUG 2019	
CHECKED BY:	HBRIDGES	
DATE:	AUG 2019	

JEA
Building Community

BOULEVARD FORCE MAIN AND WATER MAIN REPLACEMENT PLAN AND PROFILE

PROJ. NO. 09302-055-01
DATE: AUGUST, 2019
SCALE: 1"=20'H 1"=2'V

NO. SHEETS 34
SHEET NO. 5
DRAWING NO. C1

Xrefs Attached= XR055-C-TBPP [\\Topsen01\jonesfiels\09302-JEA\Projects\055-01 BOULEVARD FM & WM REPLACEMENT\CAD\Dwgs\Xref\general\XR055-C-TBPP.dwg]
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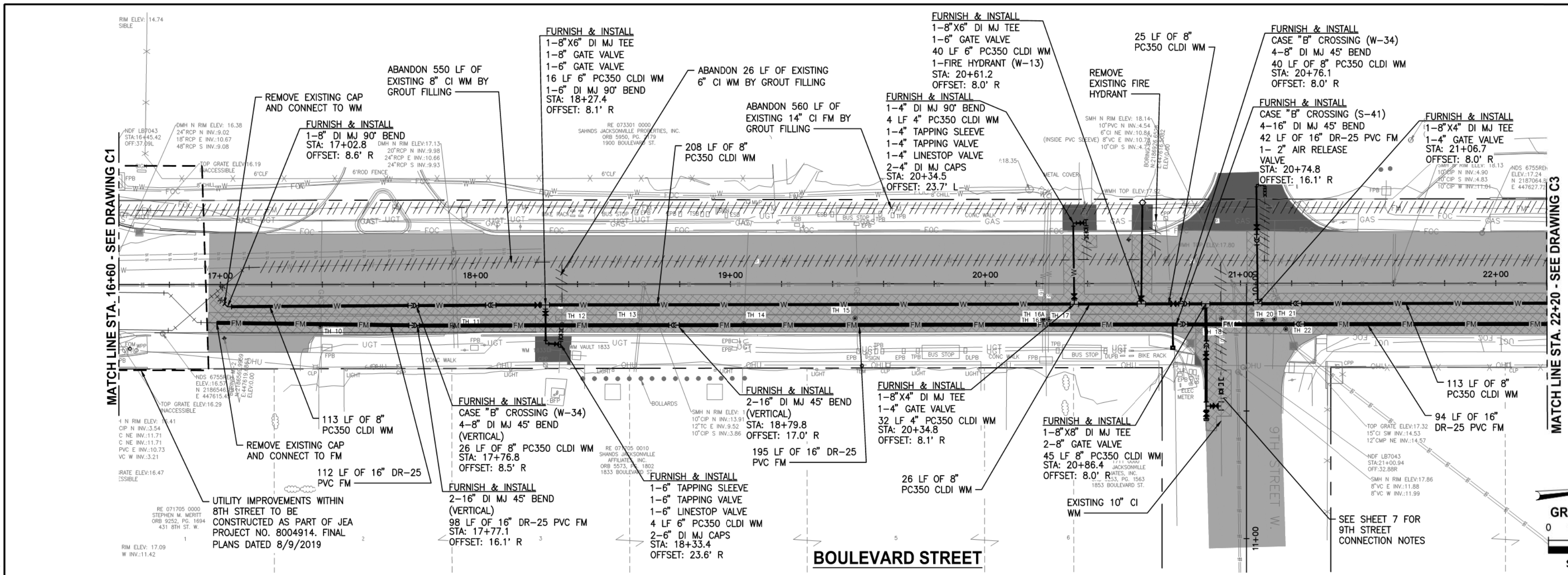

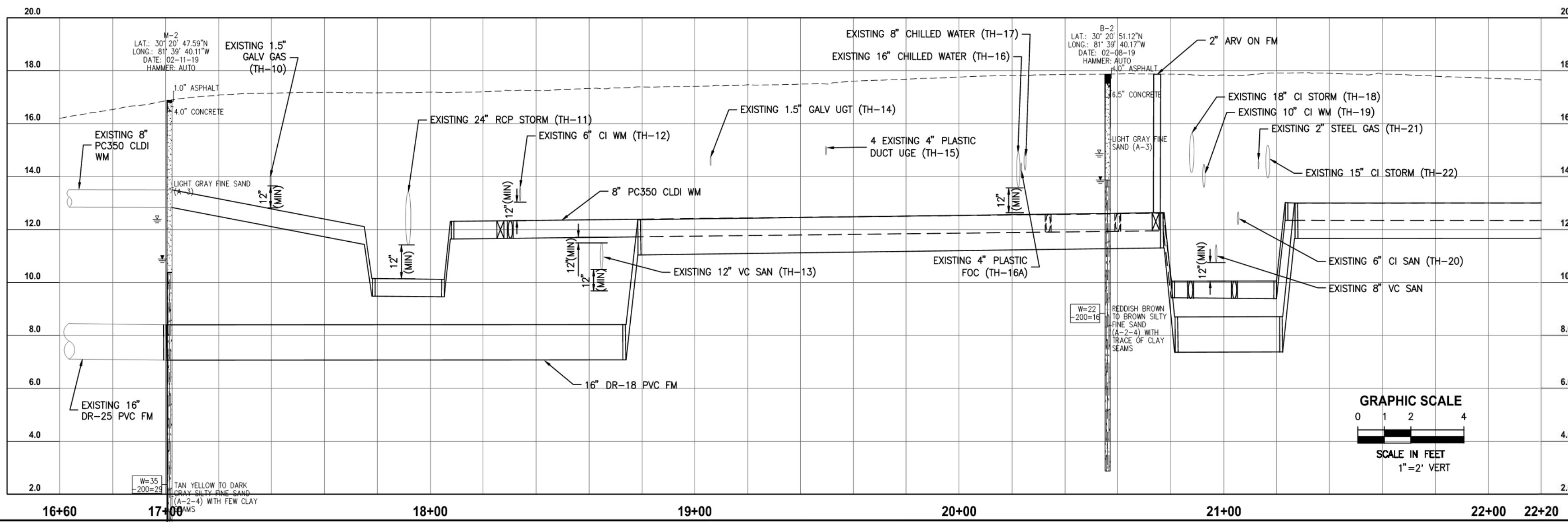

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NO.	BY	DATE	REVISIONS

DESIGN ENGINEER
KENNETH A. FRASER, PE
FLORIDA REGISTRATION NO.
57452

DESIGNED: KFRASER
DRAWN BY: RWADE
DATE: AUG 2019
CHECKED BY: HBRIDGES
DATE: AUG 2019

JEA Building Community

BOULEVARD FORCE MAIN AND WATER MAIN REPLACEMENT
PLAN AND PROFILE

PROJ. NO. 09302-055-01
DATE: AUGUST, 2019
SCALE: 1"=20'H 1"=2'V

NO. SHEETS 34
SHEET NO. 6
DRAWING NO. C2

Xrefs Attached= XR055-C-TBPP [\\Topgun01\jonsclients\09302-JEA\Projects\055-01 BOULEVARD FM & WM REPLACEMENT\CAD\Dwgs\Xref\general\XR055-C-TBPP.dwg]
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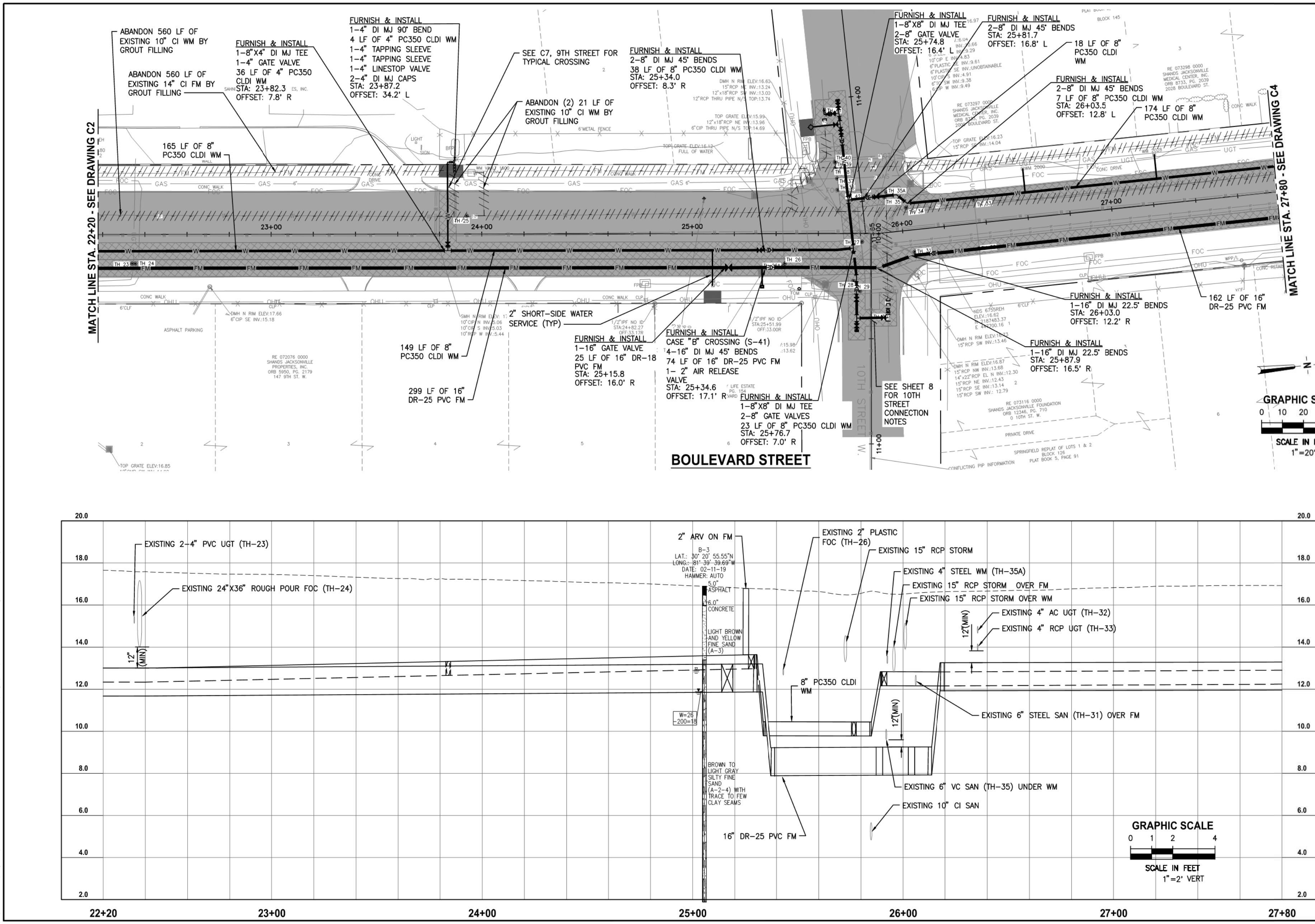

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KENNETH A. FRASER, PE
FLORIDA REGISTRATION NO. 57452

JEA Building Community

BOULEVARD FORCE MAIN AND WATER MAIN REPLACEMENT
PLAN AND PROFILE

PROJ. NO. 09302-055-01
DATE: AUGUST, 2019
SCALE: 1"=20'H 1"=2'V
NO. SHEETS 34
SHEET NO. 7
DRAWING NO. C3

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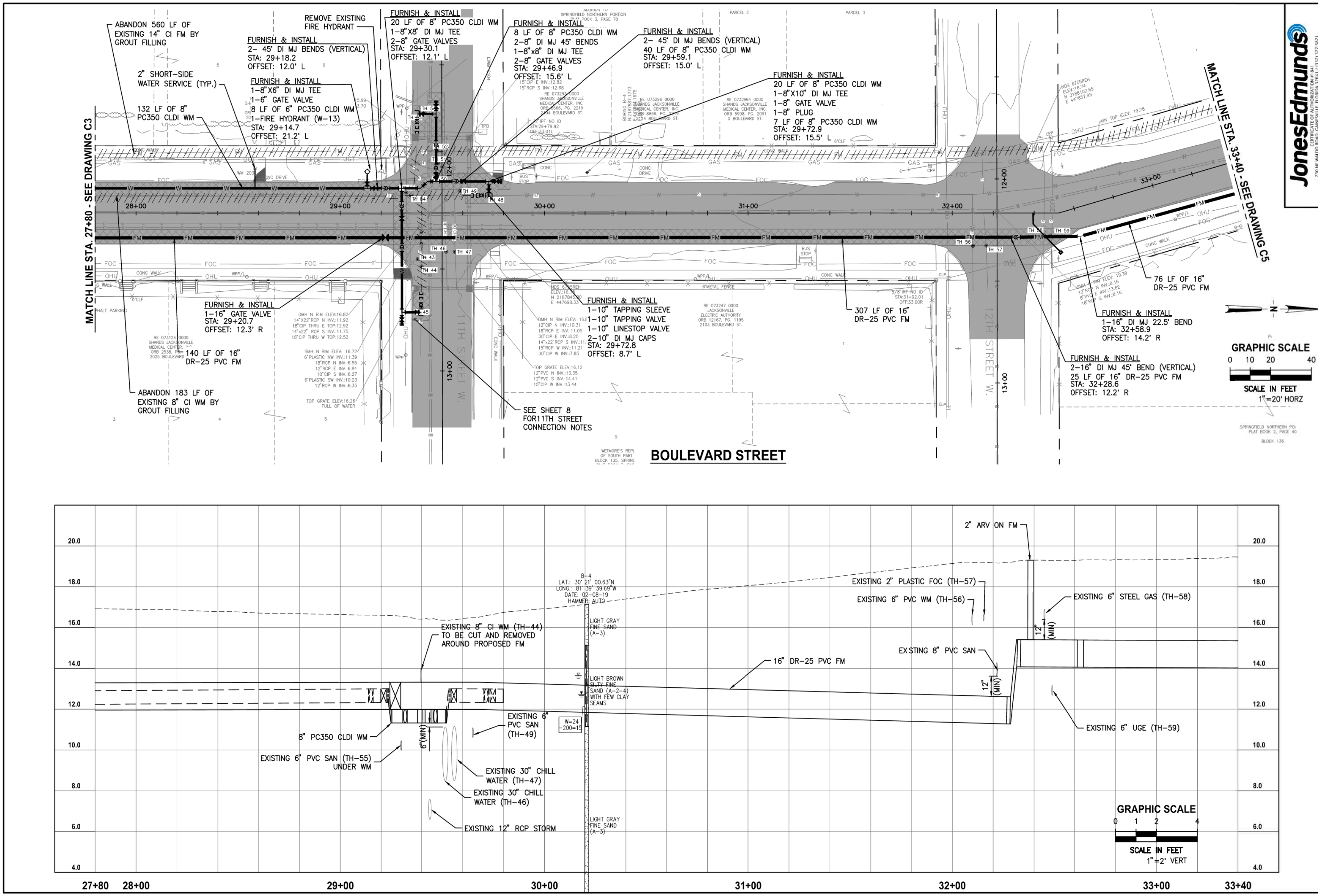

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730 NE WALDO ROAD, GAINESVILLE, FLORIDA 32641 / (352) 377-5821
8657 BAYPINE ROAD SUITE 300, JACKSONVILLE, FL 32256 / (904) 744-5401
CERTIFICATE OF AUTHORIZATION #1841

NO.	BY	DATE	REVISIONS

DESIGN ENGINEER: KENNETH A. FRASER, PE
FLORIDA REGISTRATION NO. 57452

DESIGNER: KFRASER
DRAWN BY: RWADE
DATE: AUG 2019
CHECKED BY: HBRIDGES
DATE: AUG 2019

JEA Building Community

BOULEVARD FORCE MAIN AND WATER MAIN REPLACEMENT
PLAN AND PROFILE

PROJ. NO. 09302-055-01
DATE: AUGUST, 2019
SCALE: 1"=20'H 1"=2'V
NO. SHEETS 34
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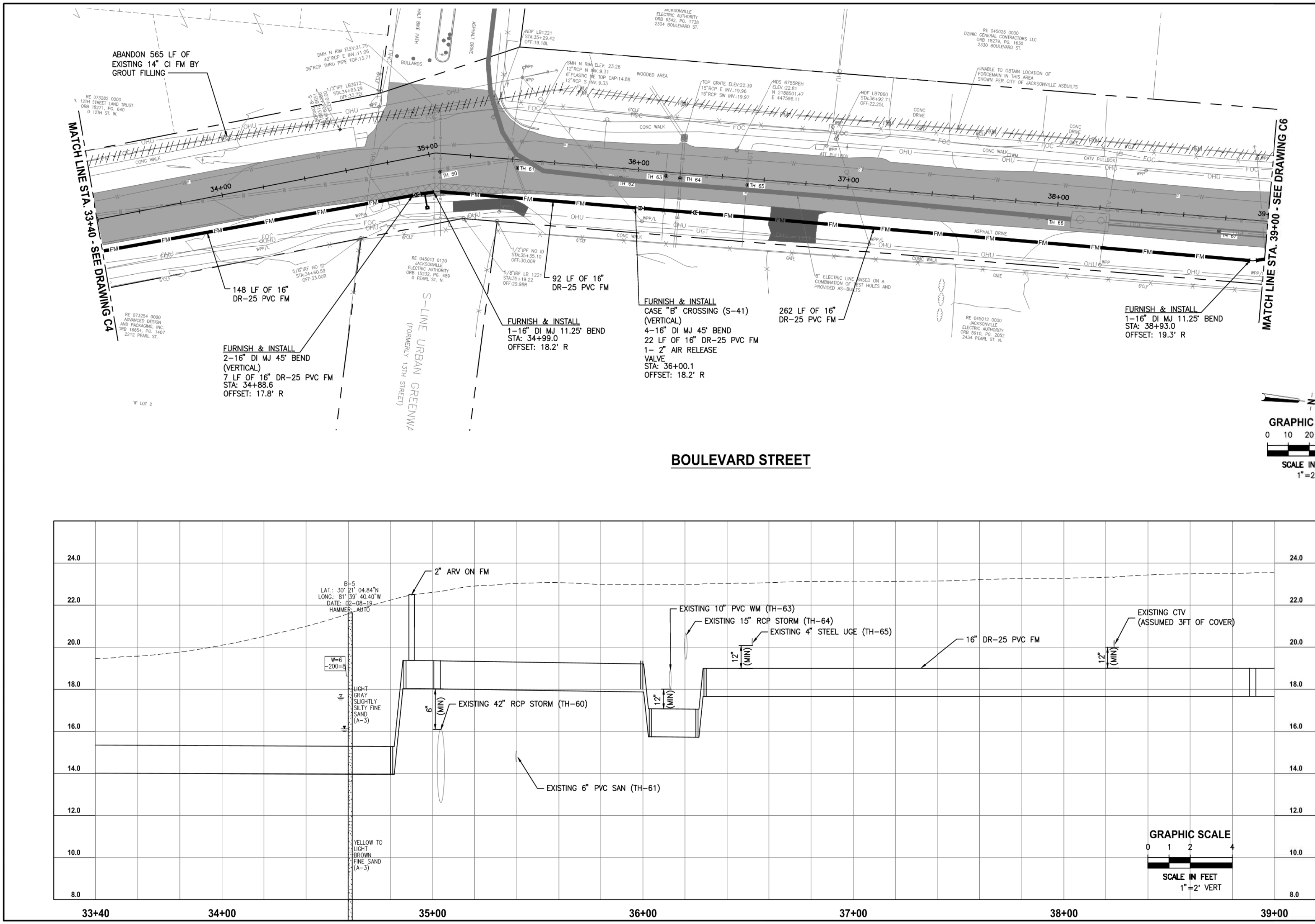

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DESIGN ENGINEER: KENNETH A. FRASER, PE
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DESIGNED: KFRASER
DRAWN BY: RWADE
DATE: AUG 2019
CHECKED BY: HBRIDGES
DATE: AUG 2019

BOULEVARD FORCE MAIN AND WATER MAIN REPLACEMENT
PLAN AND PROFILE

PROJ. NO. 09302-055-01
DATE: AUGUST, 2019
SCALE: 1"=20'H 1"=2'V

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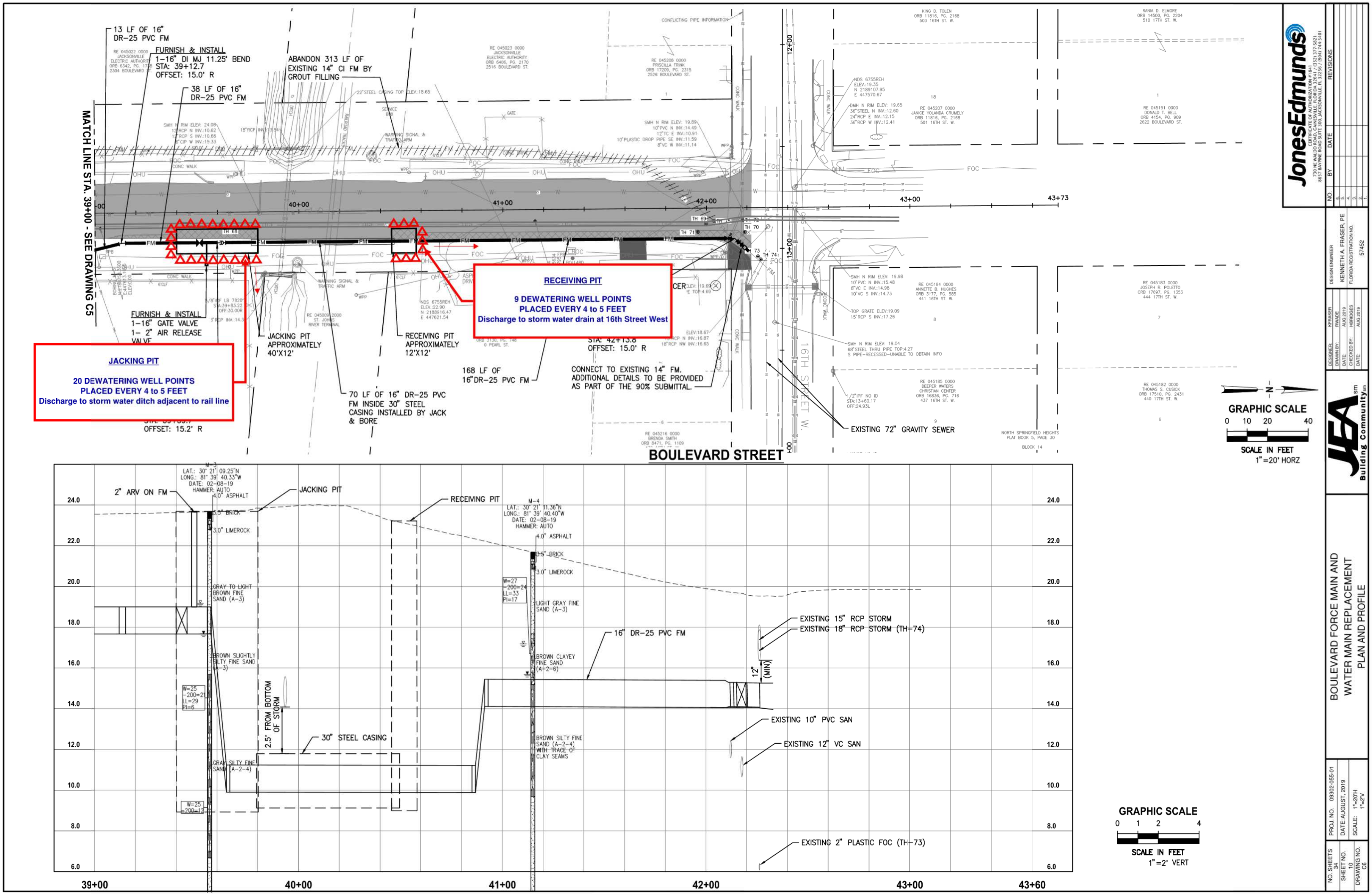
13 LF OF 16" DR-25 PVC FM
FURNISH & INSTALL 1-16" DI MJ 11.25° BEND STA: 39+12.7 OFFSET: 15.0' R
38 LF OF 16" DR-25 PVC FM
ABANDON 313 LF OF EXISTING 14" CI FM BY GROUT FILLING
MATCH LINE STA. 39+00 - SEE DRAWING C5
FURNISH & INSTALL 1-16" GATE VALVE 1- 2" AIR RELEASE VALVE
JACKING PIT
20 DEWATERING WELL POINTS PLACED EVERY 4 to 5 FEET
Discharge to storm water ditch adjacent to rail line
OFFSET: 15.2' R
JACKING PIT APPROXIMATELY 40'X12'
70 LF OF 16" DR-25 PVC FM INSIDE 30" STEEL CASING INSTALLED BY JACK & BORE
RECEIVING PIT APPROXIMATELY 12'X12'
168 LF OF 16" DR-25 PVC FM
RECEIVING PIT
9 DEWATERING WELL POINTS PLACED EVERY 4 to 5 FEET
Discharge to storm water drain at 16th Street West
OFFSET: 15.0' R
CONNECT TO EXISTING 14" FM. ADDITIONAL DETAILS TO BE PROVIDED AS PART OF THE 90% SUBMITTAL.
EXISTING 72" GRAVITY SEWER
16TH STREET W.
BOULEVARD STREET
40+00
41+00
42+00
43+00
43+73
GRAPHIC SCALE
0 10 20 40
SCALE IN FEET
1"=20' HORZ
2" ARV ON FM
JACKING PIT
RECEIVING PIT
16" DR-25 PVC FM
30" STEEL CASING
2.5' FROM BOTTOM OF STORM
EXISTING 15" RCP STORM
EXISTING 18" RCP STORM (TH-74)
12" (MIN)
EXISTING 10" PVC SAN
EXISTING 12" VC SAN
EXISTING 2" PLASTIC FOC (TH-73)
39+00
40+00
41+00
42+00
43+00
43+60
GRAPHIC SCALE
0 1 2 4
SCALE IN FEET
1"=2' VERT
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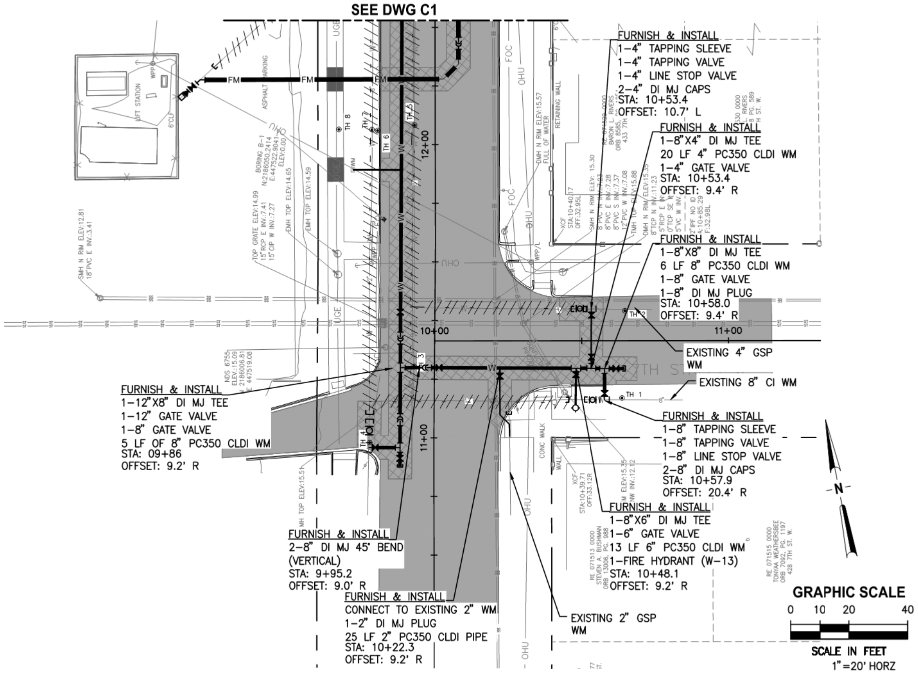
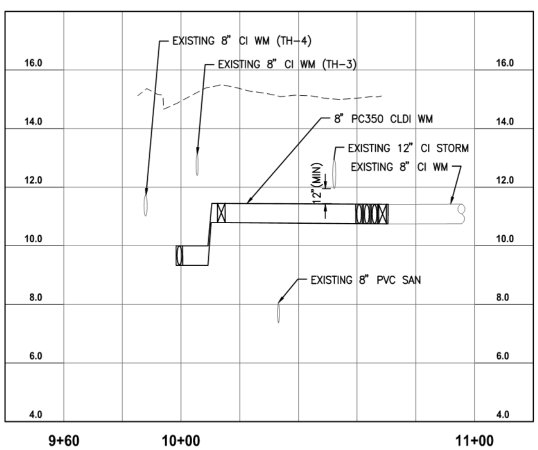
DESIGN ENGINEER KENNETH A. FRASER, PE
FLORIDA REGISTRATION NO. 57452
BOULEVARD FORCE MAIN AND WATER MAIN REPLACEMENT
PLAN AND PROFILE
PROJ. NO. 09302-055-01
DATE: AUGUST, 2019
SCALE: 1"=20'H 1"=2'V
NO. SHEETS 34
SHEET NO. 10
DRAWING NO. C6

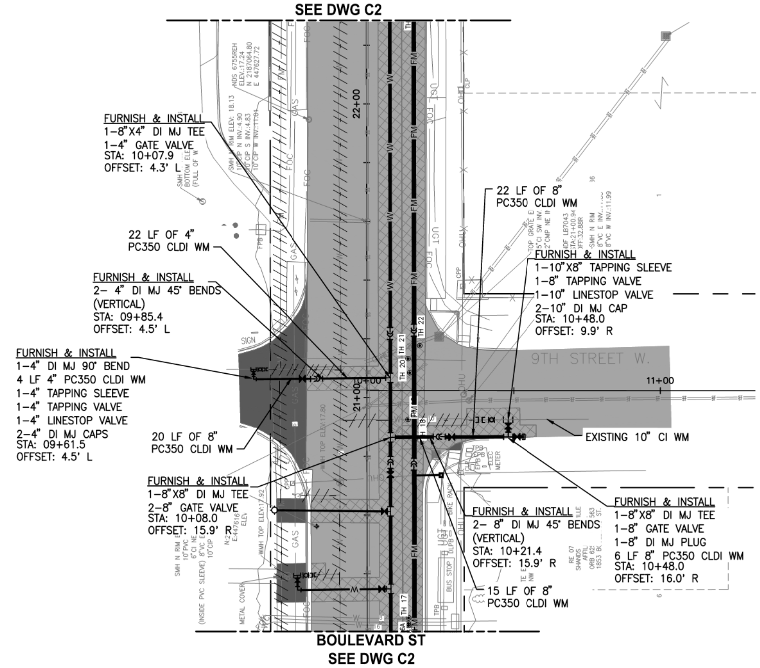
7TH STREET

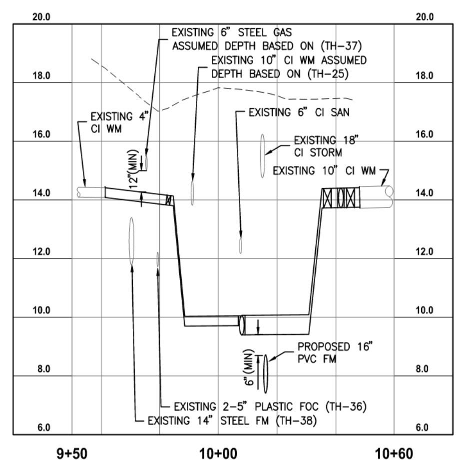




GRAPHIC SCALE
0 1 2 4
SCALE IN FEET
1"=2' VERT

9TH STREET





GRAPHIC SCALE
0 1 2 4
SCALE IN FEET
1"=2' VERT

JonesEdmunds

REVISIONS
NO. | BY | DATE

DESIGN ENGINEER
KENNETH A. FRASER, PE
FLORIDA REGISTRATION NO.
57452

DESIGNED: KFRASER
DRAWN BY: RWADE
DATE: AUG 2019
CHECKED BY: HBRIDGES
DATE: AUG 2019

JEA
Building Community

BOULEVARD FORCE MAIN AND WATER MAIN REPLACEMENT
PLAN AND PROFILE

PROJ. NO. 09302-055-01
DATE: AUGUST, 2019
SCALE: 1"=20'H 1"=2'V

NO. SHEETS 34
SHEET NO. 11
DRAWING NO. C7

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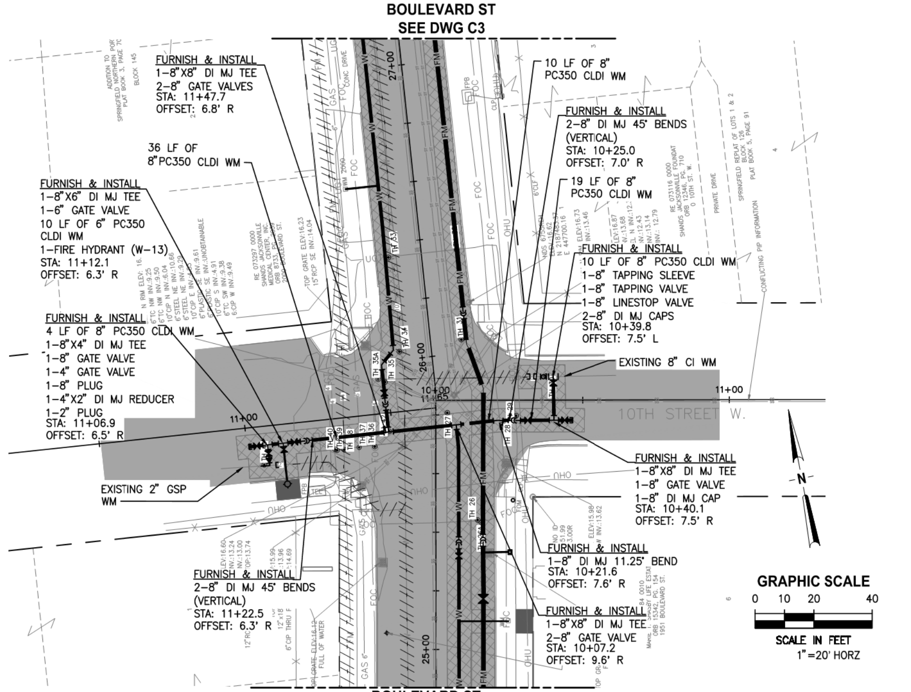
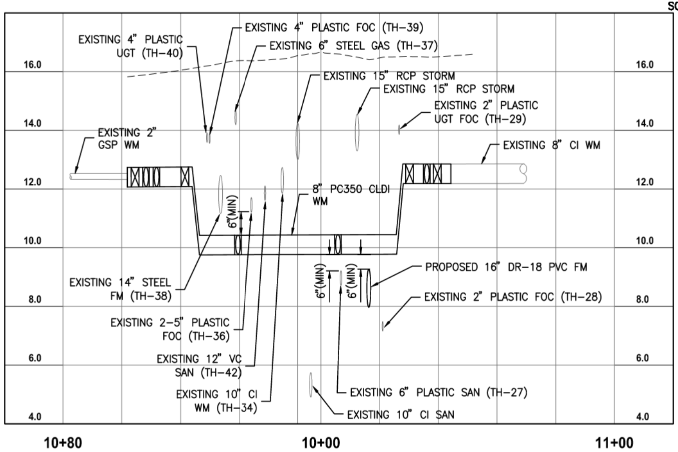
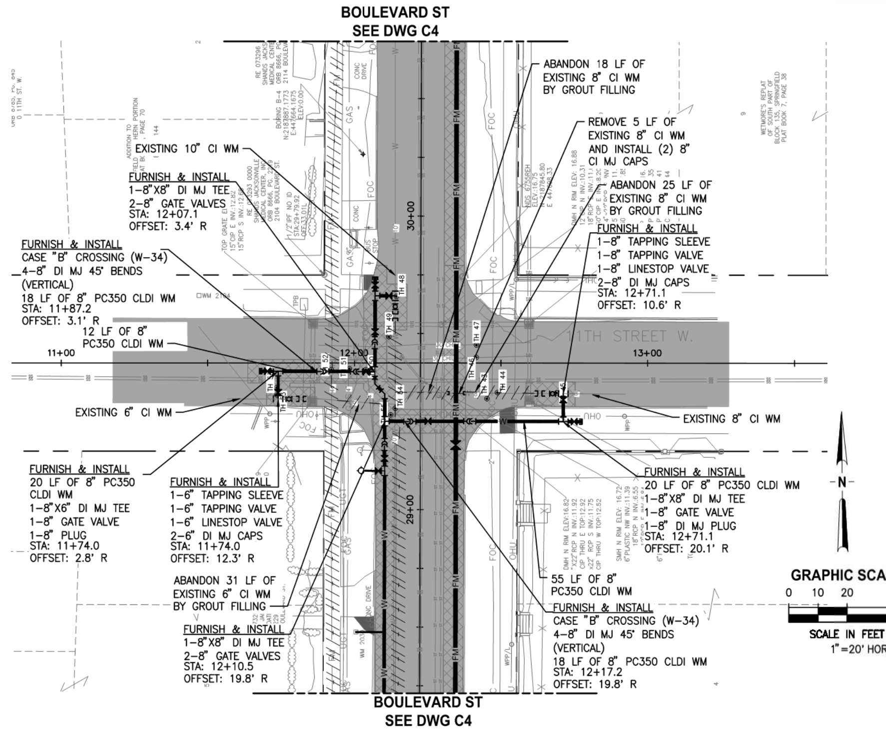


10TH STREET

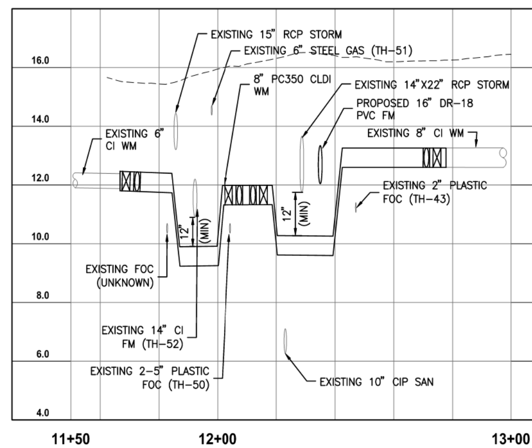
GRAPHIC SCALE
0 1 2 4
SCALE IN FEET
1"=2' VERT





11TH STREET

GRAPHIC SCALE
0 1 2 4
SCALE IN FEET
1"=2' VERT



JonesEdmunds

JEA Building Community

BOULEVARD FORCE MAIN AND WATER MAIN REPLACEMENT PLAN AND PROFILE

DESIGN ENGINEER: KENNETH A. FRASER, PE
FLORIDA REGISTRATION NO. 57452

DESIGNER: KFRASER
DRAWN BY: RWADE
CHECKED BY: HBRIDGES
DATE: AUG 2019

PROJ. NO. 09302-055-01
DATE: AUGUST, 2019
SCALE: 1"=20'H 1"=2'V

NO. SHEETS 34
SHEET NO. 12
DRAWING NO. C8

APPENDIX B:

Geotechnical Exploration & Evaluation Report by CSI Geo, Inc.

Geotechnical Exploration and Evaluation Report

Boulevard Street Forcemain and Watermain
Jacksonville, Florida

CSI Geo Project No.: 71-19-329-10
Client Project No.: 09302-055-01
JEA Contract No.: 153003
Purchase Order: 179335

Prepared by

CSI Geo, Inc.
2394 St. Johns Bluff Road S., Suite 200
Jacksonville, FL 32246
Tel: (904) 641-1993
Fax: (904) 641-0057

Prepared for

Jones Edmunds & Associates, Inc.

March 11, 2019

Geotechnical • CMT • CEI

March 11, 2019

Dr. Harold Bridges, Ph.D, P.E.
Jones Edmunds & Associates, Inc.
8657 Baypine Road, Suite 300
Jacksonville, Florida 32256-8634

RE: Boulevard Street Forcemain and Watermain
Jacksonville, Florida

Subject: Geotechnical Exploration and Evaluation Report
CSI Geo Project No.: 71-19-329-10
Client Project No.: 09302-055-01
JEA Contract No.: 153003
Purchase Order: 179335

Dear Dr. Bridges:

CSI Geo, Inc. has performed the authorized geotechnical exploration and laboratory testing program for the proposed Boulevard Street forcemain and watermain improvements in Jacksonville, Florida. This report presents our understanding of the subsurface conditions along with our engineering evaluation and recommendations.

We have enjoyed working with you on this project and look forward to working with you on future projects. If you have any questions concerning this report, please contact our office.

Sincerely,

CSI Geo, Inc.

Nader Amer, Ph.D
Geotechnical Engineer

BRUCE KHOSROZADEH LICENSE No 45273 STATE OF FLORIDA PROFESSIONAL ENGINEER

Bruce Khosrozadeh, P.E.
Senior Geotechnical and
Materials Engineer
Registered, Florida No. 45273

TABLE OF CONTENTS

1.0 PROJECT INFORMATION

1.1 General Project Information

The purpose of this geotechnical exploration program was to develop information concerning the subsurface conditions in order to evaluate the site with respect to the proposed Boulevard Street forcemain and watermain improvements in Jacksonville, Florida. The general site location is shown on the Site Location Map included in the **Appendix**. This report describes the field and laboratory testing activities performed and presents the findings. The report also includes the subsurface soil and groundwater conditions encountered, soil parameters for use in the Jack & Bore design, and general site preparation recommendations for the proposed construction.

Information regarding this project was provided to CSI Geo, Inc. (CSI Geo) by Dr. Harold Bridges, Ph.D, P.E and Mr. Kenneth A. Fraser, P.E. of Jones Edmunds & Associates, Inc. (Jones Edmunds). The following document was provided to us in electronic format.

- Boulevard Street Forcemain and Watermain Technical Memorandum
  Provided by: Jones Edmunds
  Dated: August 2018

1.2 Project Description and Existing Conditions

The proposed construction along Boulevard Street consists of the replacement of the existing watermains from West 7th Street to West 11th Street for a distance of about 1,400 LF and upgrading the existing forcemain from West 7th Street to West 16th for a distance of about 3,100 LF. The proposed pipe alignments cross a major roadway at West 8th Street, and also at the CSX railroad tracks just south of West 16th Street. The pipelines at the major crossings will be installed by means of Jack & Bore method. The remaining areas along the alignment are generally flat and will utilize open-cut installation methods.

Boulevard Street within the project limits consists of an undivided two-lane urban roadway with grass shoulders, sidewalks, and several commercial businesses and medical centers on both sides of the road.

2.0 GEOTECHNICAL EXPLORATION

2.1 Field Exploration

The subsurface conditions along the areas where the pipelines will be installed using open-cut method of installation were explored by means of a total of five (5) Standard Penetration Test (SPT) borings B-1 through B-5 drilled to a depth of 15 feet below the existing grades.

The subsurface conditions in the areas of the entry and exit points of the Jack & Bore pipe installation were explored by means of four (4) SPT borings M-1 through M-4 drilled to a depth of 30 feet below the existing grades. Borings M-1 and M-2 were performed for the entry and exit points of the West 8^{th} Street crossing, and borings M-3 and M-4 were performed for the entry and exit points of the CSX railroad crossing.

The boring locations and depths were selected and located in the field by personnel from CSI Geo. All borings were grouted to full depth after boring completion. Soil samples collected were visually classified in the field and then transported to our laboratory for re-classification and testing. Representative soil samples obtained during our field exploration program were visually classified using the American Association of State Highway and Transportation Officials (AASHTO) Soil Classification System. The approximate locations of the soil borings are shown on the Field Exploration Plan sheets included in the **Appendix**.

2.2 Laboratory Testing

Quantitative laboratory testing was performed on representative soil samples to better define their composition. Laboratory tests performed were percent fines, natural moisture content, and Atterberg limits. A Summary of Laboratory Test Results, and Field and Laboratory Test Procedures, are included in the **Appendix**.

3.0 GENERAL SUBSURFACE CONDITIONS

3.1 General

An illustrated representation of the subsurface conditions encountered is shown on the Report of SPT Borings sheets presented in the **Appendix**. The soil conditions outlined below highlight the major subsurface stratification. The Report of SPT Borings in the **Appendix** should be consulted for a detailed description of the subsurface conditions encountered at each boring location. When reviewing the Report of SPT Borings, it should be understood that soil conditions may vary outside of the explored areas.

3.2 Soil Conditions

3.2.1 Open-Cut Method of Pipe Installation

Review of test borings B-1 through B-5 indicates that the pipeline alignments are generally underlain by very loose to medium dense sands and slightly silty sands (A-3, AASHTO) followed by very loose to medium dense silty sands (A-2-4) and clayey sands (A-2-6) until the borings termination depth of 15 feet below the existing grades.

3.2.2 Jack & Bore Method of Pipe Installation

Review of test borings M-1 through M-4 indicates that the areas of the proposed Jack & Bore installations are generally underlain by loose to medium dense sands and slightly silty sands (A-3) to depths of 4 to 8 feet below the existing grades. The overburden sands are followed by very loose to medium dense silty sands (A-2-4) and firm clayey sands (A-2-6) to depths of 12 to 22 feet below the existing grades. Thereafter, medium dense to dense sands (A-3) were encountered until the borings termination depth of 30 feet below the existing grades.

3.3 Groundwater Conditions

The groundwater level was measured and recorded as encountered at the time of drilling. The depths of the groundwater level and estimated seasonal high water level at the test locations are marked on the Report of SPT Borings sheets presented in the **Appendix**. The depth of groundwater level measured at the time of drilling ranged from 4.0 to 6.0 feet below the existing grades. The estimated seasonal high groundwater table for the borings performed ranged from 3.0 to 4.5 feet below the existing grades.

Fluctuations of the groundwater level should be anticipated as a result of the close proximity to the St. Johns River, urbanization/development, topographic changes, seasonal climatic variations, surface water runoff patterns, fluctuations of adjacent water bodies, construction activities, and other factors. During seasonal high precipitation, groundwater levels can be expected to rise. Therefore, design drawings and specifications should account for the possibility of groundwater level variations, and construction planning should be based on the assumption that such variations will occur.

Determination of the estimated seasonal high groundwater table was made using the methodology described by the United States Department of Agriculture (USDA) Soil Conservation Service (SCS). In sandy soils the method involves examining soil cuttings from the borings for subtle changes in root content and soil coloration. These subtle changes are indicators of the highest level the groundwater level has been for a prolonged period. It should be anticipated that the groundwater level will fluctuate due to seasonal climate variations, surface water runoff patterns, nearby water bodies, construction operations, and other related factors.

3.4 Existing Pavement System Thickness

Pavement cores were performed whenever possible at the test boring locations to determine the thickness of the existing pavement system. Generally, the existing pavement system was found to consist of 1 to 5 inches of asphalt over 4 to 6 ½ inches of concrete. It should be noted that cores taken at borings M-3 and M-4 near the CSX railroad crossing show a pavement system consisting of 4 inches of asphalt over 3 ½ inches of brick followed by 3 inches of limerock base. The results of the pavement cores are included in the **Appendix**.

4.0 DESIGN RECOMMENDATIONS

4.1 General

Our geotechnical evaluation of the site and the subsurface conditions is based on our understanding of the proposed project, our observations, and results of field and laboratory testing. The recommendations provided in this report present construction methods and techniques that are appropriate for the proposed construction. If the project location is changed or if field conditions encountered during construction are different from those presented in this report, the information should be provided to CSI Geo for evaluation. We also recommend that CSI Geo be given the opportunity to review the design plans and specifications to ensure that our recommendations have been properly included and implemented.

4.2 Open-Cut Excavations

In general, we consider the subsurface soil conditions at the site to be favorable for support of the proposed pipe over a properly prepared and compacted subgrade, provided that the site preparation and earthwork construction recommendations in this report are performed.

The (A-3) type soils are considered select material. Silty sands (A-2-4) can be treated as select material, however, they may contain excess moisture and may be difficult to dry and to compact. Clayey sands (A-2-6) should be considered plastic materials and should be excavated to a minimum depth of one foot below the design invert elevations and replaced with suitable A-3 fill material. It is likely that the excavated suitable soils may get mixed with plastic soils during construction and should be regarded as unsuitable for backfill purposes. We recommend that allowances be made for possible overruns in quantities of subsoil removal and replacement with select backfill. It should be noted that boundaries and limits of plastic soils are approximate and represent soils encountered at each boring location. Subsurface variance between borings may occur and should be anticipated.

If encountered, unsuitable organic soils (A-8) should be considered as muck and not suitable for use as backfill. if unsuitable organic materials are encountered, they should be removed in their entirety and replaced with select sands (A-3) material.

We anticipate that the buried pipe lines will exert little downward pressure on the subgrade soils. In areas where the surrounding groundwater level is above the pipe invert elevation, the line should be designed to resist lateral earth pressures and hydrostatic uplift pressures appropriate to its depth below the existing grade and the seasonal high-water level.

4.3 Recommended Design Soil Parameters for Jack & Bore Crossings

Jack & Bore will be used to install the proposed pipes underneath West 8th Street and the CSX railroad tracks. Pipes installed using Jack & Bore should follow the latest JEA Water & Wastewater Standards Manual and project technical specifications. We recommend that soil parameters and assumptions for the Jack & Bore design follow the information provided in the Recommended Design Soil Parameters for Jack & Bore tables included in the **Appendix**. Soil parameters provided in the tables are representative of the soil conditions at the variable depths and have been generated based on N-values that were corrected for hammer efficiency and overburden pressure.

5.0 SITE PREPARATION & EARTHWORK RECOMMENDATIONS

5.1 Existing Utilities

The locations of existing utilities should be established prior to construction. Provisions should be made to relocate utilities interfering with the proposed alignments and construction, as needed. Underground pipes that are not operational should be either removed, plugged, or grouted in place otherwise they may become conduits for subsurface erosion and cause settlements.

5.2 Temporary Groundwater Control

Groundwater level was encountered at the time of drilling at depths ranging from 4.0 to 6.0 feet below the existing grades. Therefore, groundwater control should be anticipated. The groundwater level should be maintained at a minimum of two feet below the subgrade of the proposed inverts.

Similarly, dewatering at the Jack & Bore locations should be maintained at two feet below any casing invert elevation and below the entry & exit pits. Dewatering may be achieved by conventional open pumping using ditches graded to a sump, using a well point system, or deep wells. Dewatering should continue until pipe installation is complete. Piezometers should be installed to monitor groundwater levels near the entry and exit pits and Jack & Bore crossings. Base line readings should be obtained prior to excavating the entry and exit pits.

5.3 Excavation Protection

All excavations should meet OSHA Excavation Standard Subpart P regulations for Type C soils. A trench box or braced sheet pile structures may be considered to support open excavations. The soil support system should be designed according to OSHA by a Florida registered Professional Engineer.

5.4 Pipe Backfill and Compaction of Pipe Backfill

The A-3 type soils are considered select material and suitable for use as backfill. Silty sands (A-2-4) can be treated as select material, however, they may contain excess moisture and may be difficult to dry and to compact. Clayey sands (A-2-6) should be considered plastic materials and should be excavated to a minimum depth of one foot below the design invert elevations and replaced with suitable A-3 fill material. Plastic clayey sands (A-2-6) and unsuitable organic soils (A-8), if encountered, should be considered unsuitable for backfilling and compaction purposes.

As mentioned earlier, some of the excavated suitable soils will likely get mixed with plastic soils during construction. Therefore, some of the excavated material should be regarded as unsuitable for backfill purposes. We recommend that allowance be made for overruns in quantities of subsoil removal and replacement with select (A-3) backfill.

The backfill material within the excavation should be placed in thin loose lifts not exceeding 6 inches in thickness. The backfill material should be compacted by the use of hand-operated equipment. The backfill material should be granular (A-3) fill with less than 10 percent material passing the no. 200 mesh sieve and containing less than 3 percent organic matter. The backfill material should be compacted to a minimum density of 98% or 95% of maximum dry density obtained from the Modified Proctor compaction test (ASTM D1557), as required by JEA. The moisture content during compaction should be maintained within $\pm$ 3 percent of the optimum moisture content as obtained from the Modified Proctor compaction test.

Hand held compaction equipment should be used for the backfill placed around the pipe and to a height of 2 feet above the pipe. Heavier equipment may be used on the remaining backfill lifts placed above 2 feet. However, care should be taken not to damage the pipe below. The pipe should be designed to withstand the anticipated dead (overburden) and live loads.

6.0 REPORT LIMITATIONS

The subsurface exploration program including our evaluation and recommendations was performed in general accordance of accepted geotechnical engineering principles and standard practices. CSI Geo is not responsible for any independent conclusions, opinions, or interpretations made by others based on the data presented in this report.

This report does not reflect any variations that may occur adjacent or between soil borings. The discovery of any site or subsurface condition during construction that deviates from the findings and data as presented in this report should be reported to CSI Geo for evaluation. If the project location is changed, our office should be contacted so our recommendations can be re-evaluated. We recommend that CSI Geo be given the opportunity to review the final design drawings and specifications to ensure that our recommendations are properly included and implemented.

APPENDIX

Site Location Map

Field Exploration Plan

Report of SPT Borings

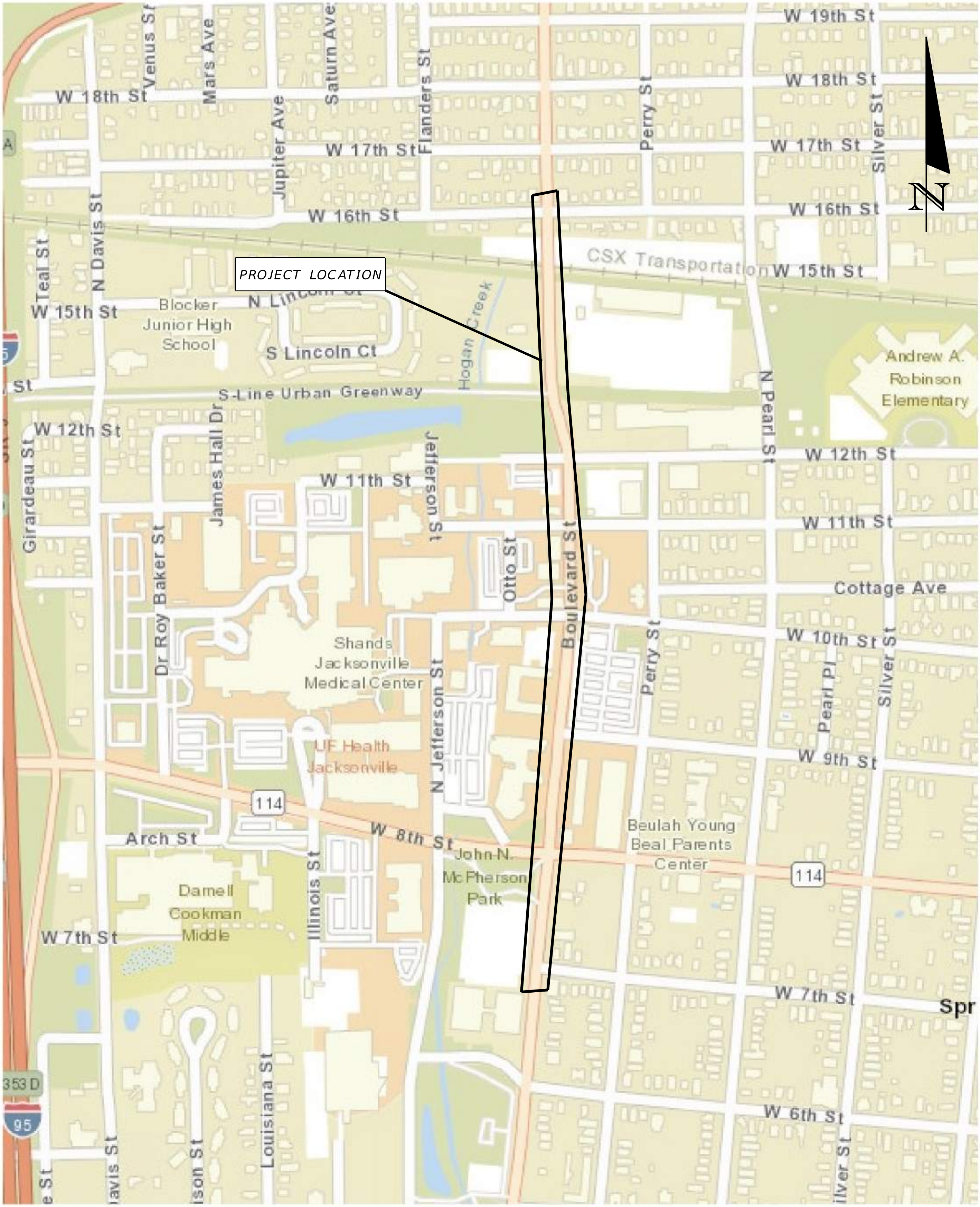
Summary of Laboratory Test Results

Recommended Design Soil Parameters
for Jack & Bore Crossings

Key to Soil Classification

Field and Laboratory Test Procedures

Site Location Map



CSI GEO, INC.
2394 ST. JOHNS BLUFF ROAD S., SUITE 200
JACKSONVILLE, FLORIDA 32246

SITE LOCATION MAP
BOULEVARD STREET FORCEMAIN & WATERMAIN
JACKSONVILLE, FLORIDA

Field Exploration Plan

CSIGeo
GEOTECHNICAL·CMT·CEI
2394 ST. JOHNS BLUFF ROAD, S. SUITE 200
JACKSONVILLE, FLORIDA 32246

GEOTECHNICAL ENGINEERING
CONSTRUCTION MATERIAL TESTING
CONSTRUCTION ENGINEERING INSPECTION

FIELD EXPLORATION PLAN

BOULEVARD STREET FORCEMAIN & WATERMAIN
JACKSONVILLE, FLORIDA

CSIGeo
GEOTECHNICAL·CMT·CEI
2394 ST. JOHNS BLUFF ROAD, S. SUITE 200
JACKSONVILLE, FLORIDA 32246

GEOTECHNICAL ENGINEERING
CONSTRUCTION MATERIAL TESTING
CONSTRUCTION ENGINEERING INSPECTION

FIELD EXPLORATION PLAN

BOULEVARD STREET FORCEMAIN & WATERMAIN
JACKSONVILLE, FLORIDA

Report of SPT Borings

LEGEND

ASPHALT

CONCRETE

LIMEROCK

BRICK

FINE SAND; SLIGHTLY SILTY FINE SAND (A-3)

SILTY FINE SAND (A-2-4)

CLAYEY FINE SAND (A-2-6)

(A-3) AASHTO SOIL CLASSIFICATION SYSTEM

B.T. STANDARD PENETRATION TEST BORING TERMINATION

ESTIMATED SEASONAL HIGH GROUND WATER LEVEL

N STANDARD PENETRATION RESISTANCE IN BLOWS PER FT UNLESS OTHERWISE NOTED, NUMBERS TO THE LEFT OF BORING INDICATE N-VALUES.

GROUND WATER LEVEL AT TIME OF DRILLING

W	NATURAL MOISTURE CONTENT (%)
-200	FINES PASSING NO. 200 SIEVE (%)
LL	LIQUID LIMIT
PI	PLASTICITY INDEX

GRANULAR MATERIALS

RELATIVE DENSITY	AUTOMATIC HAMMER SPT N-VALUE (BLOWS/FT)
VERY LOOSE	LESS THAN 3
LOOSE	3-8
MEDIUM DENSE	8-24
DENSE	24-40
VERY DENSE	GREATER THAN 40

SILTS AND CLAYS

CONSISTENCY	AUTOMATIC HAMMER SPT N-VALUE (BLOWS/FT)
VERY SOFT	LESS THAN 1
SOFT	1-3
FIRM	3-6
STIFF	6-12
VERY STIFF	12-24
HARD	GREATER THAN 24

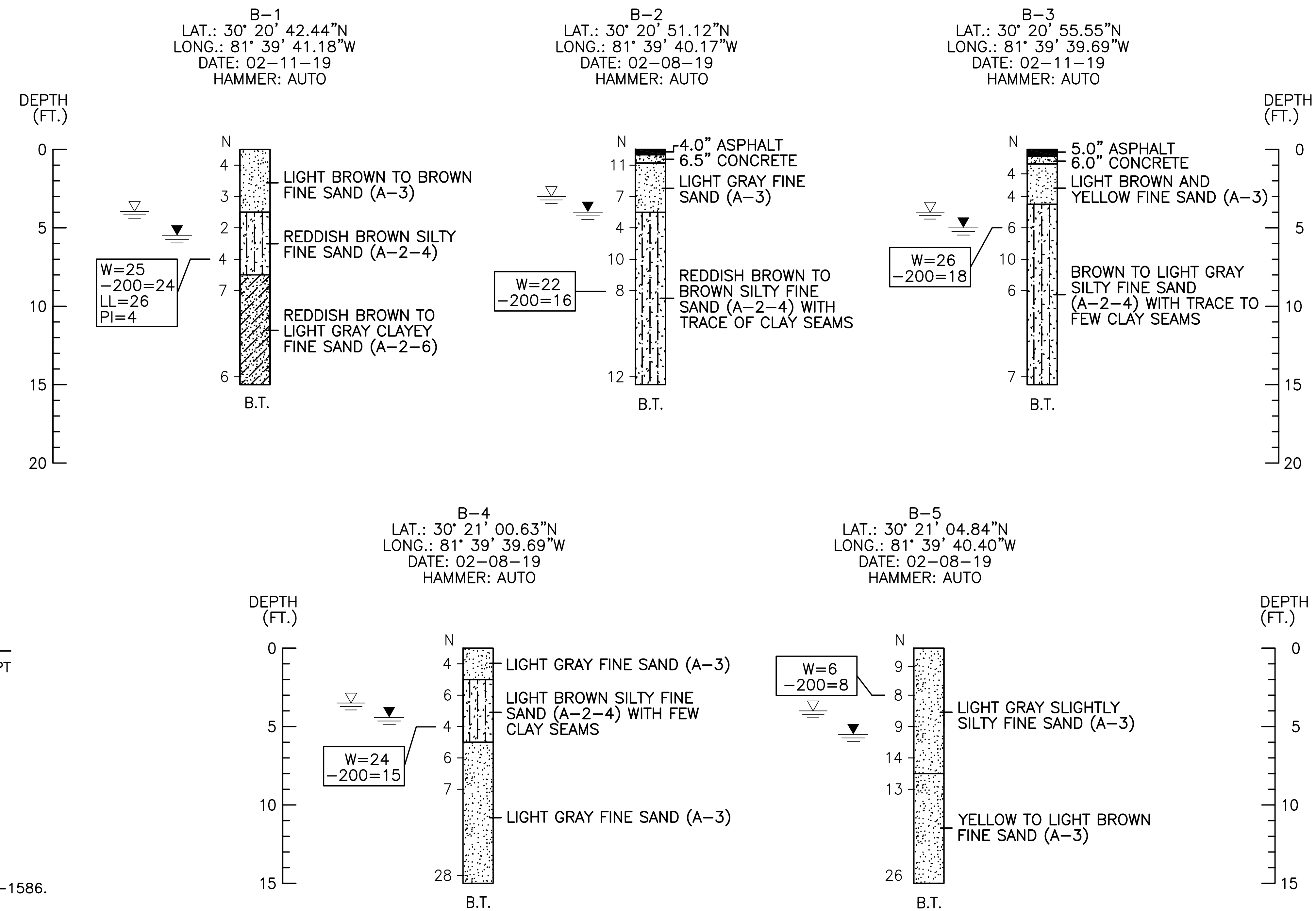
STANDARD PENETRATION TEST DATA

SPOON INSIDE DIA.	1.44 INCHES
SPOON OUTSIDE DIA.	2.0 INCHES
ASTM STANDARD DROP HAMMER	
AVG. HAMMER DROP	30.0 INCHES
HAMMER WEIGHT	140.0 LBS

NOTES:

1) DRILL AND PENETRATION TESTING WAS PERFORMED IN ACCORDANCE WITH ASTM D-1586.

2) LAYER BOUNDARIES ARE APPROXIMATE AND MAY VARY BETWEEN OR AWAY FROM BORING LOCATIONS.



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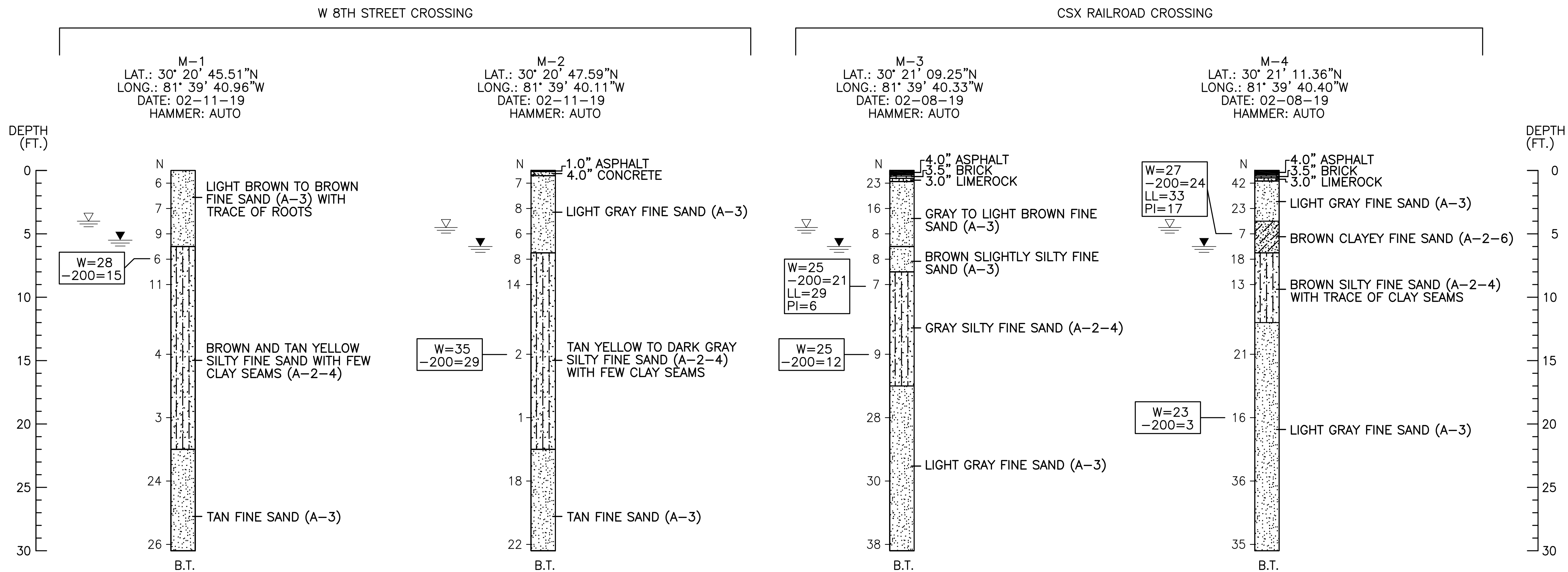
REPORT OF SPT BORINGS

BOULEVARD STREET FORCEMAIN AND WATERMAIN
JACKSONVILLE, FLORIDA



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REPORT OF SPT BORINGS
BOULEVARD STREET FORCEMAIN AND WATERMAIN
JACKSONVILLE, FLORIDA

Summary of Laboratory Test Results

SUMMARY OF LABORATORY TEST RESULTS

Boulevard Street Forcemain & Watermain
Jacksonville, Florida

Boring No.	Sample No.	Approximate Depth (ft)	Natural Moisture Content (%)	Organic Content (%)	Percent Passing Sieve Size (%)						Atterberg Limits		Soil Classification Symbol
					#4	#10	#40	#60	#100	#200	LL	PI	
B-1	4	6.0 - 8.0	25							24	26	4	A-2-4
B-2	5	8.0 - 10.0	22							16			A-2-4
B-3	3	4.0 - 6.0	26							18			A-2-4
B-4	3	4.0 - 6.0	24							15			A-2-4
B-5	2	2.0 - 4.0	6							8			A-3
M-1	4	6.0 - 8.0	28							15			A-2-4
M-2	6	13.5 - 15.0	35							29			A-2-4
M-3	5	8.0 - 10.0	25							21	29	6	A-2-4
M-3	6	13.5 - 15.0	25							12			A-2-4
M-4	3	4.0 - 6.0	27							24	33	17	A-2-6
M-4	7	18.5 - 20.0	23							3			A-3

Recommended Design Soil Parameters for Jack & Bore Crossings

Recommended Design Soil Parameters for Jack & Bore Crossings

Boulevard Street Forcemain and Watermain

Boring M-3 (South of CSX Railroad Crossing)

Soil Parameter*	Loose to Medium Dense Sands & Silty Sands	Loose Silty Sands	Medium Dense Sands
Depth (ft)	0.0 to 8.0	8.0 to 17.0	17.0 to 30.0
Saturated Unit Weight – γ (pcf)	115	110	120
Submerged Unit Weight – γ' (pcf)	53	48	58
Angle of Internal Friction – ϕ (degrees)	32	29	36
Cohesion – C (psf)	-	-	-
At Rest Earth Pressure Coefficient – K_o	0.47	0.52	0.41
Active Earth Pressure Coefficient - K_a	0.31	0.35	0.26
Passive Earth Pressure Coefficient – K_p	3.25	2.88	3.85

* Representative soil parameters based on N-values corrected for hammer efficiency and overburden

Boring M-4 (North of CSX Railroad Crossing)

Soil Parameter*	Medium Dense to Very Dense Sands	Stiff Clayey Sands	Medium Dense Silty Sands	Medium Dense to Dense Sands
Depth (ft)	0.0 to 4.0	4.0 to 6.5	6.5 to 12.0	12.0 to 30.0
Saturated Unit Weight – γ (pcf)	120	105	115	120
Submerged Unit Weight – γ' (pcf)	58	43	53	58
Angle of Internal Friction – ϕ (degrees)	36	-	33	38
Cohesion – C (psf)	-	1,600	-	-
At Rest Earth Pressure Coefficient – K_o	0.41	1.0	0.46	0.38
Active Earth Pressure Coefficient - K_a	0.26	1.0	0.29	0.24
Passive Earth Pressure Coefficient – K_p	3.85	1.0	3.39	4.20

* Representative soil parameters based on N-values corrected for hammer efficiency and overburden

Recommended Design Soil Parameters for Jack & Bore Crossings

Boulevard Street Forcemain and Watermain

Borings M-1 & M-2 (W 8th Street Crossing)

Soil Parameter*	Loose to Medium Dense Sands & Silty Sands	Very Loose to Loose Silty Sands	Medium Dense Sands
Depth (ft)	0.0 to 11.0	11.0 to 22.0	22.0 to 30.0
Saturated Unit Weight – γ (pcf)	115	100	120
Submerged Unit Weight – γ’ (pcf)	53	38	58
Angle of Internal Friction – ϕ (degrees)	31	26	36
Cohesion – C (psf)	-	-	-
At Rest Earth Pressure Coefficient – K_o	0.48	0.56	0.41
Active Earth Pressure Coefficient - K_a	0.32	0.39	0.26
Passive Earth Pressure Coefficient – K_p	3.12	2.56	3.85

* Representative soil parameters based on N-values corrected for hammer efficiency and overburden

Key to Soil Classification

KEY TO SOIL CLASSIFICATION

Correlation of Penetration Resistance with Relative Density and Consistency

Granular Materials

Relative Density	**Auto Hammer SPT N-Value (Blows/foot)**
Very Loose	Less than 3
Loose	3 – 8
Medium Dense	8 - 24
Dense	24 - 40
Very Dense	Greater than 40

Silts and Clays

Consistency	**Auto Hammer SPT N-Value (Blows/foot)**
Very Soft	Less than 1
Soft	1 – 3
Firm	3 - 6
Stiff	6 - 12
Very Stiff	12 - 24
Hard	Greater than 24

Particle Size Identification (Unified Soil Classification System)

Boulders:	Diameter exceeds 8 inches
Cobbles:	3 to 8 inches diameter
Gravel:	Coarse - 3/4 to 3 inches in diameter
	Fine - 4.76 mm to 3/4 inch in diameter
Sand:	Coarse - 2.0 mm to 4.76 mm in diameter
	Medium - 0.42 mm to 2.0 mm in diameter
	Fine - 0.074 mm to 0.42 mm in diameter

Modifiers

These modifiers provide our estimate of the amount of fines (silt or clay size particles) in soil samples.

Approximate Fines Content	Modifiers
5% Fines 12%	Slightly silty or slightly clayey
12% Fines 30%	Silty or clayey
30% Fines 50%	Very silty or very clayey

These modifiers provide our estimate of shell, rock fragments, or roots in the soil sample.

Approximate Content, By Weight	Modifiers
< 5%	Trace
5% to 10%	Few
15% to 25%	Little
30% to 45%	Some
50% to 100%	Mostly

These modifiers provide our estimate of organic content in the soil sample.

Organic Content	Modifiers
1% to 3%	Trace
3% to 5%	Slightly Organic
5% to 20%	Organic
20% to 75%	Highly Organic (Muck)
> 75%	Peat

Field and Laboratory Test Procedures

FIELD AND LABORATORY TEST PROCEDURES

FIELD TEST PROCEDURES

Standard Penetration Test (SPT) Borings – Standard Penetration Tests (SPT) borings were made in general accordance with ASTM D-1586-67, "Penetration Test and Split-Barrel Sampling of Soils". The borings were continuously sampled to 10 ft. Below 10 feet and until boring termination depths, split spoon sampling was performed at a spacing of 5 feet. Below the groundwater levels, the borings were advanced using rotary drilling techniques with side discharge and circulating bentonite fluid for borehole flushing and stability. Drilling tools were removed from the borehole and a split-barrel sampler inserted to the borehole bottom and driven 18-24 inches into the material using a 140-pound SPT hammer falling on the average 30 inches per hammer blow. The number of hammer blows for the second and third six inch intervals of penetration is termed the "penetration resistance, blow count, or N-value". After driving the sampler 24 inches or to refusal at each test interval, the sampler was retrieved from the borehole and a representative sample of the material within the split-barrel was placed in a glass jar or plastic bag and sealed. After completing the drilling operations, the samples for the boring were transported to our laboratory where they were examined by one of our geotechnical engineers to verify the driller's field classifications.

LABORATORY TEST PROCEDURES

Natural Moisture Content
The water content is the ratio, expressed as a percentage, of the weight of water in a given mass of soil to the weight of the solid particles. This test was conducted in the general accordance with ASTM D2216.

Percent Fine Content
To determine the percentage of soils finer than No. 200 sieve, the dried samples were washed over a 200 mesh sieve. The material retained on the sieve was oven dried and then weighed and compared with the unwashed dry weight in order to determine the weight of the fines. The percentage of fines in the soil sample was then determined as the percentage of weight of fines in the sample to the weight of the unwashed sample. This test was conducted in accordance with ASTM D 1140.

Plasticity (Atterberg Limits) - The soil's Plastic Index (PI) is bracketed by the Liquid Limit (LL) and Plastic Limit (PL). The LL is the moisture content at which the soil flows as a heavy viscous fluid and is determined in general accordance with FM 1-T 089. The PL is the moisture content at which the soil begins to crumble when rolled into a small thread and is also determined in general accordance with FM 1-T 090. The water-plasticity ratio is computed from the above test data. This ratio is an expression comparing the relative natural state of soil with its liquid and plastic consolidation characteristics.

APPENDIX C:

Pump Specifications & Manufacturing Literature

6" Vacuum-Assisted Wellpoint Pump 6VW-DJDST-4045D

Contractors worldwide trust the Thompson vacuum wellpoint pump with its incredible solids handling and high air handling capabilities. Customers experience some of the fastest priming times in the industry with the addition of the *Super Suction* vacuum-assisted priming system. The Thompson 6VW-DJDST-4045D is designed for moderate flows to 1,450 gpm and heads to 88 feet, making it perfect for wellpoint and sock systems or general construction dewatering.

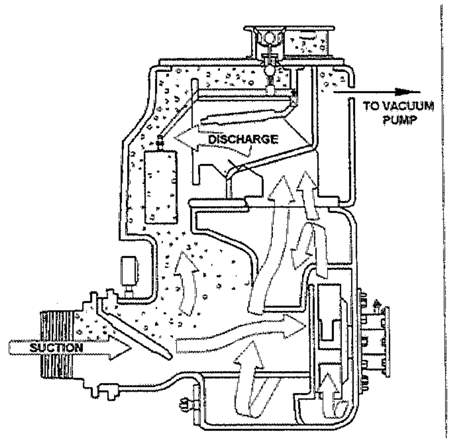
Features

- Standard engine – John Deere 4045D.
- Fully automatic, dry priming to 30 feet
- Moderate heads to 88 feet; Maximum flows to 1,450 gpm
- Handles solids to 3"
- Maximum operating time is 33.5 hours @ 1,800 rpm
- *Super Suction* vacuum-assisted priming system

Super Suction Features & Benefits

- Provides fastest priming system in portable pump dewatering industry
- Prevents discharge of pumping effluent onto the ground
- Eliminates need for a waste hose
- Eliminates need to fill up pump housing with water to obtain original prime at start-up

SUPER SUCTION
VACUUM-ASSISTED PRIMING SYSTEM

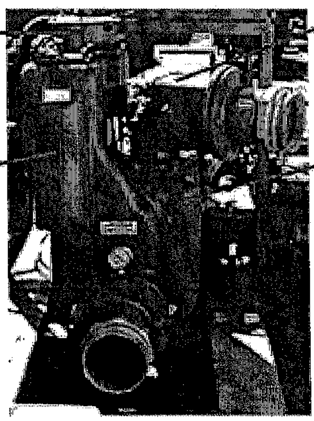


Thompson's exclusive Super Suction vacuum-assisted system works with a self-priming pump to provide the fastest priming in the industry. Water and air passes through a cross section tank and then into the vacuum pump forcing the water to rise in the separation tank until a balance point is reached.

Air cyclone vapor recovery system to prevent discharge of contaminants

Air separator assembly

Some features not available on all models



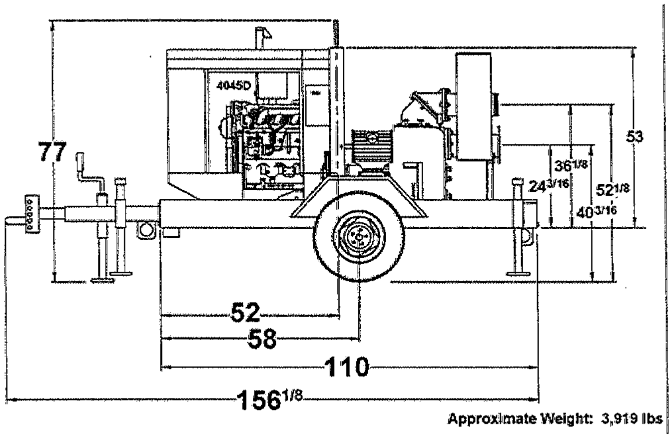
Discharge priming valve

Cast iron pump with maximum solids capacity of 3"

THOMPSON PUMP
EXPERIENCE INNOVATION

6" Vacuum-Assisted Wellpoint Pump
6VW-DJDST-4045D

6VW-DJDST-4045D Dimensions



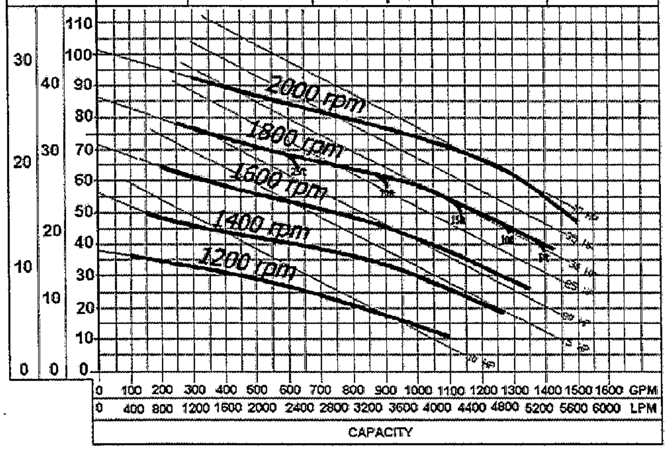
Materials of Construction

Pump Casing: Heavy-duty class 30 cast-iron with built-in volute
Impeller: Dynamically balanced, two-vane, non-clogging, semi-open, ductile iron, with rear-equalizing vanes. Diameter 9.74"
Mechanical Seal: Oil or grease lubricated with Tungsten Carbide rotating and stationary seal faces. Single, inside mounted, non-pusher type with self-adjusting elastomeric bellows.
Head: Rugged, back pull out design, heavy-duty class 30 cast iron with tapered bore design
Bearings and Frame: Heavy-duty grease lubricated to carry both axial and radial loads. Frame is heavy-duty class 30 cast iron.
Shaft: Constructed of high quality carbon steel with a 304 stainless steel shaft sleeve
Wear Plate: Replaceable, class 30 cast iron with abrasion resistant rubber facing to extend service life

6VW-DJDST-4045D Performance Curve

Hydraulic

TOT DYN HEAD	Speed	Impeller Dia.	Style	No. Vanes	Solids Dia.
MTR PSI FT	VARIOUS	9.74"	Semi-Open	2	3.0"



Engine Specifications

Engine: John Deere 4045D, 62 hp @ 1,800 rpm
Type: 4-cylinder, in-line, 4-cycle, water-cooled, natural aspiration, direct-injected, Tier II diesel
Standard Equipment: Alternator, radiator, muffler and exhaust stack with rain protection
Displacement: 276 cubic inches
Fuel Economy: .379 lb/hp-hr @ 1,800 rpm
Safety Shutdowns: High coolant temperature; Low oil pressure

Unit Specifications

Fuel Tank Capacity: 62 US gallons
Fuel Consumption: 1.84 gallons per hour
Maximum Operating Speed: 1,800 rpm
Maximum Operating Temperature: 212°F
Maximum Working Pressure: 56 psi
Maximum Suction Lift: 30 feet
Maximum Casing Pressure: 66 psi

In the interest of product improvement, Thompson Pump & Manufacturing reserves the right to change specifications without incurring any obligation for equipment previously or subsequently sold. Capacity, Head and Pump Curve are for comparative purposes. Consult engineering data for exact capabilities.

4620 City Center Drive, Port Orange, FL, 32129, USA (800) 767-7310 ✱ Fax (386) 761-0362
Email: sales@thompsonpump.com ✱ www.thompsonpump.com

December 2005

<u>APPENDIX D</u>:

Dewatering Calculations

Well Point Yield Calculations (Jacking Pit - Boulevard St)
(using Theis Equation for unconfined aquifer)

Project Name: Boulevard Street Forcemain and Watermain

<u>Variables</u>

Depth to water (feet)	d	5	Measured in the field	
Storativity	S	0.3	Estimated value	0.1 to 0.3 for an unconfined aquifer
Time of observed draw down (days)	t	5	Estimated value	
Radius of pumping well (feet)	r	0.08333	Known value given diameter of well point	
Estimated drawdown (feet)	D	12	Estimated value (one foot below bottom of well screen - depth to water)	
Conductivity (ft/day)	K	2	Estimated value	
Conductivity (gpd/ft^2)	K	14.96	(to convert to gpd/ft^2 multiply by 7.48)	(ranges in gpd/ft^2 from 10 - 10^3 for sand, 0.1 to 10 for silty sand, and 0.0001 to 0.01 for clay)*
Aquifer thickness (feet)	b	50	Estimated value	
Transmissivity (ft^2/day)	T	100	=K (ft/day) * b (ft)	
Transmissivity (gpd/ft)	T	748	= K (gpd/ft^2)* b (ft)	
Theis parameter	u	1E-06	=(r (ft)^2*S)/(4*T*t)	
Well function quotient	W	13.2174	= (-0.9793 * ln(u)) -0.2722	

<u>Calculation for pumping rate</u>

Q =	(D (ft) *12.57* T (ft^2/day))/W		
Q =	1141.23	gpd	
Q =	0.79252	gpm	per well point
Total Pumping rate (for 20 well points)	15.8504	gpm	for 20 well points
	22825	gpd	

<u>** These values are documented in 'Practical Design Calculations' by Jeff Kuo, PhD*</u>

Infiltration Calculations (Jacking Pit - Boulevard St)

Project Name: Boulevard Street Forcemain and Watermain

Length	40	ft	
Width	12	ft	
Depth	14	ft	
Porosity	0.3		
Total Vol	6,720	ft^3	
	50,266	gallons	
Total Vol GW	15,080	gallons	=Total Volume * Porosity

Flow in = hydraulic conductivity * cross-sectional area * specific yield

Hydraulic Conductivity	14.96	gpd/ft^2	(ranges in gpd/ft^2 from 10 - 10^3 for sand, 0.1 to 10 for silty sand, and 0.0001 to 0.01 for clay)*
Specific Yield	0.2		
Cross Section Area (Btm)	480	ft^2	
Cross Section Area (Sides)	1456	ft^2	

Flow In	5792.512	gpd	*(includes areas of sides and bottom of intersection dewatering pit, but does not include the head of the water in the pit)*
Flow Out =	15.8503755	gpm	Based on Pump Spec
	22825	gpd	

Well Point Yield Calculations (Receiving Pit)
(using Theis Equation for unconfined aquifer)

Project Name: Boulevard Street Forcemain and Watermain

Variables

Depth to water (feet)	d	5	Measured in the field	
Storativity	S	0.25	Estimated value	0.1 to 0.3 for an unconfined aquifer
Time of observed draw down (days)	t	5	Estimated value	
Radius of pumping well (feet)	r	0.08333	Known value given diameter of well point	
Estimated drawdown (feet)	D	12	Estimated value (one foot below bottom of well screen - depth to water)	
Conductivity (ft/day)	K	2	Estimated value	
Conductivity (gpd/ft^2)	K	14.96	(to convert to gpd/ft^2 multiply by 7.48)	(ranges in gpd/ft^2 from 10 - 10^3 for sand, 0.1 to 10 for silty sand, and 0.0001 to 0.01 for clay)*
Aquifer thickness (feet)	b	50	Estimated value	
Transmissivity (ft^2/day)	T	100	=K (ft/day) * b (ft)	
Transmissivity (gpd/ft)	T	748	= K (gpd/ft^2)* b (ft)	
Theis parameter	u	8.7E-07	=(r (ft)^2*S)/(4*T*t)	
Well function quotient	W	13.3959	= (-0.9793 * ln(u)) -0.2722	

Calculation for pumping rate

Q =	(D (ft) *12.57* T (ft^2/day))/W		
Q =	1126.02	gpd	
Q =	0.78196	gpm	per well point
Total Pumping rate (for 9 well points)	7.0376	gpm	for 9 well points
	10134	gpd	

** These values are documented in 'Practical Design Calculations' by Jeff Kuo, PhD*

Infiltration Calculations (Receiving Pit - Boulevard St)

Project Name: Boulevard Street Forcemain and Watermain

Length	12	ft	
Width	12	ft	
Depth	14	ft	
Porosity	0.3		
Total Vol	2,016	ft^3	
	15,080	gallons	
Total Vol GW	4,524	gallons	=Total Volume * Porosity

Flow in = hydraulic conductivity * cross-sectional area * specific yield

Hydraulic Conductivity	14.96	gpd/ft^2	(ranges in gpd/ft^2 from 10 - 10^3 for sand, 0.1 to 10 for silty sand, and 0.0001 to 0.01 for clay)*
Specific Yield	0.2		
Cross Section Area (Btm)	144	ft^2	
Cross Section Area (Sides)	672	ft^2	

Flow In	2441.472	gpd	*(includes areas of sides and bottom of intersection dewatering pit, but does not include the head of the water in the pit)*
Flow Out =	7.03760105	gpm	Based on Pump Spec
	10134	gpd	

Open Cut Filtration and Pumping Rate

Project Name: Boulevard Street Forcemain and Watermain

Length	200	ft	
Width	4	ft	
Depth	2	ft	
Porosity	0.3		
Total Vol	1,600	ft^3	
	11,968	gallons	
Total Vol GW	3,590	gallons	=Total Volume * Porosity

Flow in = hydraulic conductivity * cross-sectional area * specific yield

Hydraulic Conductivity	14.96	gpd/ft^2	(ranges in gpd/ft^2 from 10 - 10^3 for sand, 0.1 to 10 for silty sand, and 0.0001 to 0.01 for clay)*
Specific Yield	0.2		
Cross Section Area (Btm)	800	ft^2	
Cross Section Area (Sides)	816	ft^2	

Flow In	4835.072	gpd	*(includes areas of sides and bottom of intersection dewatering pit, but does not include the head of the water in the pit)*
Flow Out =	1450.00	gpm	Based on Pump Spec

APPENDIX E:

Groundwater Sampling Analytical Results
and Temporary Wells Test Locations

TABLE 1 - COMPARISON OF GROUNDWATER RESULTS TO FAC 62-621 SCREENING LIMITS

Boulevard Street Forcemain & Watermain

Jacksonville, Florida

Date Sampled: 12/20/19

Screening Parameter	Parameter Sample Point TW-1 (Boulevard St and W 10th St) (ug/L)	FDEP Screening Limit Freshwater Discharges for TW-1 (ug/L)	Parameter Sample Point TW-2 (Boulevard St and S Line) (ug/L)	FDEP Screening Limit Freshwater Discharges for TW-2 (ug/L)	Parameter Sample Point TW-3 (Boulevard St and RR Crossing) (ug/L)	FDEP Screening Limit Freshwater Discharges for TW-3 (ug/L)
Total Hardness	156		104		130	
ph, standard units	7.85	6.0 - 8.5	8.17	6.0 - 8.5	8.05	6.0 - 8.5
Mercury (total recoverable)	0.0035	0.012	0.012	0.012	**0.084**	0.012
Cadmium	1.0 U	0.38	1.0 U	0.28	1.0 U	0.33
Copper	4.8 I	13.64	4.0 U	9.65	8.4	11.67
Lead	**75**	5.60	**6.9 I**	3.34	**140**	4.44
Zinc	**270**	29.81	50 U	21.14	**620**	25.54
Cadmium (**Dissolved**)	1.0 U	0.38	1.0 U	0.28	1.0 U	0.33
Copper (**Dissolved**)	4.0 U	13.64	4.0 U	9.65	4.0 U	11.67
Lead (**Dissolved**)	3.0 U	5.60	3.0 U	3.34	3.0 U	4.44
Zinc (**Dissolved**)	50 U	29.81	50 U	21.14	50 U	25.54
Chromium	9.3 I	31.53	20 I	22.62	5.8 I	27.16
Benzene	0.16 U	2	0.16 U	2	0.32 U	2
Naphthalene	0.94 U	100	0.94 U	100	1.9 U	100

Notes:
U = Compound was analyzed for but not detected
I = The reported value is between the laboratory method detection limit and the laboratory practical quantitation limit

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GROUNDWATER SAMPLING PLAN

BOULEVARD STREET FORCEMAIN & WATERMAIN
JACKSONVILLE, FLORIDA

<u>APPENDIX F:</u>

BMPs for Erosion and Sedimentation Control

FLORIDA STORMWATER EROSION AND SEDIMENTATION CONTROL INSPECTOR'S MANUAL

Florida Department of Environmental Protection
Nonpoint Source Management Section
Tallahassee, Florida

July 2008

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CHAPTER 4: BEST MANAGEMENT PRACTICES FOR EROSION AND SEDIMENTATION CONTROL

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4.1 Construction Sequencing

Definition

Coordinating the construction schedule to minimize the amount of area disturbed at any one time and coordinating land clearing with the installation of erosion control measures.

Purpose

To minimize the amount of disturbed area, thus reducing erosion potential.

Condition where Practice Applies

This practice applies to all construction projects. The level of planning and management necessary to minimize erosion and control sedimentation adequately depends on the size, location, and complexity of the construction site.

Planning Considerations

The key to efficient and cost-effective erosion control is to plan construction activities in phases to reduce the erosion potential of the site. By clearing only the areas that are to be developed, only limited areas of land are disturbed, making it much easier to prevent and control erosion than if the entire site were exposed at once. Larger projects should be carried out in phases to minimize the area of exposed soil.

Before site disturbance occurs, perimeter controls, sediment traps, basins, and diversions should be in place to control runoff and capture sediments. Prioritize disturbed areas in the vicinity of waterbodies, wetlands, steep grades, long slopes, etc., for effective stabilization within seven days of disturbance. Graded areas that will not be worked on should be seeded and mulched immediately, rather than waiting until all project grading is done. A well-planned and well-maintained construction entrance with stabilized construction roads can prevent offsite sedimentation, keep sediments off roads, minimize complaints from neighbors, and reduce future expenses and aggravation.

Land-disturbing activities are best scheduled during periods of low precipitation. Generally, Florida's wet season occurs from May to November with a dry season from November to May. Check with your local water management district or FDOT office for more precise information in your area.

Specifications

The management of construction projects consists of three phases. *Phase I* is the initial installation of perimeter controls, sediment traps, basins, and diversions prior to site development. *Phase II* consists of an interim stormwater management plan in which components of the permanent stormwater management system are constructed and connected to the stormwater facilities as the site is developed. *Phase III* is the finished product and should perform as such.

Phase I

This is the first construction-related activity to occur on any site. The installation of initial controls shall be discussed at the preconstruction conference. The contractor and the inspector should understand the inspection and maintenance requirements of the specified BMPs, as well as their locations and proper installation procedures.

Offsite runoff should be diverted around the project if stabilized areas, adequate conveyance, and/or protected inlets are available. Sediment traps and basins should be built to receive the anticipated runoff and sediments. A temporary sediment basin in the location of the permanent stormwater facility makes efficient use of space and simplifies future tasks. Perimeter controls and diversions must be installed to keep sediments onsite and directed to the traps and basins. As clearing and grading progress, temporary seeding and mulching should follow immediately for areas that will not be worked for a period of seven days or more.

Phase II

During this interim phase of the project, the permanent stormwater management system is constructed in conjunction with the other construction activities. Before runoff is directed into it, the system must be properly stabilized. It must also be protected from sedimentation until the completion of the project. As the stormwater facilities are constructed, they should also be kept free of sediments. Special care must be taken if stormwater ponds are used as temporary sediment basins to ensure the complete removal of accumulated sediments that would reduce stormwater storage volume and cause premature clogging. If possible, design and excavate the sediment basin bottom 6 to 12 inches (15 to 30 centimeters [cm]) higher than the eventual pond bottom. Land disturbance should occur only in areas that are being actively worked. Graded areas should be seeded and mulched immediately if they will not be worked for a period of 7 days or more.

A regular maintenance program should be in place to ensure that the BMPs are inspected and maintained by the contractor weekly and/or after significant rain events. Any failures should be analyzed to prevent recurrence. Substantial changes to the approved plan must be made or reviewed by the designer and approved by the appropriate regulatory agency.

Phase III

This is the completed project. The entire stormwater management system should be built according to the approved plans. Substantial deviations from the plan may require revisions by the design professional, reapproval by the regulatory agency, and/or reconstruction by the contractor. The system must also function as designed and in compliance with applicable regulatory criteria. Any previously unforeseen activities that could compromise the function or maintainability of the system should be addressed immediately.

4.2 Pollution Source Controls on Construction Sites

Definition

Minimizing nonpoint source pollution from construction sites through good management and "housekeeping" techniques.

Purpose

To reduce the availability of construction-related pollutants that can contaminate runoff water, or to retain pollutants and polluted water onsite.

Conditions Where Practice Applies

This practice applies to all construction projects. The level of planning and management necessary to control nonpoint source pollution adequately depends on the size and complexity of the construction site.

Planning Considerations

Construction activities, by their nature, create many sources of potential pollutants that can contaminate runoff and thus affect the quality of downstream receiving waters. Accelerated erosion and sedimentation caused by land-disturbing activities are the major pollution problems caused by construction.

There are, however, many other potential pollutants associated with construction activities, such as gasoline, oils, grease, paints, cements, and solvents, to name only a few. Even relatively nontoxic materials such as paper and cardboard are potential pollutants when they are washed into streams and lakes.

The best way to prevent nonpoint source pollution on construction sites is to use good housekeeping practices, which usually entail simply maintaining the site in a neat and orderly condition. Specific practices should be employed to retain runoff and to deal with toxic substances and materials. An overall plan for the control of nonpoint source pollution is advisable so that control measures can be specified and implemented effectively.

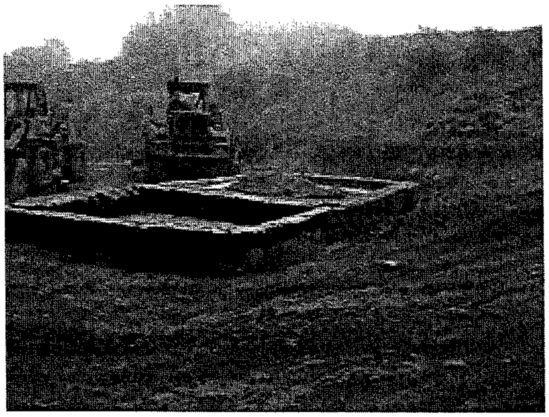
The following elements should be considered in nonpoint source pollution control planning on a construction site:

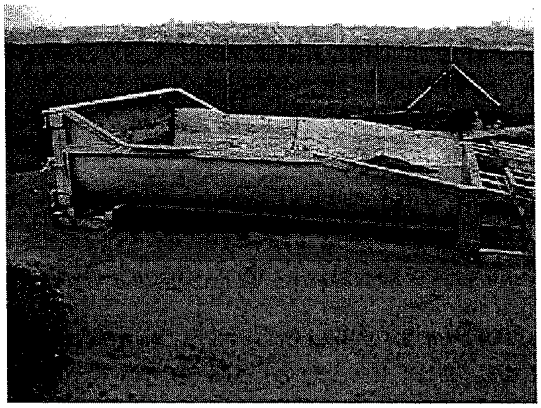
1. Erosion and Sediment Controls

Practices that minimize erosion and retain sediment onsite are also effective in controlling many other nonpoint source pollutants associated with construction activities. The development and implementation of a good erosion and sediment control plan is a key factor in controlling nonpoint source pollutants other than sediment on a construction site.

2. Vehicle Wash Areas

Vehicles such as dump trucks, concrete trucks, and other construction equipment should **NOT** be washed at locations where the runoff will flow directly into a waterbody or stormwater conveyance system. Special areas should be designated for washing vehicles. Concrete washout areas should be located where the runoff can be collected and removed from the site or collected for drying and reused on site. Concrete washout areas may be constructed onsite by digging a pit and lining it with plastic. Manufactured products and waste disposal companies also are available.





3. Equipment Maintenance and Repair

The maintenance and repair of construction machinery and equipment should be confined to areas specifically designated for that purpose. Such areas should be located and designed so that oils, gasoline, grease, solvents, and other potential pollutants cannot be washed directly into receiving streams, stormwater conveyance systems, or existing and potential well fields. These areas should have adequate waste disposal receptacles for liquid and solid wastes. Maintenance areas should be inspected and cleaned daily.

On a construction site where designated equipment maintenance areas are not feasible, exceptional care should be taken during each individual repair or maintenance operation to prevent potential pollutants from being washed into streams or conveyance systems. Temporary waste disposal receptacles should be provided and emptied as required.

4. Waste Collection and Disposal

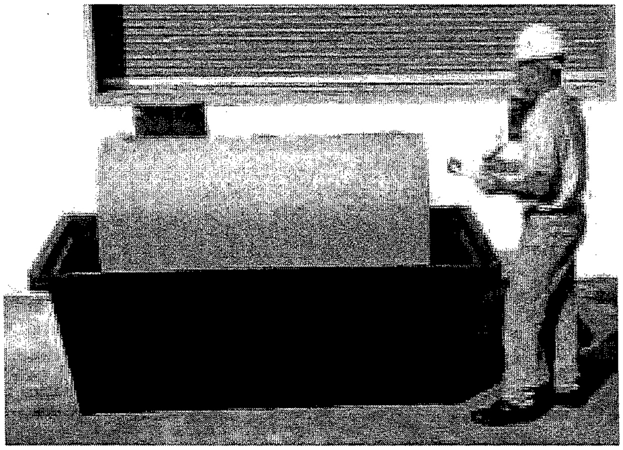
A plan should be formulated for collecting and disposing of waste materials on a construction site. It should designate locations for trash and waste receptacles and establish a specific collection schedule. Methods for the ultimate disposal of waste should be specified and carried out according to applicable local and state health and safety regulations. Special provisions should be made for the collection, storage, and disposal of liquid wastes and toxic or hazardous materials.

Receptacles and other waste collection areas should be kept neat and orderly to the extent possible. Trash cans should have lids and dumpsters should have covers to prevent rainwater from entering. Waste should not be allowed to overflow its container or accumulate for excessively long periods. Trash collection points should be located where they are least likely to be affected by concentrated stormwater runoff.

5. Demolition Areas

Demolition projects usually generate large amounts of dust with significant concentrations of heavy metals and other toxic pollutants. Dust control techniques should be used to limit the transport of airborne pollutants. However, water or slurry used to control dust should be retained onsite and should not be allowed to run directly into watercourses or stormwater conveyance systems.

6. Storage of Construction Materials, Chemicals, Etc.



Sites where chemicals, cements, solvents, paints, or other potential water pollutants are to be stored should be isolated in areas where they will not cause runoff pollution. Toxic chemicals and materials, such as pesticides, paints, and acids, should be stored according to the manufacturers' guidelines. Overuse should be avoided, and great care should be taken to prevent accidental spillage. Containers should **NEVER** be washed in or near flowing streams or stormwater conveyance systems. Ground water resources should be protected from leaching by placing a plastic mat, tarpaper, or other impervious materials on any areas where toxic liquids are to be opened and stored. Portable storage units are also commercially available for material storage and can be locked at the end of the day.

7. Stockpiles

Soil stockpiles should be protected or adequately covered from stormwater during construction. Simple protection measures include silt fencing or a trench around the base of the stockpile. A tarp or temporary seeding also can provide adequate cover for a soil stockpile. Stockpiles should not be placed near the perimeter of the site, near a waterbody or storm drain inlet, or within 10 feet of an infiltration/exfiltration system.

4.3 Stabilized Construction Exit

Definition

A stabilized pad located at points where vehicles enter and leave a construction site.

Purpose

To reduce the amount of sediment transported onto public roads by motor vehicles or runoff.

Conditions Where Practice Applies

Wherever traffic will be leaving a construction site and moving directly onto a public road or other paved area.

Planning Considerations

Construction entrances provide an area where mud can be removed from construction vehicle tires before they enter a public road. If the action of the vehicle traveling over the stabilized pad is not sufficient to remove most of the mud, then the tires must be washed before the vehicle enters a public road. If tire washing is provided, provisions must be made to intercept the wash water and trap the sediment before it is carried offsite. Construction entrances should be used in conjunction with the stabilization of construction roads to reduce the amount of mud picked up by construction vehicles.

Design Criteria

Aggregate Size

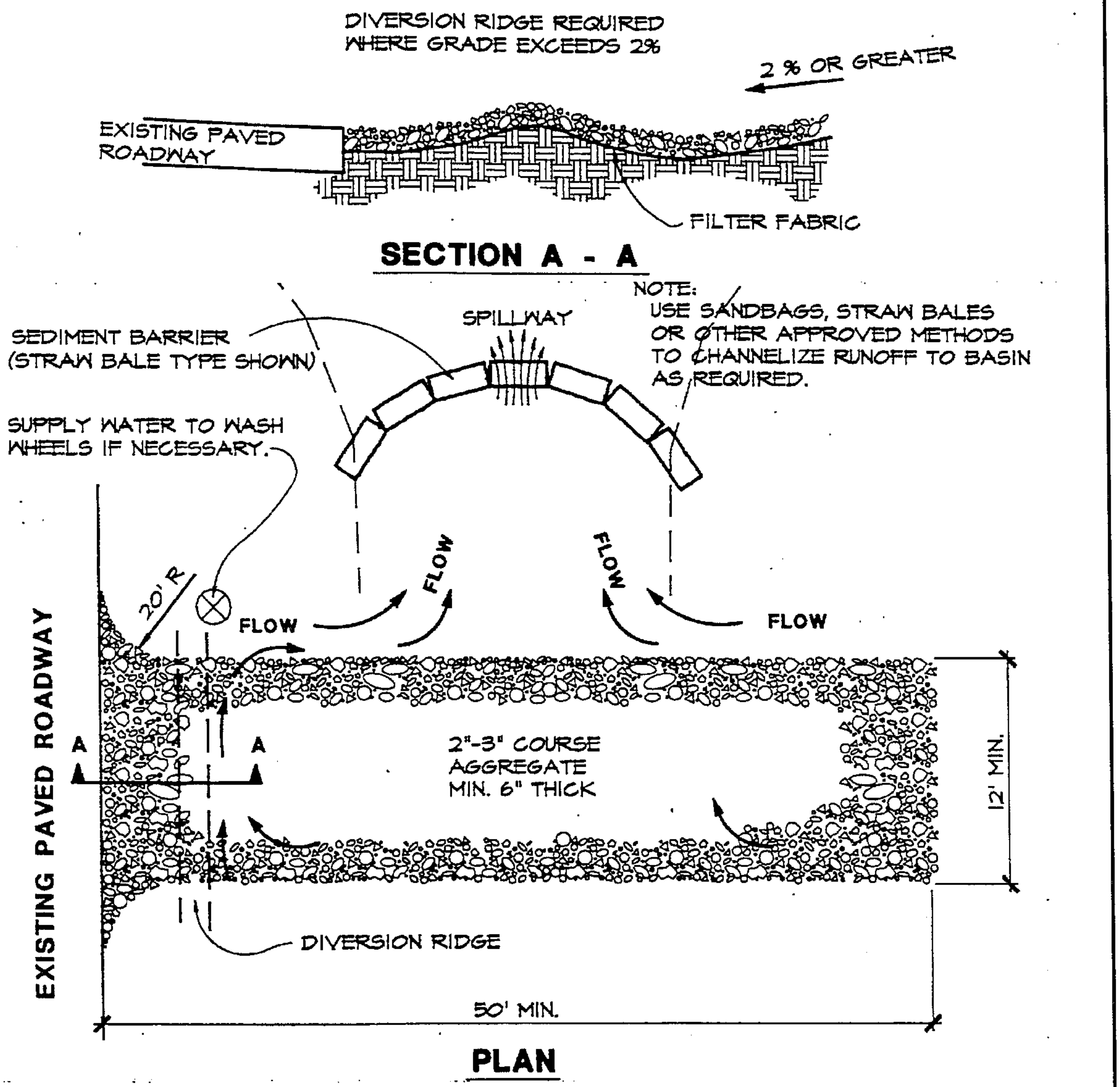
If stone is utilized, FDOT No. 1 Coarse Aggregate, 1½ to 3½ inch (4 to 9 cm) stone is suggested. Wood chips may be used for single-family residential construction, provided that they can be prevented from floating away during a storm event. Manufactured products also are available to prevent or reduce the amount of sediment tracked onto roadways. If a stabilized exit is not sufficient, street sweeping can be provided as an additional measure.

Dimensions

If stone is used, then the aggregate layer must be at least 6 inches (15 cm) thick. It must extend the **FULL WIDTH** of the vehicular ingress and egress area. The length of the entrance must be at least 50 feet (20 m). The exit should widen at its connection to the roadway to accommodate the turning radius of large trucks (see **Figure 4.3a**).

Washing

If conditions on the site are such that most of the mud is not removed by the vehicles traveling over the stone, then the vehicle tires must be washed before entering a public road. Wash water must be carried away from the entrance to a settling area to remove sediment (see **Figure 4.3b**). A wash rack may also be used to make washing more convenient and effective (see **Figure 4.3c**).

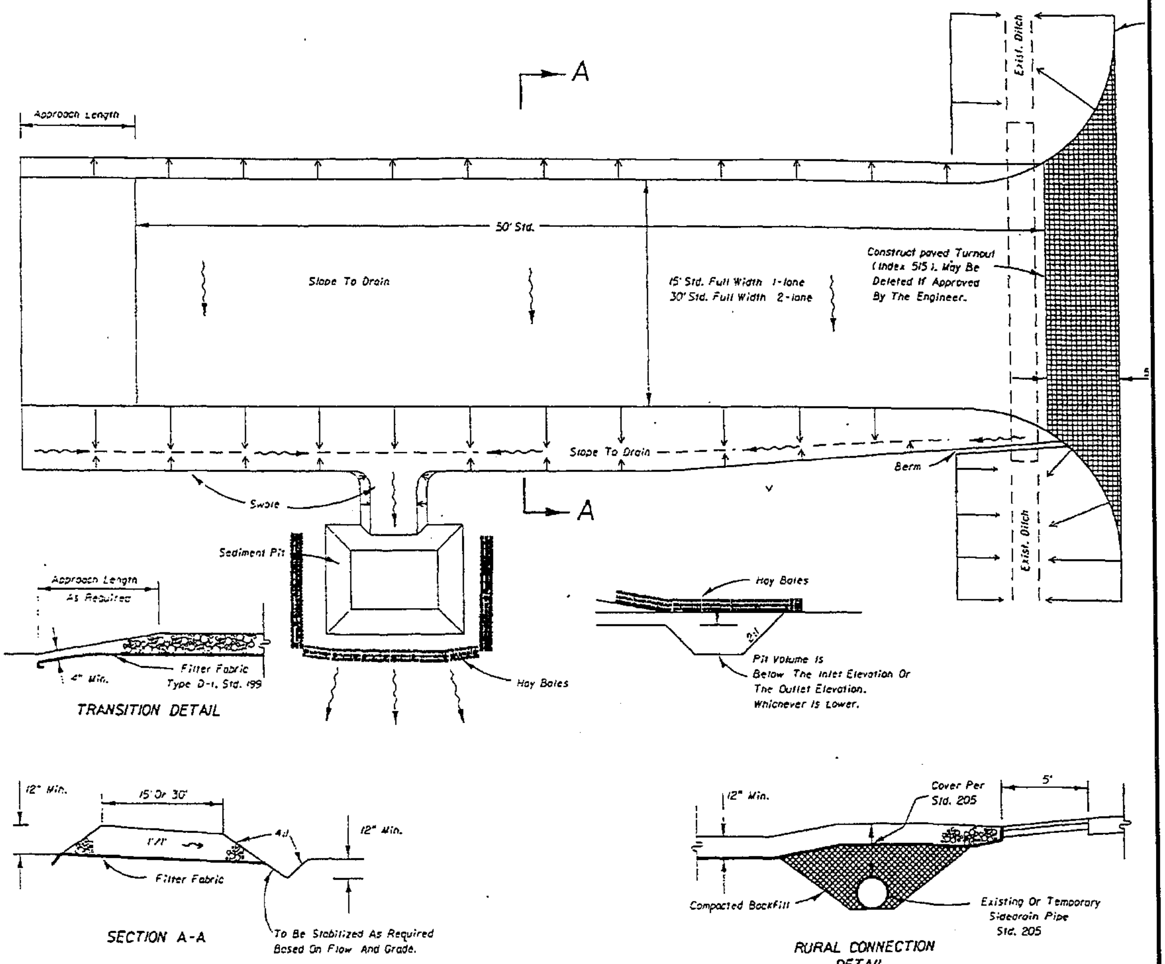


NOTES:

1. THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION THAT WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHTS-OF-WAY. THIS MAY REQUIRE TOP DRESSING, REPAIR AND/OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT.
2. WHEN NECESSARY, WHEELS SHALL BE CLEANED PRIOR TO ENTRANCE ONTO PUBLIC RIGHT-OF-WAY.
3. WHEN WASHING IS REQUIRED, IT SHALL BE DONE ON AN AREA STABLIZED WITH CRUSHED STONE THAT DRAINS INTO AN APPROVED SEDIMENT TRAP OR SEDIMENT BASIN.

Figure 4.3a. Temporary Gravel Construction Entrance

Source: Erosion Draw



GENERAL NOTES:

1. A Soil Tracking Prevention Device (STPD) shall be constructed at locations designated by the engineer for points of egress from unstabilized areas of the project to public roads where offsite tracking of mud could occur. Traffic from unstabilized areas of the construction project shall be directed thru a STPD. Barriers, flagging or other positive means shall be used as required to limit and direct vehicular egress across the STPD.

2. The Contractor may propose an alternative technique to minimize offsite tracking of sediment. The alternative must be reviewed and approved by the Engineer prior to its use.

3. All materials spilled, dropped, or tracked onto public roads (including the STPD aggregate and construction mud) shall be removed daily, or more frequently if so directed by the Engineer.

4. Aggregates shall be as described in Section 901 excluding 901-2.3. Aggregates shall be FDOT Size #1. Other sizes contain excessive small size aggregate which would track off project and are unsuitable. #2 aggregate may be substituted only with approval of the Engineer.

5. The Sediment Pit should provide a retention volume of 3600 cubic feet/acre of surface area draining to the pit.
When the STPD is isolated from other drainage areas, the following pit volumes will satisfy this requirement:
15' x 50' = 100 CF   30' x 50' = 200 CF

As an option to the sediment pit, the width of the swale bottom can be increased to obtain the volume. When the sediment pit or swale volume has been reduced to one half, it shall be cleaned. When a swale is used, bales shall be placed along the entire length.

6. The swale ditch draining the STPD shall have a 0.2% minimum and a 1.0% maximum grade along the STPD and to the sediment pit.

7. Mitered End Sections are not required when the temporary sidedrain pipe satisfy the clear zone requirements of Standard Index 700.

8. The STPD shall be maintained in a condition that will allow it to perform its function. To prevent offsite tracking, the STPD shall be rinsed (daily when in use) to move accumulated mud downward thru the stone. Additional stabilization of the vehicular route leading to the STPD may be required to limit the mud tracked.

9. The unit price shall constitute full compensation for construction, maintenance, replacement of materials, removal, and restoration of the area utilized for the STPD; including but not limited to excavation, grading, temporary pipe (including MESs when required), filter fabric, aggregate, paved turnout (including asphalt and base construction), ditch stabilization, approach route stabilization, sediment removal and disposal, water, rinsing and cleaning of the STPD and cleaning of public roads, grassing and sod, Hay bales, TN., and silt fence, LF., shall be paid for separately.

10. A STPD shall be paid for under the item Soil Tracking Prevention Device EA. The nominal size of a standard STPD is 15' x 50' unless otherwise shown in the plans. If the volume of entering and existing vehicles warrant, a 30' width STPD may be used. When a double width (30') STPD is used, the pay quantity shall be 2 for each location.

Plate 4.03b Soil Tracking Prevention Device
Source: FDOT Roadway and Traffic Design Standards

Figure 4.3b. Soil Tracking Prevention Device

Source: FDOT Roadway and Traffic Design Standards

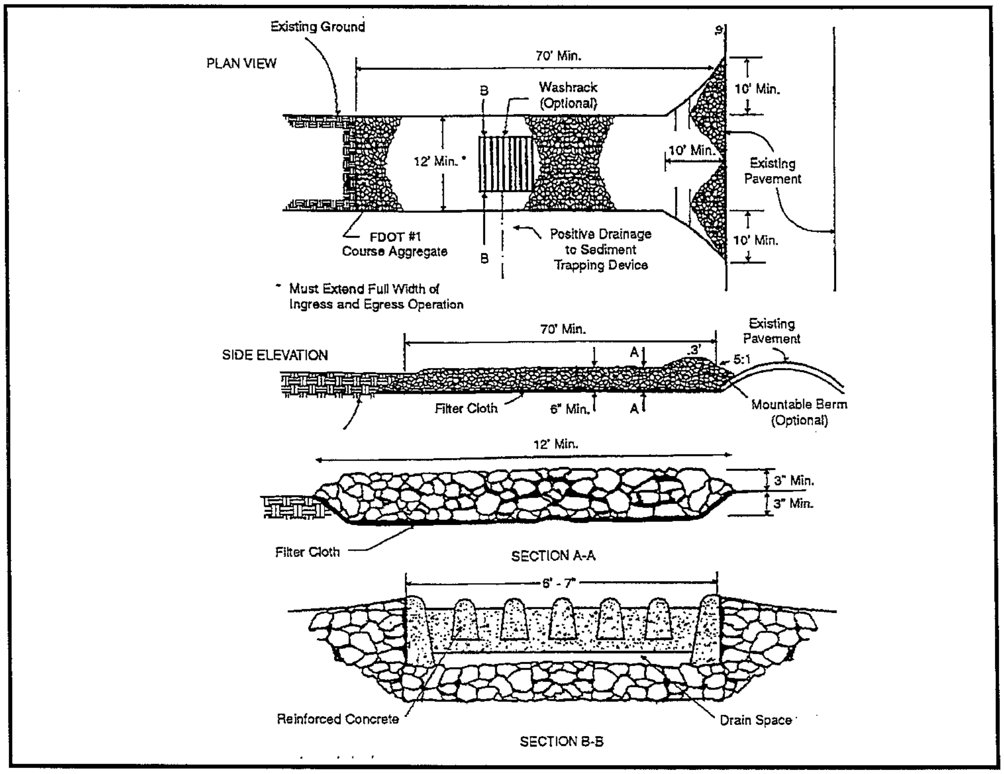
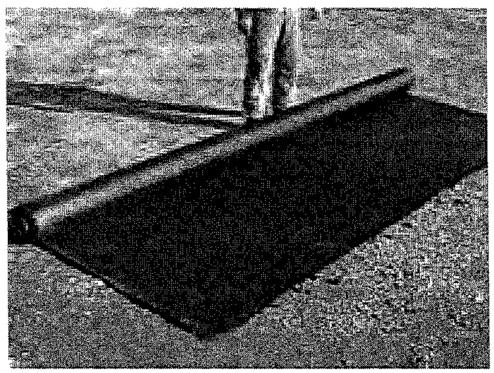


Figure 4.3c. Construction Entrance with Wash Rack
Source: 1983 Maryland Standards for Soil Erosion and Sediment Control

Location

The entrance should be located to provide for maximum utility by all construction vehicles.

Construction Specifications



The entrance area should be cleared of all vegetation, roots, and other objectionable material. A geotextile should be laid down to improve stability and simplify maintenance when gravel is used. The gravel shall then be placed over the geotextile to the specified dimensions.

Maintenance

The stabilized construction exit shall be maintained in a condition that will prevent the tracking or flow of mud onto public rights of way. This may require periodic maintenance as conditions demand, and the repair and/or cleanout of any structures used to trap sediments. All materials spilled, dropped, washed, or tracked from vehicles onto roadways or into storm drains must be removed immediately. Look for signs of trucks and trailered equipment "cutting corners" where the construction exit meets the roadway. Sweep the paved road as needed.

4.4 Perimeter Controls

Overview

Perimeter controls intercept and detain small amounts of sediment from disturbed areas during construction operations. These measures include silt fences, filter socks, temporary diversion berms, temporary fill diversions, temporary slope drains, and floating turbidity barriers. They are the last line of defense and one of the most visible and maintenance-intensive BMPs on an active construction site.

These measures reduce the potential for sediment to enter offsite areas such as roadways, storm drains, or adjacent properties. They are used under the following conditions:

1. *Below disturbed areas where erosion would occur in the form of sheet and rill erosion.*
2. *Where the size of the drainage area is no more than ¼ acre per 100 feet of perimeter control measure; the maximum slope length behind the barrier is 100 feet; and the maximum gradient behind the barrier is 50% (2:1).*

These measures should be installed before clearing and grading activities begin. They typically remain installed and maintained until the contributing drainage area is stabilized.

4.4.1 Silt Fence

Definition

A temporary sediment barrier consisting of a filter fabric stretched across and attached to supporting posts and entrenched. Some silt fence is wire reinforced for support.

Purpose

The purpose of a silt fence is to slow the velocity of water and retain sediment onsite.

Conditions Where Practice Applies

A silt fence should only be installed for sediment capture under sheetflow conditions. It should not be installed for channel flow conditions or in live streams or waterways.

Planning Considerations

Silt fences can trap a much higher percentage of suspended sediments than straw bales and are preferable to straw barriers in many cases. The most effective application is to install two parallel silt fences spaced a minimum of three feet apart. The installation and maintenance methods outlined here can improve performance.

Silt fences composed of a wire support fence with attached synthetic filter fabric slow the flow rate significantly and have high filtering efficiency. Both woven and nonwoven synthetic fabrics are commercially available. The woven fabrics are generally stronger than the nonwoven fabrics. When tested under acid and alkaline water conditions, most of the woven fabrics increase in strength. There is a variety of reactions among the nonwoven fabrics. The same is true of testing under extensive ultraviolet radiation. Permeability rates vary regardless of fabric type. While all of the fabrics demonstrate high filtering efficiencies for sandy sediments, there is considerable variation among both woven and nonwoven fabrics when filtering finer silt and clay particles.

Design Criteria

1. *No formal design is required for many small projects and for minor and incidental applications.*
2. *Silt fences shall have an expected usable life of six months. They are applicable around perimeters and stockpiles, and at temporary locations where continuous construction changes the earth contour and runoff characteristics.*
3. *Silt fences have limited applicability to situations in which only sheet or overland flows are expected. They normally cannot filter the volumes of water generated by channel flows, and many fabrics do not have sufficient structural strength to support the weight of water ponded behind the fence line.*

Construction Specifications

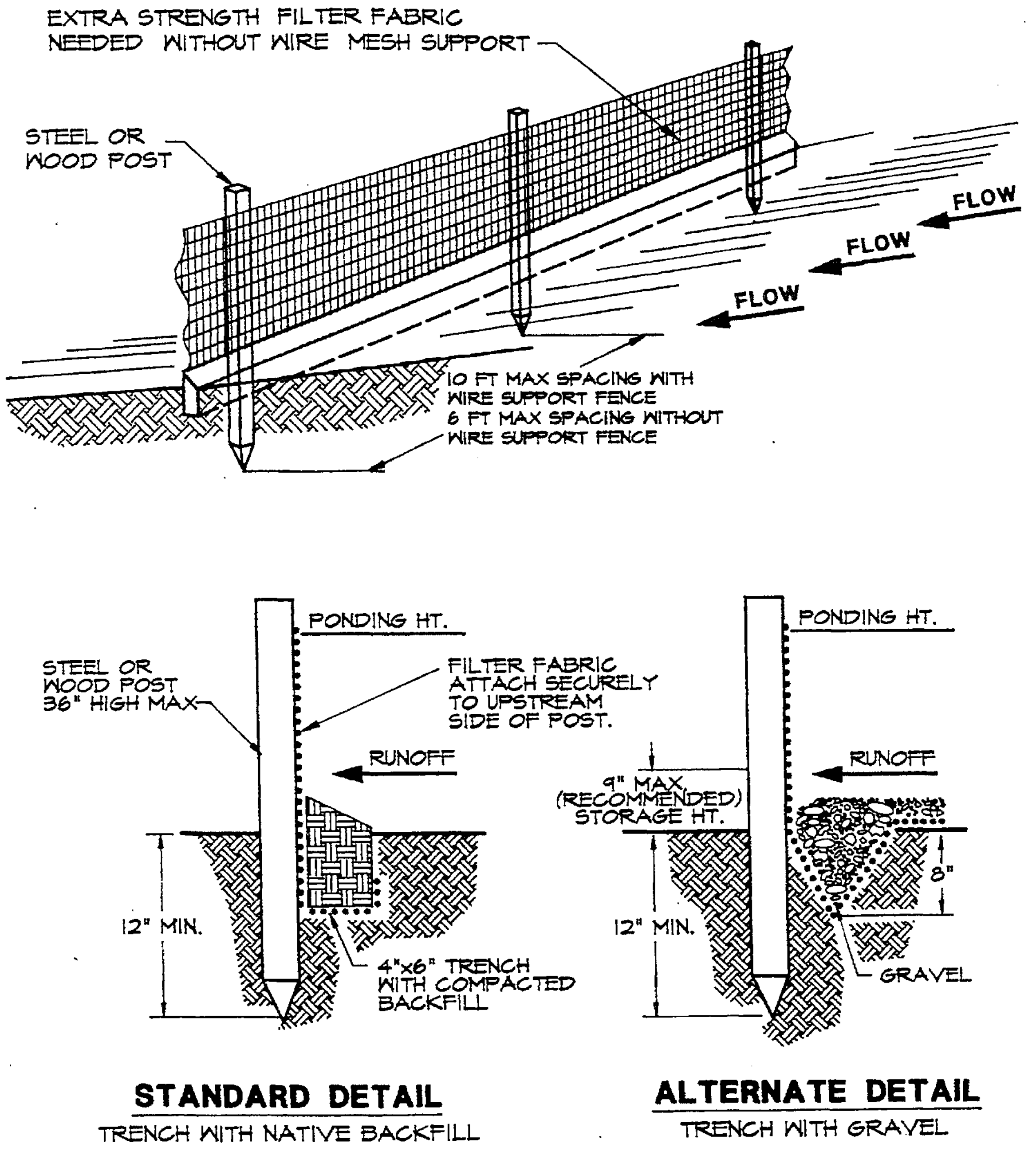
Materials

1. *Synthetic filter fabric shall be a pervious sheet of propylene, nylon, polyester, or polyethylene yarn. It shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of 6 months of expected usable construction life at a temperature range of 0°F. to 120°F. (-17°C. to 49°C.).*
2. *The stakes for a silt fence shall be 1 x 2 inches (2.5 x 5 cm) wood (preferred), or equivalent metal with a minimum length of 3 feet (90 cm).*
3. *Wire fence reinforcement for silt fences using standard-strength filter cloth shall be a minimum of 36 inches (90 cm) in height, shall be a minimum of 14 gauge, and shall have a maximum mesh spacing of 6 inches (15 cm).*

Sheetflow Application: Silt Fence

This sediment barrier uses standard-strength or extra-strength synthetic filter fabrics. It is designed for situations in which only sheet or overland flows are expected (see **Figures 4.4a** and **4.4b**):

1. *The height of a silt fence shall not exceed 36 inches (90 cm). Higher fences may impound volumes of water sufficient to cause failure of the structure.*
2. *The filter fabric shall be purchased in a continuous roll cut to the length of the barrier to avoid the use of joints. When joints are necessary, filter cloth shall be spliced as described in Item 8 below.*
3. *Posts shall be spaced a maximum of 10 feet (3 m) apart at the barrier location and driven securely into the ground a minimum of 12 inches (30 cm). When extra-strength fabric is used without the wire support fence, post spacing shall not exceed 6 feet (1.8 m).*
4. *A trench shall be excavated approximately 4 inches (10 cm) wide and 4 inches (10 cm) deep along the line of posts and upslope from the barrier.*
5. *When standard-strength filter fabric is used, a wire mesh support fence shall be fastened securely to the upslope side of the posts using heavy-duty wire staples at least 1 inch (25 mm) long, tie wires, or hog rings. The wire shall extend into the trench a minimum of 2 inches (5 cm) and shall not extend more than 36 inches (90 cm) above the original ground surface.*
6. *The standard-strength filter fabric shall be stapled or wired to the fence, and 8 inches (20 cm) of the fabric shall be extended into the trench. The fabric shall not extend more than 36 inches (90 cm) above the original ground surface.*
7. *When extra-strength filter fabric and closer post spacing are used, the wire mesh support fence may be eliminated. In this case, the filter fabric is stapled or wired directly to the posts with all other provisions of Item 6 applying.*



NOTE:
1. INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN NECESSARY.
2. REMOVED SEDIMENT SHALL BE DEPOSITED TO AN AREA THAT WILL NOT CONTRIBUTE SEDIMENT OFF-SITE AND CAN BE PERMANENTLY STABILIZED.
3. SILT FENCE SHALL BE PLACED ON SLOPE CONTOURS TO MAXIMIZE PONDING EFFICIENCY.

Figure 4.4a. Silt Fence

Source: Erosion Draw

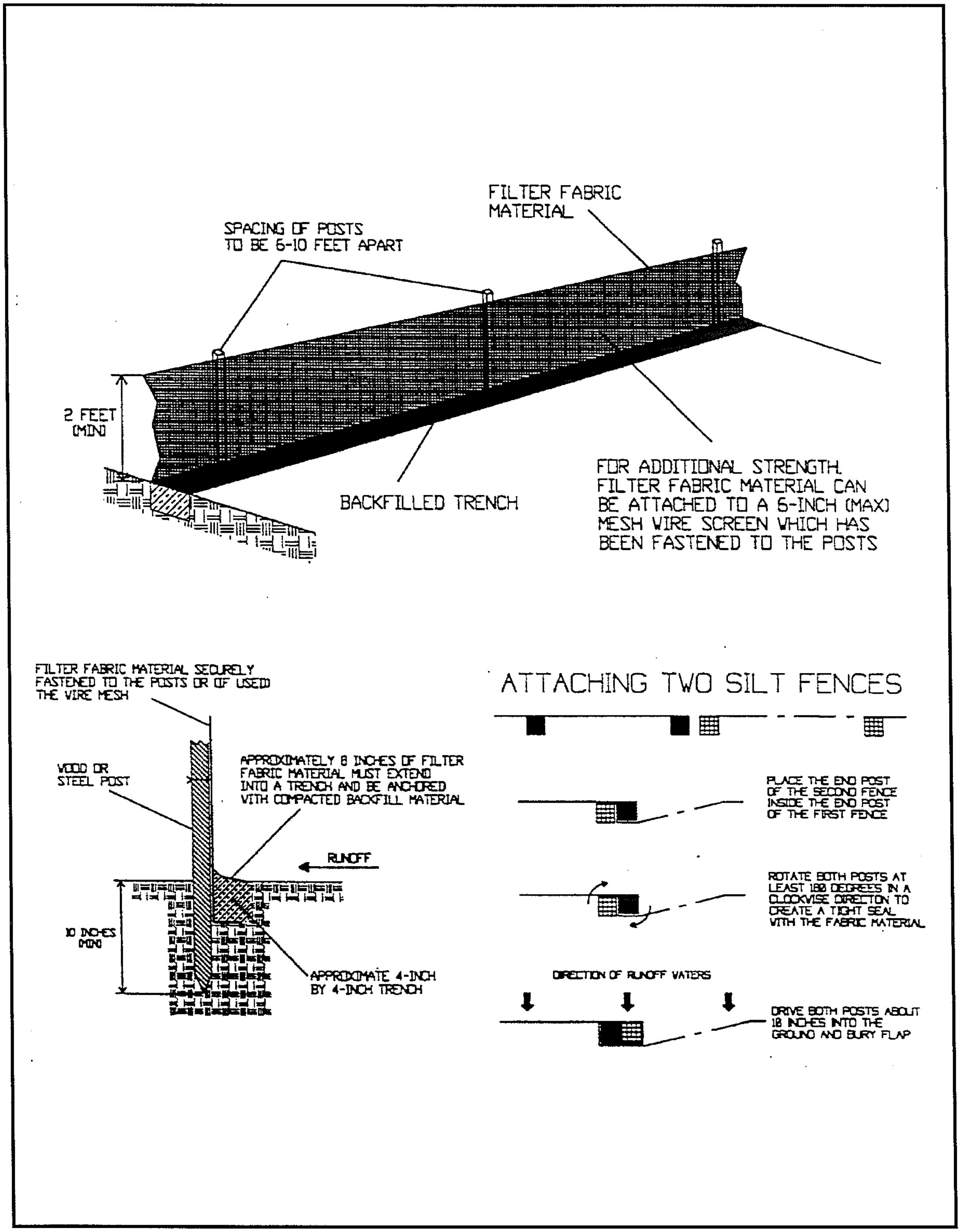


Figure 4.4b. Installing a Filter Fabric Silt Fence

Source: HydroDynamics, Inc.

8. *When attaching 2 silt fences together, place the end post of the second fence inside the end post of the first fence. Rotate both posts at least 180 degrees in a clockwise direction to create a tight seal with the filter fabric. Drive both posts into the ground and bury the flap (see **Figure 4.4b**).*
9. *The trench shall be backfilled and the soil compacted over the filter fabric.*
10. *The most effective application consists of a double row of silt fences spaced a minimum of 3 feet apart, so that if the first row collapses it will not fall on the second row. Wire or synthetic mesh may be used to reinforce the first row (see **Figure 4.4c**).*
11. *When used to control sediments from a steep slope, silt fences should be placed away from the toe of the slope for increased holding capacity (see **Figure 4.4d**).*
12. *Silt fences shall be removed when they have served their useful purpose, but not before the upslope area has been permanently stabilized.*

Maintenance

1. *Silt fences shall be inspected within 24 hours after each ½-inch rainfall event and at least once a week. Any required repairs shall be made immediately.*
2. *Should the fabric on a silt fence decompose or become ineffective before the end of the expected usable life and the barrier is still necessary, the fabric shall be replaced promptly.*
3. *Sediment deposits should be removed when deposits reach approximately one-half the height of the barrier.*
4. *Any sediment deposits remaining in place after the silt fence is no longer required shall be dressed to conform with the existing grade, prepared, and seeded.*

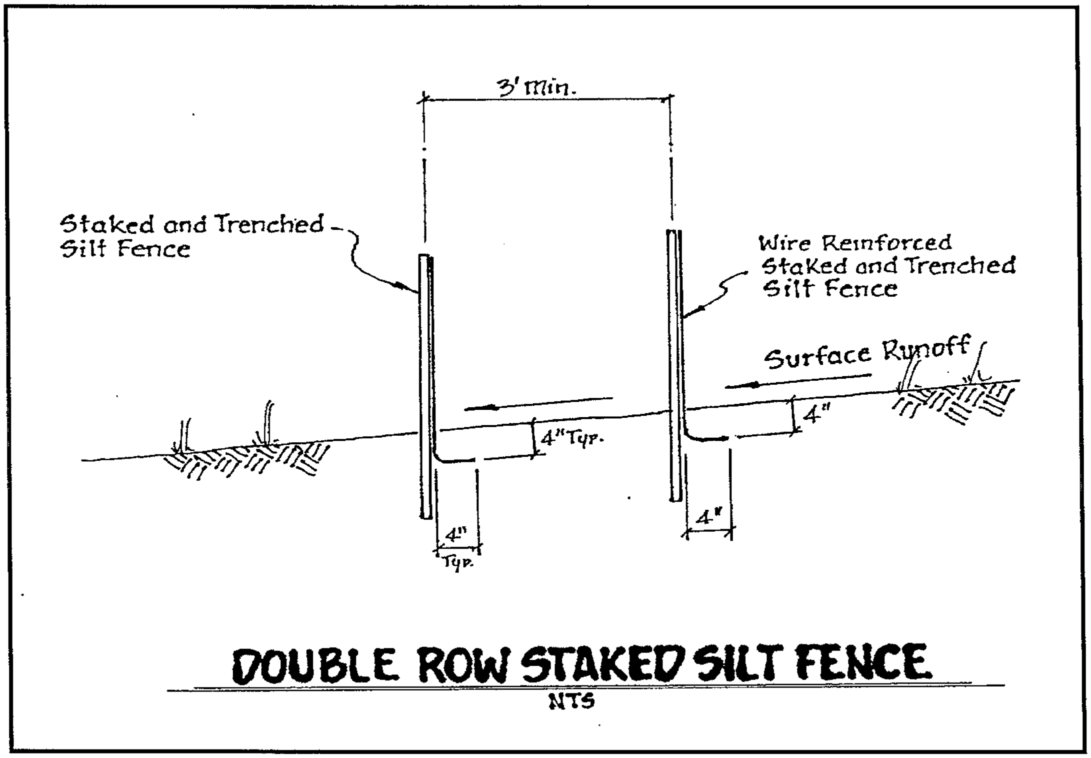


Figure 4.4c. Double Row Staked Silt Fence
Source: Reedy Creek Improvement District

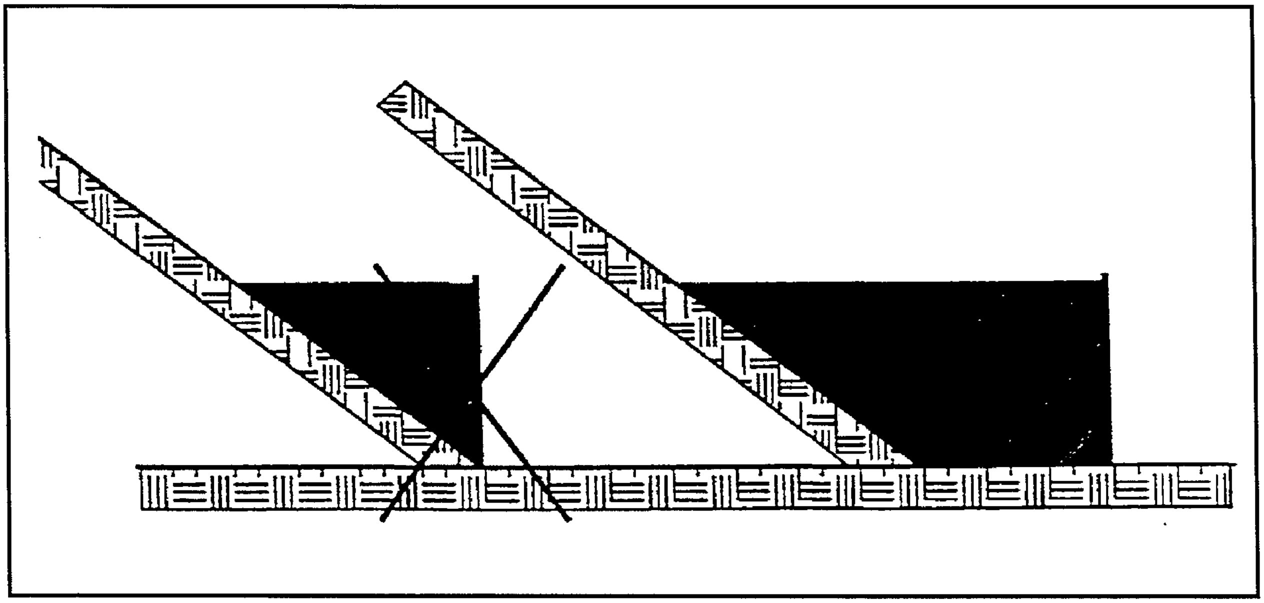
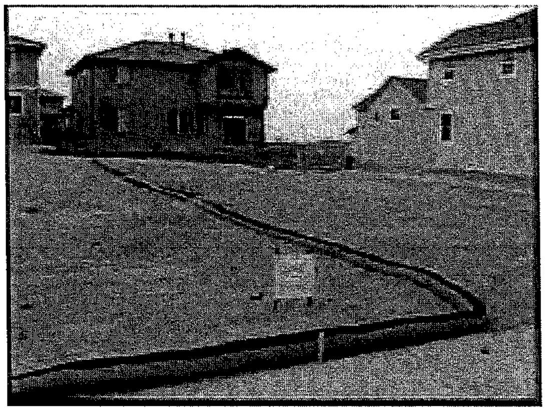


Figure 4.4d. Proper Placement of a Silt Fence at the Toe of a Slope
Source: HydroDynamics, Inc.

4.4.2 Filter Sock

Definition

A filter sock is a three-dimensional, tubular sediment control and stormwater runoff filtration device, typically used for the perimeter control of sediment and soluble pollutants.



Purposes

1. *To trap sediment and soluble pollutants by filtering runoff water as it passes through the fiber matrix, allowing the deposition of suspended solids.*
2. *To decrease the velocity of sheetflows and low- to moderate-level channel flows.*

Conditions Where Practice Applies

1. *Site perimeters.*
2. *Below disturbed areas where erosion would occur in the form of sheet and rill erosion.*
3. *Above and below exposed and erodible slopes.*
4. *Around curb and drop inlets.*
5. *Along the toe of stream and channel banks.*
6. *Where the size of the drainage area is no more than ¼ acre per 100 feet (1.3 ha/100 m) of silt fence length, the maximum slope length behind the barrier is 100 feet (30 m), and the maximum gradient behind the barrier is 50% (2:1).*
7. *Around sensitive trees where the trenching of a silt fence is not beneficial for tree survival or may unnecessarily disturb established vegetation.*
8. *In areas where it is necessary to minimize the obstruction of wildlife movement and migration.*

Planning Considerations

A filter sock can be easily implemented as a BMP within a treatment train onsite. The filter sock is installed on top of the soil and does not require soil disturbance for installation and removal. A filter sock contains organic material that can be direct seeded at the time of application to provide greater stability and filtration capacity once vegetation is established. The mesh socks are biodegradable or photodegradable and can be left onsite after construction activity. Filter sock performance depends on ground surface contact and may not be suitable for an extremely bumpy or rocky land surface.

Design Criteria

1. *No formal design is required for many small projects and for minor and incidental applications.*
2. *Filter socks shall have an expected usable life of 9 months. They are applicable in ditch lines, around drop inlets, and at temporary locations where continuous construction changes the earth contour and runoff characteristics, and where low or moderate flows (not exceeding 1 cubic foot per second [cfs]) (0.03 cubic meters per second [m^3/sec]) are expected.*
3. *Filter socks also are applicable where sheet or overland flows are expected. They can be used in channel flow applications to slow the water down and allow time for sediment to settle out of suspension.*

Construction Specifications

Materials

1. *A synthetic filter sock shall be a photodegradable or biodegradable mesh netting material providing a minimum of 9 months of expected usable life at a temperature range of 0°F. to 120°F. (-17°C. to 49°C.).*
2. *The media within the filter sock shall contain composted material suitable for removing solids and soluble pollutants from stormwater runoff.*
3. *Socks are available in 9-inch, 12-inch, 18-inch, and 24-inch diameters for a variety of applications and may be stacked for increased storage capacity.*
4. *Posts for the filter sock shall be 2 x 2 inches (2.5 x 5 cm) wood (preferred), or equivalent metal with a maximum height of 3 feet.*

Installation

1. *Posts shall be spaced a maximum of 10 feet (3 m) apart at the barrier location and driven securely into the ground a minimum of 8 inches (30 cm) in clay soils or 12 inches for sand soils. For use on pavement, heavy concrete blocks shall be used behind the filter socks for stabilization.*
2. *When joining two filter socks together, overlap the two sections by about a foot. Drive a stake into the ground through each filter sock.*
3. *Filter socks shall be removed or cut open when they have served their useful purpose, but not before the upslope area is permanently stabilized.*
4. *Filter socks shall not be used in perennial, ephemeral, or intermittent streams.*

Maintenance

1. *Filter socks shall be inspected at least once per week and within 24 hours of each ½ inch or greater rainfall event. Replacements and repairs must be made within a maximum of 7 days.*
2. *Sediment deposits should be removed when deposits reach approximately one-half the height of the barrier.*

4.4.3 Temporary Diversion Berm

Definition

A temporary ridge of compacted soil located at the top or base of a sloping, disturbed area.

Purposes

1. *To divert storm runoff from higher drainage areas away from unprotected slopes to a stabilized outlet.*
2. *To divert sediment-laden runoff from a disturbed area to a sediment-trapping facility.*

Condition Where Practice Applies

Wherever stormwater runoff must be temporarily diverted to protect disturbed slopes or retain sediments onsite during construction. These structures generally have a life expectancy of 18 months or less.

Planning Considerations

A temporary diversion berm is intended to divert overland sheetflow to a stabilized outlet or a sediment-trapping facility during the establishment of permanent stabilization on sloping, disturbed areas. When used at the top of a slope, the structure protects exposed slopes by keeping upland runoff away. When used at the base of a slope, the structure protects adjacent and downstream areas by diverting sediment-laden runoff to a sediment-trapping facility.

If the berm is going to remain in place for longer than 30 days, it is very important that it be established with temporary or permanent vegetation. The slope behind the berm is also an important consideration. The berm must have a positive grade to ensure drainage, but if the slope is too great, precautions must be taken to prevent erosion from high-velocity flow behind the berm.

This practice is considered economical because it uses material available onsite and can usually be constructed with equipment needed for site grading. The useful life of the practice can be extended by stabilizing the berm with vegetation.

As specified here, this practice is intended to be temporary. However, with more stringent design criteria, it can be made permanent in accordance with **DIVERSION (Chapter 6)**.

Design Criteria

No formal design is required. The following criteria must be met:

Drainage Area

The maximum allowable drainage area is 5 acres (2 ha).

Dimensions

The minimum allowable height measured from the upslope side of the berm is 18 inches (45 cm). The top width shall be a minimum of 2 feet (60 cm) with a minimum base width of 4½ feet (1.4 m) (see **Figure 4.4e**).

Side Slopes

3:1 or flatter.

Grade

The channel behind the berm shall have a positive grade to a stabilized outlet. If the channel slope is less than or equal to 2%, no stabilization is usually required. If the slope is greater than 2%, the channel shall be stabilized in accordance with **STORMWATER CONVEYANCE CHANNEL (Chapter 6)**.

Outlet

1. *The diverted runoff, if free of sediment, must be released through a stabilized outlet or channel.*
2. *Sediment-laden runoff must be diverted and released through a sediment-trapping facility.*

Construction Specifications

1. *Whenever feasible, the berm should be built before construction begins on the project.*
2. *The berm should be adequately compacted to prevent failure.*
3. *Temporary or permanent seeding and mulch shall be applied to the berm within 15 days of construction.*
4. *The berm should be located to minimize damage by construction operations and traffic.*

Maintenance

The berm shall be inspected after every storm and repairs made to the berm, flow channel, and outlet, as necessary. Approximately once a week, whether a storm has occurred or not, the berm shall be inspected and repairs made if needed. Damage caused by construction traffic or other activity must be repaired before the end of each working day.

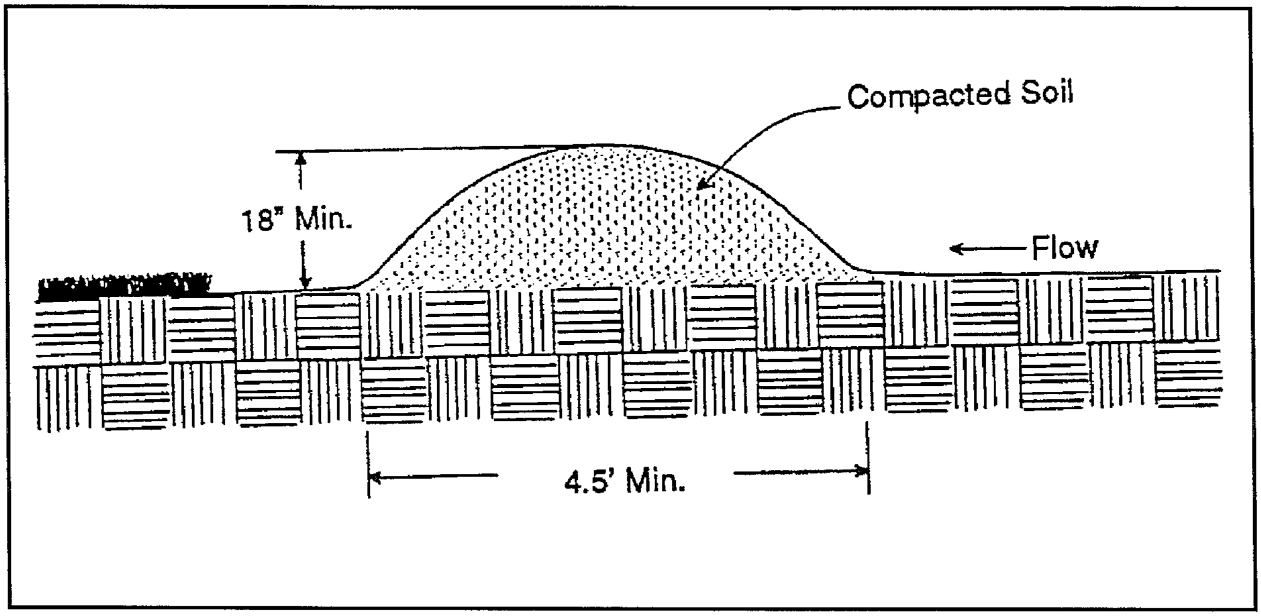


Figure 4.4e. Temporary Diversion Berm
Source: Virginia Division of Soil and Water Conservation (DSWC)

4.4.4 Temporary Fill Diversion

Definition

A channel with a supporting ridge on the lower side cut along the top of an active earth fill.

Purpose

To divert storm runoff away from the unprotected slope of the fill to a stabilized outlet or sediment-trapping facility

Conditions Where Practice Applies

Where the drainage area at the top of an active earth fill slopes toward the exposed slope and where continuous fill operations make the use of a **DIVERSION** (**Chapter 6**) unfeasible. This temporary structure should remain in place for less than one week.

Planning Considerations

One important principle of erosion and sediment control is to keep stormwater runoff away from exposed slopes. This is often accomplished by installing a berm, diversion, or paved ditch at the top of a slope to carry the runoff away from the slope to a stabilized outlet or downdrain. In general, these measures are installed after the final grade has been reached. On cuts, the measures may be installed at the beginning, since the work proceeds from the top and the measures have little chance of being covered or damaged. On fills, the work proceeds from the bottom to the top and the elevation changes daily. It is therefore not feasible to construct a compacted berm or permanent diversion that may be covered by the next day's activity.

The temporary fill diversion is intended to provide some slope protection on a daily basis until final elevations are reached and a more permanent measure can be constructed. This measure can be carried out using a motor grader or one of the smaller bulldozers. To shape the diversion, the piece of machinery used may run near the edge of the fill with its blade tilted to form the channel, as described in **Figure 4.4f**. This work should be done at the end of the working day and should provide a channel with a berm on the lower side to protect the slope. Wherever possible, the temporary diversion should be sloped to direct water to a stabilized outlet. If the runoff is diverted over the fill itself, the practice may cause more problems than it solves by concentrating water at a single point.

Good timing is essential to fill construction. The filling operation should be completed as quickly as possible and the permanent slope protection measures and slope stabilization measures installed as soon after completion as possible. With quick and proper construction, the developer or contractor will save both time and money in building, repairing, and stabilizing the fill area. The longer the period for construction and stabilization, the more prone the fill operation is to erosion damage. Repairing the damage adds time and expense to the project.

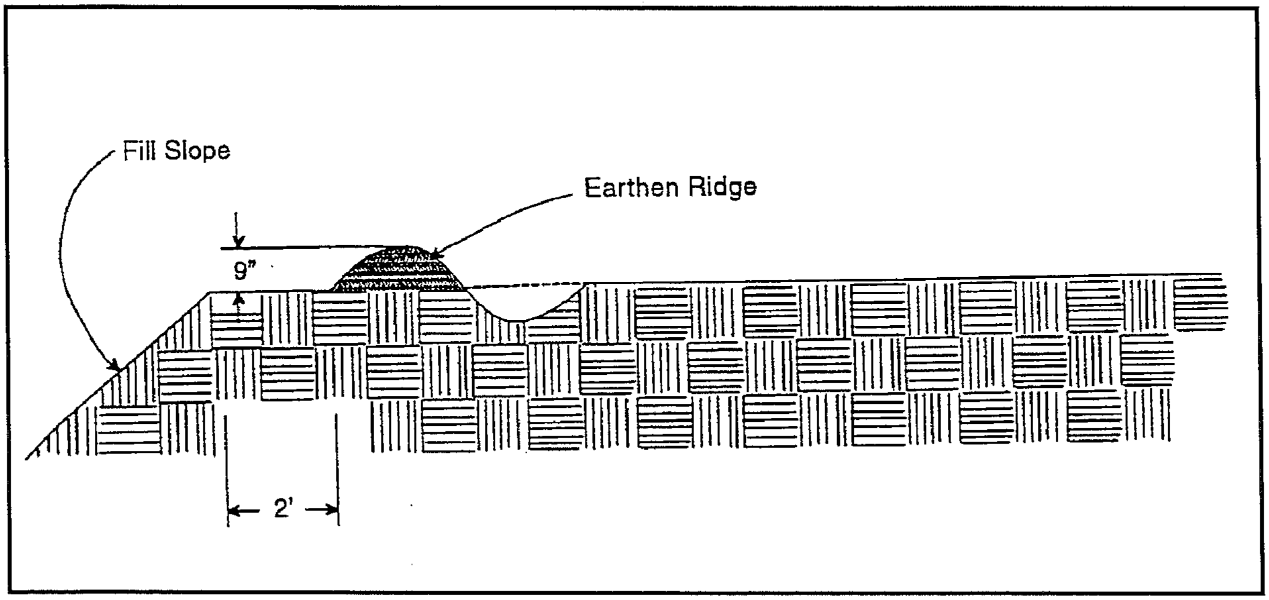


Figure 4.4f. Temporary Fill Diversion
Source: Virginia DSWC

Design Criteria

No formal design is required. The following criteria shall be met:

Drainage Area

The maximum allowable drainage area is 5 acres (2 ha).

Height

The minimum height of the supporting ridge shall be 9 inches (23 cm) (see **Figure 4.4f**).

Grade

The channel shall have a positive grade to a stabilized outlet.

Outlet

The diverted runoff should be released through a stabilized outlet, slope drain, or sediment-trapping measure.

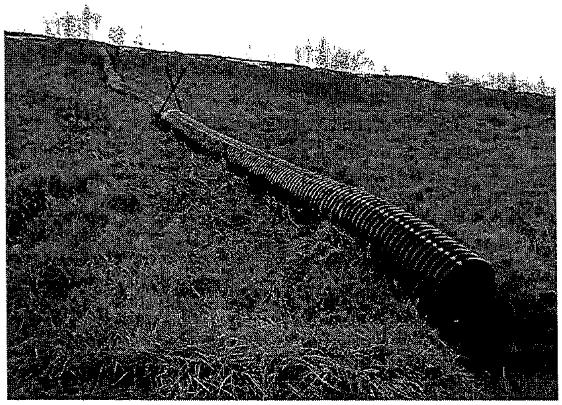
Construction Specifications

1. *The diversion shall be constructed at the top of the fill at the end of each workday as needed.*
2. *The diversion shall be located at least 2 feet (60 cm) inside the top edge of the fill (see **Figure 4.4f**).*
3. *The supporting ridge of the lower side shall be constructed with a uniform height along its entire length.*

Maintenance

Since the diversion is temporary and under most situations will be covered the next workday, the maintenance required should be low. If it is to remain in use for more than one day, the structure must be inspected at the end of each workday and repairs made if needed. The contractor should avoid placing any material over the structure while it is in use. Construction traffic should not be permitted to cross the diversion.

4.4.5 Temporary Slope Drain



Definition

A flexible tubing or conduit extending from the top to the bottom of a cut or fill slope.

Purpose

To temporarily convey concentrated stormwater runoff safely down the face of a cut or fill slope without causing erosion problems on or below the slope.

Conditions Where Practice Applies

On cut or fill slopes before permanent stormwater drainage structures are installed.

Planning Considerations

There is often a significant lag between the completion of a cut or fill slope and the installation of a permanent drainage system. During this period, the slope is usually not stabilized and is particularly vulnerable to erosion. This situation also occurs on slope construction that is temporarily delayed before final grade is reached. Temporary slope drains can provide valuable protection of exposed slopes until permanent drainage structures can be installed.

When used in conjunction with diversion berms, temporary slope drains can be used to convey stormwater from the entire drainage area above a slope to the base of the slope without erosion. It is very important that these temporary structures be installed properly, since their failure will often result in severe gully erosion. The entrance section must be securely entrenched, all connections must be watertight, and the conduit must be staked securely.

Design Criteria

Drainage Area

The maximum allowable drainage area per drain is 5 acres (2 ha).

Flexible Conduit

1. *The slope drain shall consist of heavy-duty flexible material designed for this purpose. The diameter of the slope drain shall be equal over its entire length. Reinforced hold-down grommets shall be spaced at 10 foot (3 m) maximum intervals.*
2. *Slope drains shall be sized according to the specifications in* ***Table 4.1.***

Overside Drain

For small flows and/or short slopes, an open top chute may be used in place of a pipe (see **Figure 4.4g**).

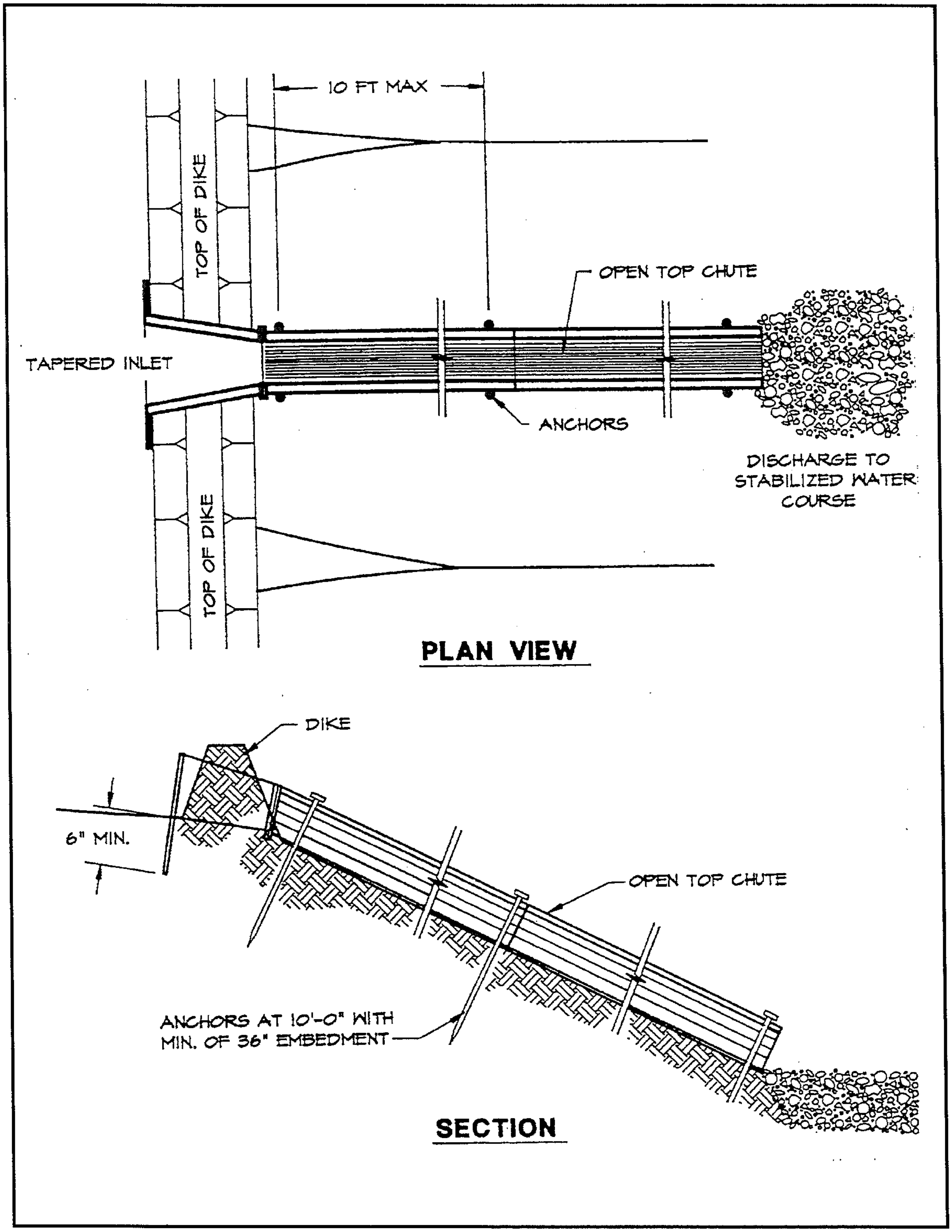


Figure 4.4g. Overside Drain

Source: Erosion Draw

Table 4.1. Size of Slope Drain

Maximum Drainage Area (acres)	Pipe Diameter (inches)
0.5	12
1.5	18
2.5	21
3.5	24
5.0	30

Entrance Sections

The entrance to the slope drain shall consist of a standard FDOT "Flared End-Section for Metal Pipe Culverts." Extension collars shall consist of 12 inch (30 cm) long corrugated metal pipe. Watertight fittings shall be provided (see **Figures 4.4h** and 4.**4i**).

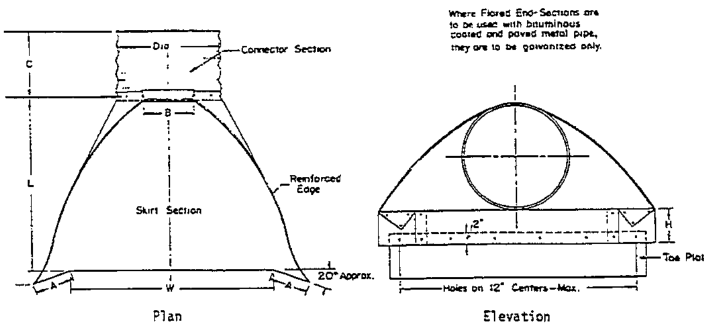
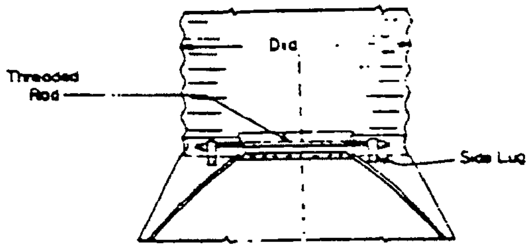


Figure 4.4h. Flared End Section Schematic

Source: Virginia Department of Highways and Transportation (DH&T) Road Designs and Standards

Alternate Connection



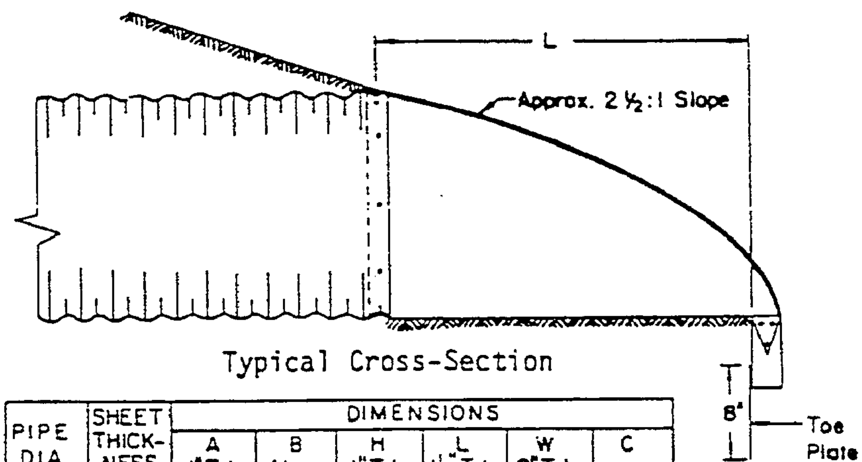
Toe plate, where needed, to be punched to match holes in skirt lip. 3/8" galv. bolts to be furnished. Length of toe plate is W+10" for 12" to 30" dia. pipe and W+22" for 36" to 60" dia. pipe.

Skirt Section for 12" to 30" dia. pipe to be made in one piece.

Skirt Section for 36" to 54" dia. pipe may be made from two sheets joined by riveting or bolting on center line, 60" may be constructed in 3 pieces.

Connector Section, Corner Plate and Toe Plate to be same sheet thickness as skirt.

End-sections and fittings are to be galvanized steel or aluminum alloy for use with like pipe.



Typical Cross-Section

PIPE DIA	SHEET THICK-NESS	DIMENSIONS					
		A 1" Tol	B Max	H 1" Tol	L 1½" Tol	W 2" Tol	C
12"	.064"	6"	6"	6"	21"	24"	24"
15"	.064"	7"	8"	6"	26"	30"	24"
18"	.064"	8"	10"	6"	31"	36"	24"
24"	.064"	10"	13"	6"	41"	48"	24"
30"	.079"	12"	16"	8"	51"	60"	24"
36"	.079"	14"	19"	9"	60"	72"	36"
42"	.109"	16"	22"	11"	69"	84"	36"
48"	.109"	18"	27"	12"	78"	90"	24"
54"	.109"	18"	30"	12"	84"	102"	36"
60"	~~109~~ 138	18"	33"	12"	87"	114"	36"

FLARED END-SECTION
(Continued)

Figure 4.4i. Flared End Section Specifications

Source: Virginia DH&T Road Designs and Standards

Berm Design

1. *An earthen berm shall be used to direct stormwater runoff into the temporary slope drain and shall be constructed according to* ***DIVERSION (Chapter 6)*** *(see* ***Figure 4.4j****).*
2. *The height of the berm at the center line of the inlet shall be equal to the diameter of the pipe (D) plus 6 inches (15 cm). Where the berm height is greater than 18 inches (45 cm) at the inlet, it shall be sloped at the rate of 3:1 or flatter to connect with the remainder of the berm (see* ***Figure 4.4j****).*

Outlet Protection

The outlet of the slope drain shall be protected from erosion according to **OUTLET PROTECTION** (**Chapter 6**) (see **Figure 4.4k**).

Construction Specifications

1. *The measure shall be placed on undisturbed soil or well-compacted fill.*
2. *The entrance section shall slope toward the slope drain at the minimum rate of ½ inch per foot (4 cm/m).*
3. *The soil around and under the entrance section shall be hand-tamped in 8 inch (20 cm) lifts to the top of the berm to prevent piping failure around the inlet.*
4. *The slope drain shall be securely staked to the slope at the grommets provided.*
5. *The slope drain sections shall be securely fastened together and have watertight fittings.*

Maintenance

The slope drain structure shall be inspected weekly and after every storm, and shall have repairs made if necessary. The contractor should avoid the placement of any material on and prevent construction traffic across the slope drain.

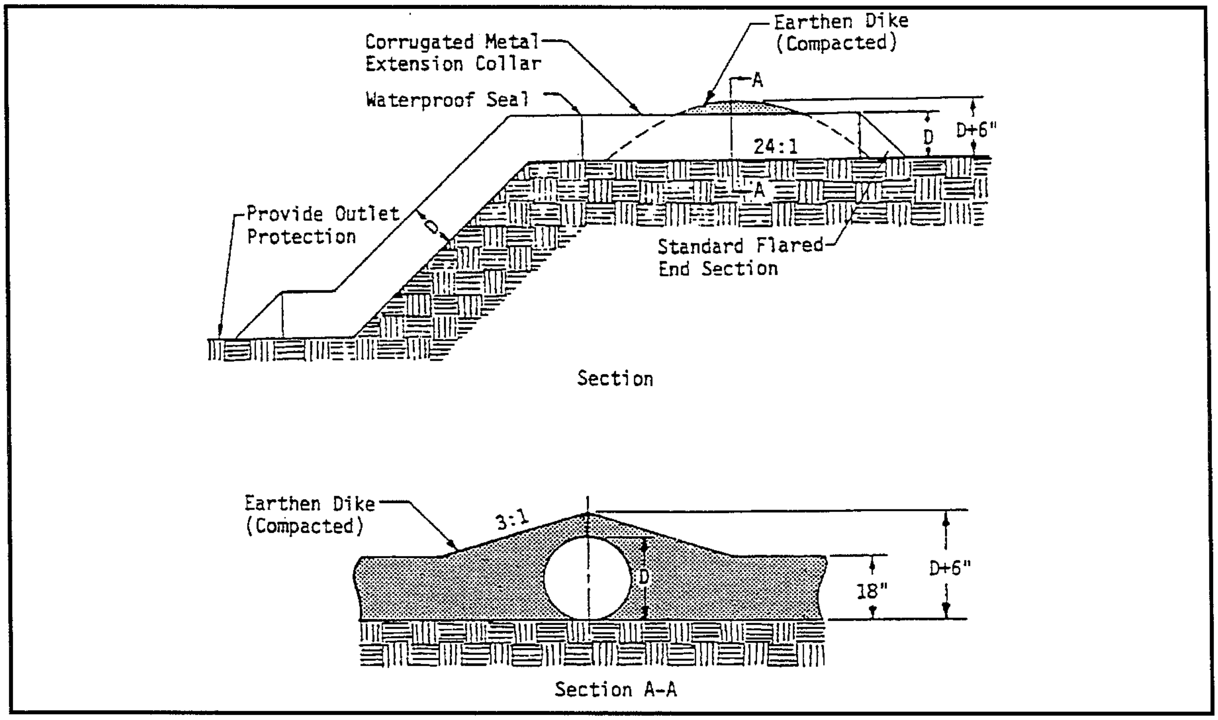


Figure 4.4j. Temporary Slope Drain

Source: Virginia Soil and Water Conservation Commission (SWCC)

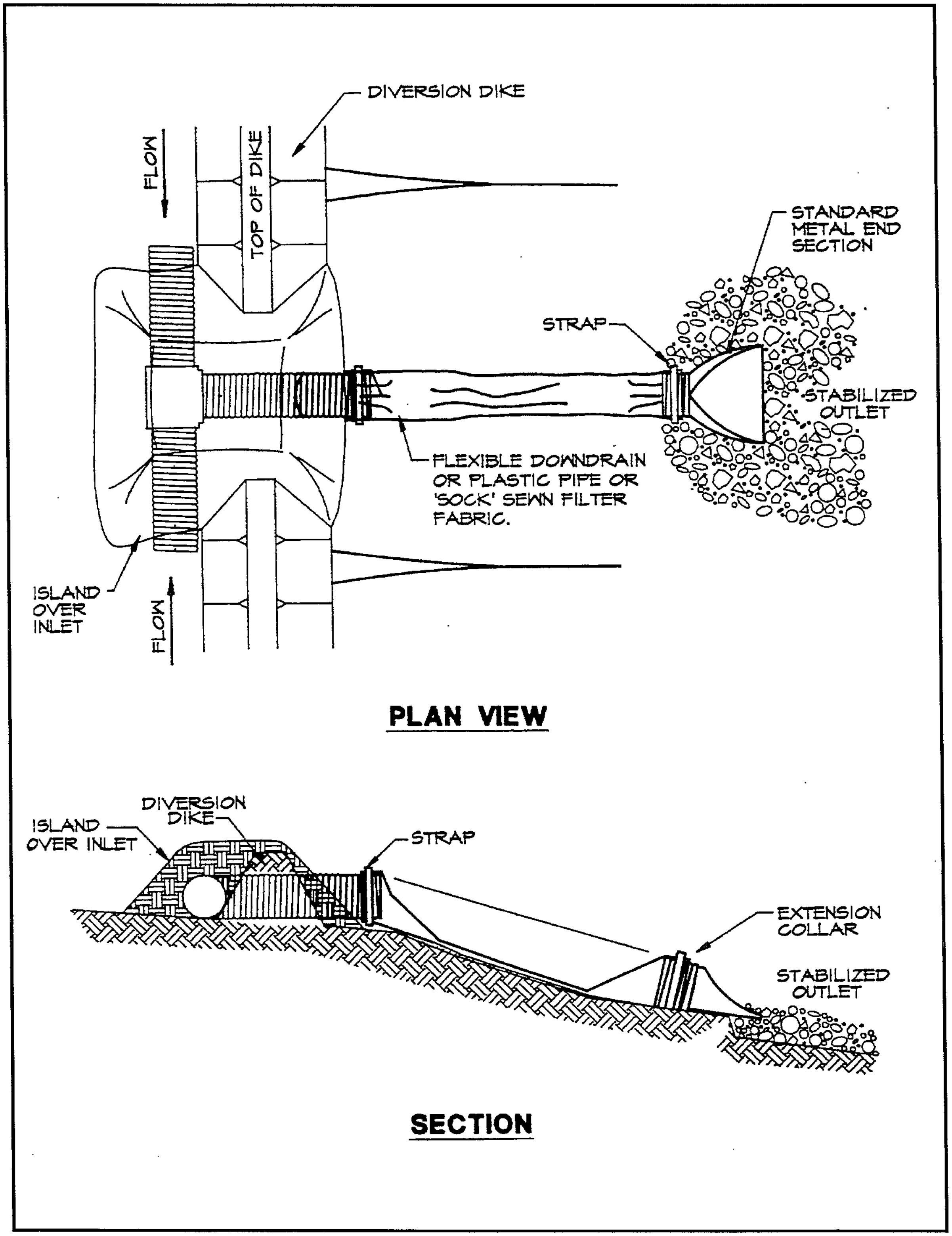


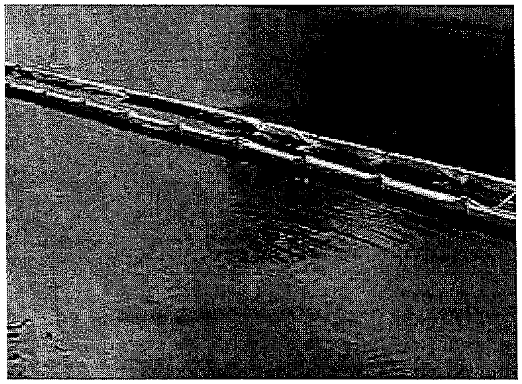
Figure 4.4k. Slope Drain

Source: Erosion Draw

4.4.6 Floating Turbidity Barrier

Definition

A floating geotextile material that minimizes sediment transport from a disturbed area adjacent to or within a waterbody.



Purpose

To provide sedimentation protection for a watercourse from upslope land disturbance where conventional erosion and sediment controls cannot be used, or from dredging or filling within the watercourse.

Conditions Where Practice Applies

Applicable to nontidal and tidal watercourses where intrusion into the watercourse by construction activities has been permitted and subsequent sediment movement is unavoidable.

Planning Considerations

Soil loss into a watercourse results in the long-term suspension of sediment. In time, the suspended sediment may travel long distances and affect widespread areas. A turbidity curtain is designed to deflect and contain sediment within a limited area and provide enough residence time so that soil particles will fall out of suspension and not travel to other areas.

Turbidity curtain types must be selected based on the flow conditions in the waterbody, whether a flowing channel, lake, pond, or tidal watercourse. The specifications in this measure pertain to minimal and moderate flow conditions where the velocity of flow may reach 5 feet (1.5 m) per second (or a current of approximately 3 knots). For situations where there are greater flow velocities or currents, a qualified engineer and product manufacturer should be consulted.

Consideration must also be given to the direction of water movement in channel flow situations. Turbidity curtains are not designed to act as water impoundment dams and cannot be expected to stop the flow of a significant volume of water. They are designed and installed to trap sediment, not to halt the movement of water itself. **In most situations, turbidity curtains should not be installed across channel flows.**

In tidal or moving water conditions, provisions must be made to allow the volume of water contained within the curtain to change. Since the bottom of the curtain is weighted and external anchors are frequently added, the volume of water contained within the curtain will be much greater at high tide vs. low tide, and measures must be taken to prevent the curtain from submerging.

In addition to allowing slack in the curtain to rise and fall, water must be allowed to flow through the curtain, if the curtain is to remain in roughly the same place and maintain the same shape. Normally, this is achieved by constructing part of the curtain from a heavy, woven filter fabric. The fabric allows the water to pass through the curtain but retains the sediment particles. Consideration should be given to the volume of water that must pass through the fabric and sediment particle size when specifying fabric permeability.

Sediment that has been deflected and settled out by the curtain **may be removed** if so directed by the onsite inspector or the permitting agency. However, the probable outcome of the procedure must be considered—**will it create more of a sediment problem by the resuspension of particles and by accidental dumping of the material through the equipment involved?**

It is, therefore, recommended that the soil particles trapped by a turbidity curtain only be removed if there has been a significant change in the original contours of the affected area in the watercourse. Regardless of the decision made, soil particles should always be allowed to settle for a **minimum of 6 to 12 hours** before their removal by equipment or before the removal of a turbidity curtain.

It is imperative that the intended function of the other controls in this chapter, **to keep sediment out of the watercourse**, be the strategy used in every erosion control plan. However, when proximity to the watercourse makes successfully mitigating sediment loss impossible, the use of the turbidity curtain during land disturbance is essential. **Under no circumstances shall permitted land-disturbing activities create violations of water quality standards!**

Design Criteria

1. *Type I configuration (see **Figure 4.4l**) should be used in protected areas where there is no current and the area is sheltered from wind and waves.*
2. *Type II configuration (see **Figure 4.4l**) should be used in areas where there may be low to moderate current running (up to 2 knots or 3.5 feet [1 m] per second) and/or wind and wave action can affect the curtain.*
3. *Type III configuration (see **Figure 4.4m**) should be used in areas where considerable current (up to 3 knots or 5 feet [1.5 m] per second) may be present, where tidal action may be present, and/or where the curtain may be subject to wind and wave action.*
4. *Turbidity curtains should extend the entire depth of the watercourse whenever it is not subject to tidal action and/or significant wind and wave forces. This prevents silt-laden water from escaping under the barrier, scouring and resuspending additional sediments.*
5. *In situations with tidal and/or wind and wave action, the curtain should never be so long as to touch the bottom. There should be a minimum 1 foot (30 cm) gap between the weighted lower end of the skirt and the bottom at mean low water. The movement of the lower skirt over the bottom due to tidal reverses or wind and wave action on the flotation system may fan and stir sediments already settled out.*
6. *In situations with tidal and/or wind and wave action, it is seldom practical to extend a turbidity curtain lower than 10 to 12 feet (3 to 4 m) below the surface, even in deep water. Curtains that are installed deeper than this will be subject to very large loads with consequent strain on curtain materials and the mooring system. In addition, a curtain installed in this*

manner can "billow up" toward the surface under the pressure of the moving water, resulting in an effective depth that is significantly less than the skirt depth.

7. *Turbidity curtains should be located parallel to the direction of flow of a moving body of water.* ***They should not be placed across the main flow of a significant body of moving water.***
8. *When sizing the length of the floating curtain, allow an additional 10 to 20% variance in the straight-line measurements. This will allow for measuring errors, make installation easier, and reduce stress from potential wave action during high winds.*
9. *An attempt should be made to avoid an excessive number of joints in the curtain; a minimum continuous span of 50 feet (15 m) between joints is a good rule of thumb.*
10. *To maintain stability, a maximum span of 100 feet (30 m) between anchor or stake locations is also a good rule to follow.*
11. *The ends of the curtain, both floating upper and weighted lower, should extend well up into the shoreline, especially if high-water conditions are expected. The ends should be secured firmly to the shoreline to fully enclose the area where sediment may enter the water.*
12. *When there is a specific need to extend the curtain to the bottom of the watercourse in tidal or moving water conditions, a heavy, woven, pervious filter fabric may be substituted for the normally recommended impervious geotextile. This creates a "flow-through" medium that significantly reduces the pressure on the curtain and helps to keep it in the same relative location and shape during the rise and fall of tidal waters.*
13. ***Figure 4.4m*** *shows the typical alignments of turbidity curtains. The number and spacing of external anchors may vary depending on current velocities and potential wind and wave action; the manufacturer's recommendations should be followed.*
14. *Be certain that the type, location, and installation of the barrier are as shown on the approved plan and permit. Additional permits may be required in navigable waterways, especially when the barrier creates an obstruction.*

Construction Specifications

Materials

1. *Barriers should be a bright color (yellow or "international" orange are recommended) that will attract the attention of nearby boaters.*
2. *The curtain fabric must meet the minimum requirements.*
3. *Seams in the fabric shall be either vulcanized welded or sewn, and shall develop the full strength of the fabric.*
4. *Flotation devices shall be flexible, buoyant units contained in an individual flotation sleeve or collar attached to the curtain. Buoyancy provided by*

*the flotation units shall be sufficient to support the weight of the curtain and maintain a freeboard of at least 3 inches (8 cm) above the water surface level (**see Figure 4.4n**).*

5. *Load lines must be fabricated into the bottom of all floating turbidity curtains. Types II and III must have load lines also fabricated into the top of the fabric. The top load line shall consist of woven webbing or vinyl-sheathed steel cable and shall have a break strength in excess of 10,000 pounds (4.5 tonnes [t]). The supplemental (bottom) load-line shall consist of a chain incorporated into the bottom hem of the curtain of sufficient weight to serve as ballast to hold the curtain in a vertical position. Additional anchorage shall be provided as necessary. The load lines shall have suitable connecting devices that develop the full breaking strength for connecting to load lines in adjacent sections (see **Figures 4.4l** and **4.4m**, which portray this orientation).*

6. *External anchors may consist of 2 x 4 inch (5 x 10 cm) or 2 ½ inch (6 cm) minimum diameter wooden stakes, or 1.33 pounds per linear foot (2 kilograms [kg]/m]) steel posts when Type I installation is used; with Type II or Type III installations, bottom anchors should be used.*

7. *Bottom anchors must be sufficient to hold the curtain in the same position relative to the bottom of the watercourse without interfering with the action of the curtain. The anchor may dig into the bottom (grappling hook, plow or fluke-type) or may be weighted (mushroom-type) and should be attached to a floating anchor buoy via an anchor line. The anchor line then runs from the buoy to the top load line of the curtain. When used with Type III installations, these lines must contain enough slack to allow the buoy and curtain to float freely with tidal changes without pulling the buoy or curtain down, and must be checked regularly to make sure they do not become entangled with debris. As previously noted, anchor spacing varies with current velocity and expected wind and wave action; the manufacturer's recommendations should be followed (see the orientation of external anchors and anchor buoys for tidal installation in **Figure 4.4m**).*

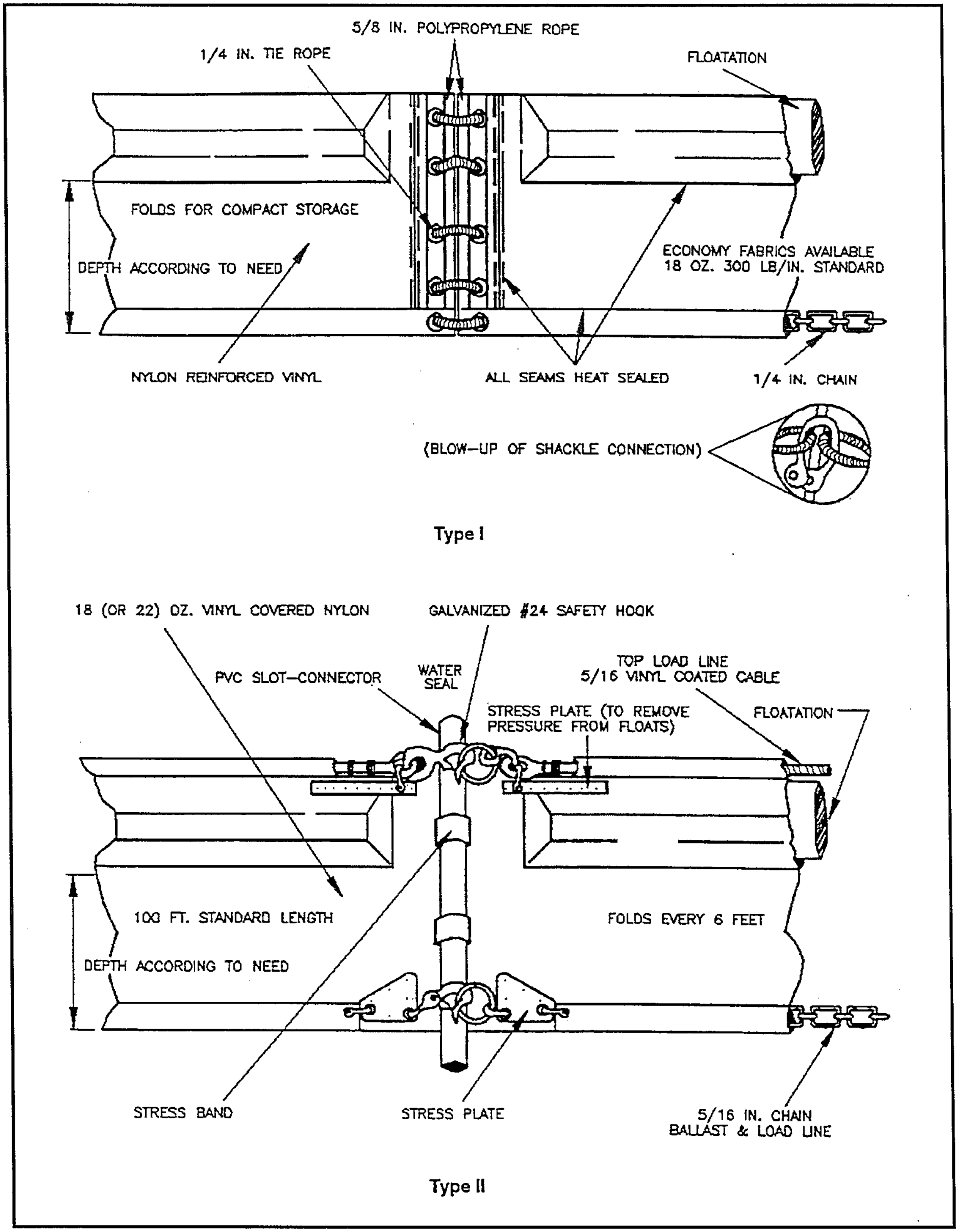
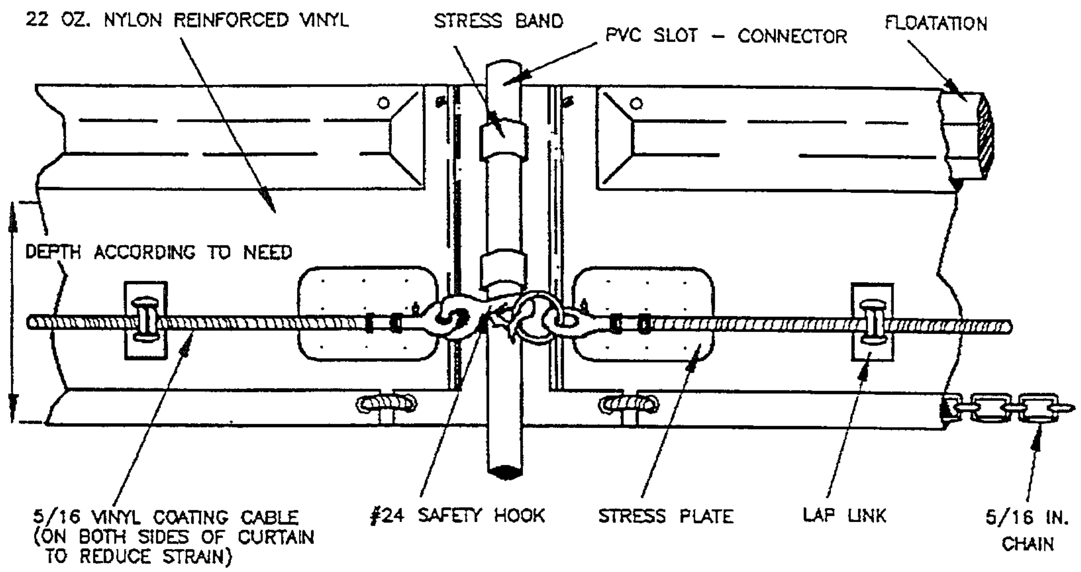


Figure 4.4l. Type I and II Floating Turbidity Barriers

Source: American Boom and Barrier Corporation

Type III



Orientation When Installed
(Tidal Situation - Type III)

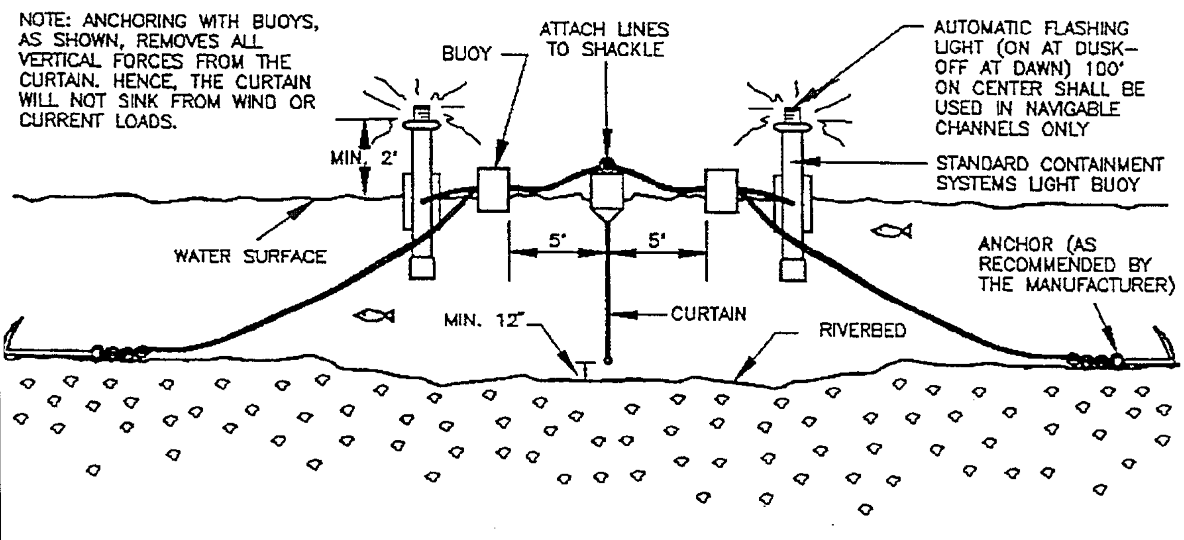


Figure 4.4m. Type III Floating Turbidity Barrier

Source: American Boom and Barrier Corporation and Virginia Department of Transportation (DOT) Standard Sheets

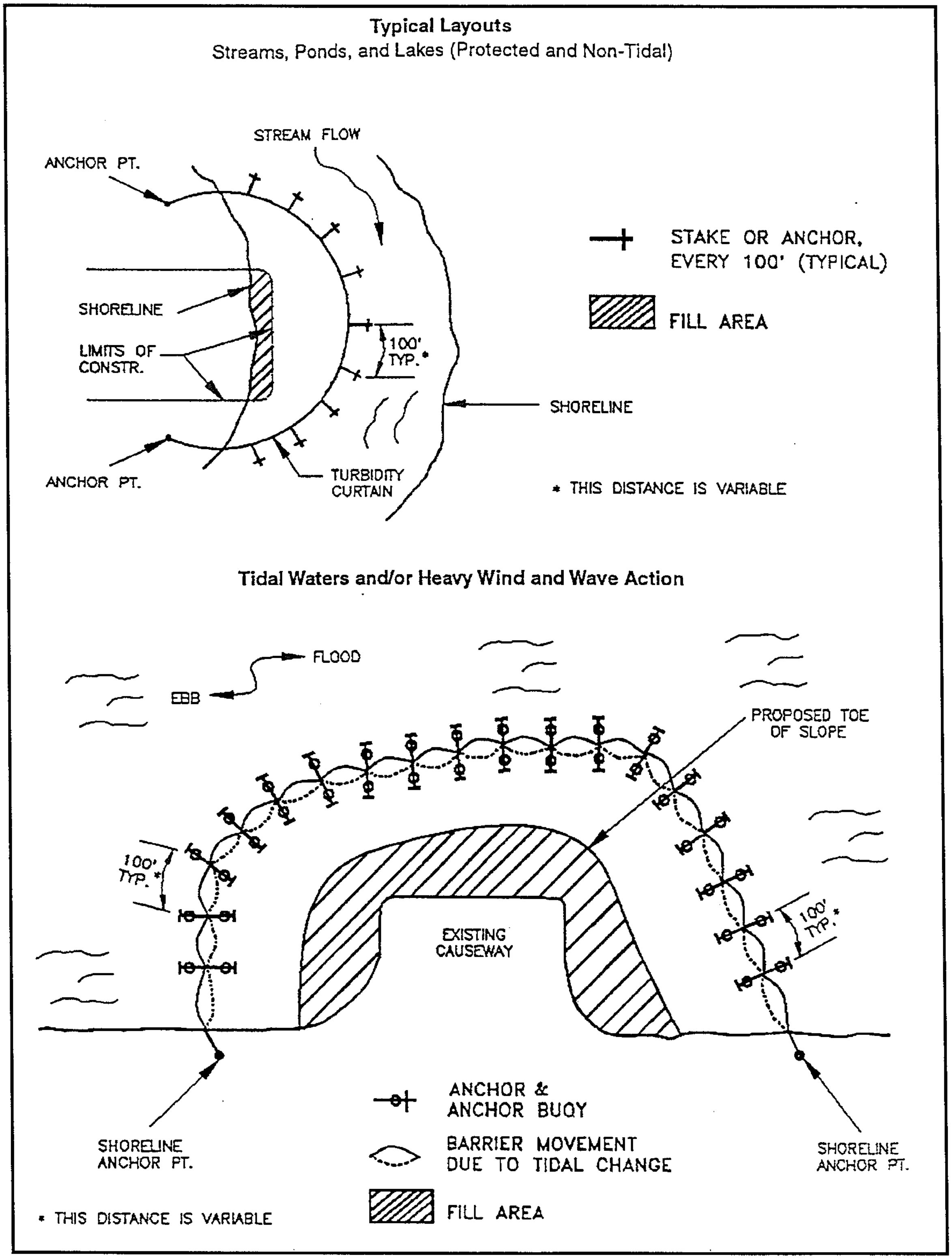


Figure 4.4n. Typical Installation Layouts

Source: FDOT Roadway and Traffic Design Standards

Installation

1. *In the calm water of lakes or ponds (Type I installation), it is usually sufficient to merely set the curtain end stakes or anchor points (using anchor buoys if bottom anchors are employed), then tow the curtain* ***in the furled condition*** *out and attach it to these stakes or anchor points. Following this, any additional stakes or buoyed anchors required to maintain the desired location of the curtain may be set and these anchor points made fast to the curtain.* ***Only then*** *should the furling lines be cut to let the curtain skirt drop.*

2. *In rivers or in other moving water (Type II and III installations), it is important to set all the curtain anchor points. Care must be taken to ensure that anchor points are of sufficient holding power to retain the curtain under the expected current conditions, before putting the furled curtain into the water. Anchor buoys should be employed on all anchors to prevent the current from submerging the flotation at the anchor points. If the moving water into which the curtain is being installed is tidal and will subject the curtain to currents in both directions as the tide changes, it is important to provide anchors on both sides of the curtain for two reasons, as follows:*

    a. Curtain movement will be minimized during tidal current reversals, and

    b. The curtain will not overrun the anchors or pull them out when the tide reverses.

    When the anchors are secure, the furled curtain should be secured to the upstream anchor point and then sequentially attached to each next downstream anchor point until the entire curtain is in position. At this point, and before unfurling, the "lay" of the curtain should be assessed and any necessary adjustments made to the anchors. Finally, when the desired location is achieved, the furling lines should be cut to allow the skirt to drop.

3. ***Always attach anchor lines to the flotation device, not to the bottom of the curtain.*** *The anchoring line attached to the flotation device on the downstream side will provide support for the curtain. Attaching the anchors to the bottom of the curtain could cause premature failure of the curtain due to the stresses imparted on the middle section of the curtain.*

4. *There is an exception to the rule that turbidity curtains should not be installed across channel flows: when there is a danger of creating a silt buildup in the middle of a watercourse, thus blocking access or creating a sandbar. Curtains have been used effectively in large areas of moving water by forming a very long-sided, sharp "V" to deflect clean water around a work site, confine a large part of the silt-laden water to the work area inside the "V," and direct much of the silt toward the shoreline. Care must be taken, however, not to install the curtain perpendicular to the water current.*

5. *See* ***Figure 4.4n*** *for typical installation layouts.*

6. *The effectiveness of the barrier can be increased by installing 2 parallel curtains, separated at regular intervals by 10 foot (3 m) long wooden boards or lengths of pipe.*

Removal

1. *Care should be taken to protect the skirt from damage as the turbidity curtain is dragged from the water.*
2. *The site selected to bring the curtain ashore should be free of sharp rocks, broken cement, debris, etc., to minimize damage when hauling the curtain over the area.*
3. *If the curtain has a deep skirt, it can be further protected by running a small boat along its length with a crew installing furling lines before attempting to remove the curtain from the water.*

Maintenance

1. *The developer/owner shall be responsible for maintaining the filter curtain for the duration of the project to ensure the continuous protection of the watercourse.*
2. *Should repairs to the geotextile fabric become necessary, repair kits are normally available from the manufacturer; the manufacturer's instructions must be followed to ensure the adequacy of the repair.*
3. *When the curtain is no longer required as determined by the inspector, the curtain and related components shall be removed in a manner that minimizes turbidity. Sediment shall be removed and the original depth (or plan elevation) restored before removing the curtain. The remaining sediment shall be sufficiently settled before the curtain is removed. Any spoils must be taken to an upland area and stabilized.*

4.5 Storm Drain Inlet Protection

Definition

A sediment filter or an excavated impounding area around a storm drain drop inlet or curb inlet.

Purpose

To prevent sediment from entering stormwater conveyance systems prior to permanent stabilization of the disturbed area.

Condition Where Practice Applies

Where storm drain inlets are to be made operational before permanent stabilization of the disturbed drainage area. Different types of structures are applicable to different conditions (see **Figures 4.5a** through **4.5j**).

Planning Considerations

Storm sewers that are made operational before their drainage area is stabilized can convey large amounts of sediment to receiving waters. In the case of extreme sediment loading, the storm sewer itself may clog and lose most of its capacity. To avoid these problems, it is necessary to prevent sediment from entering the system at the inlets.

There are several types of inlet filters and traps, which have different applications depending on the site conditions and type of inlet. Other innovative techniques for accomplishing the same purpose are encouraged, but only after specific plans and details are submitted to and approved by the stormwater permitting agency.

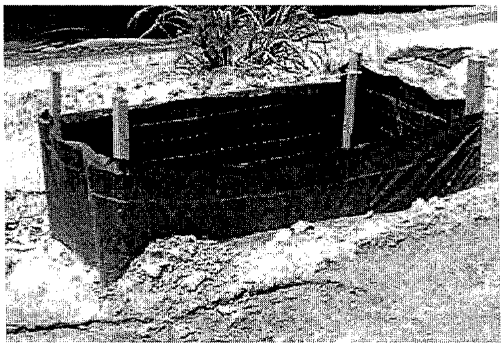
Note that these various inlet protection devices are for drainage areas of **less than 1 acre (0.4 ha)**. Runoff from large, disturbed areas should be routed through a **TEMPORARY SEDIMENT TRAP** (**Chapter 4**).

Design Criteria

1. *The drainage area shall be no greater than 1 acre (0.4 ha).*
2. *The inlet protection device shall be constructed to facilitate the cleanout and disposal of trapped sediment and to minimize interference with construction activities.*
3. *The inlet protection devices shall be constructed so that any resultant ponding or stormwater will not cause excessive inconvenience or damage to adjacent areas or structures.*
4. ***Figures 4.5a** through **4.5j** provide specific design criteria for each particular inlet protection device.*

Construction Specifications

Fabric Drop Inlet Sediment Filter



1. *Fabric shall be cut from a continuous roll to avoid joints.*
2. *Stakes shall be 2 x 4 inches (5 x 10 cm) wood (preferred) or equivalent metal with a minimum length of 3 feet (90 cm) (see* ***Figure 4.5a****).*
3. *Staples shall be of heavy duty wire at least ½ inch (13 mm) long.*
4. *Stakes shall be spaced around the perimeter of the inlet a maximum of 3 feet (90 cm) apart and securely driven into the ground a minimum of 8 inches (20 cm). A frame of 2 x 4 inches (5 x 10 cm) of wood shall be constructed around the top of the stakes for proper stability.*
5. *A trench shall be excavated approximately 4 inches (10 cm) wide and 4 inches (10 cm) deep around the outside perimeter of the stakes (see* ***Figure 4.5b****).*
6. *The fabric shall be stapled to the wooden stakes, and 8 inches (20 cm) of the fabric shall be extended into the trench. The height of the filter barrier shall be a minimum of 15 inches (38 cm) and shall not exceed 18 inches (45 cm).*
7. *The trench shall be backfilled and the soil compacted over the fabric.*

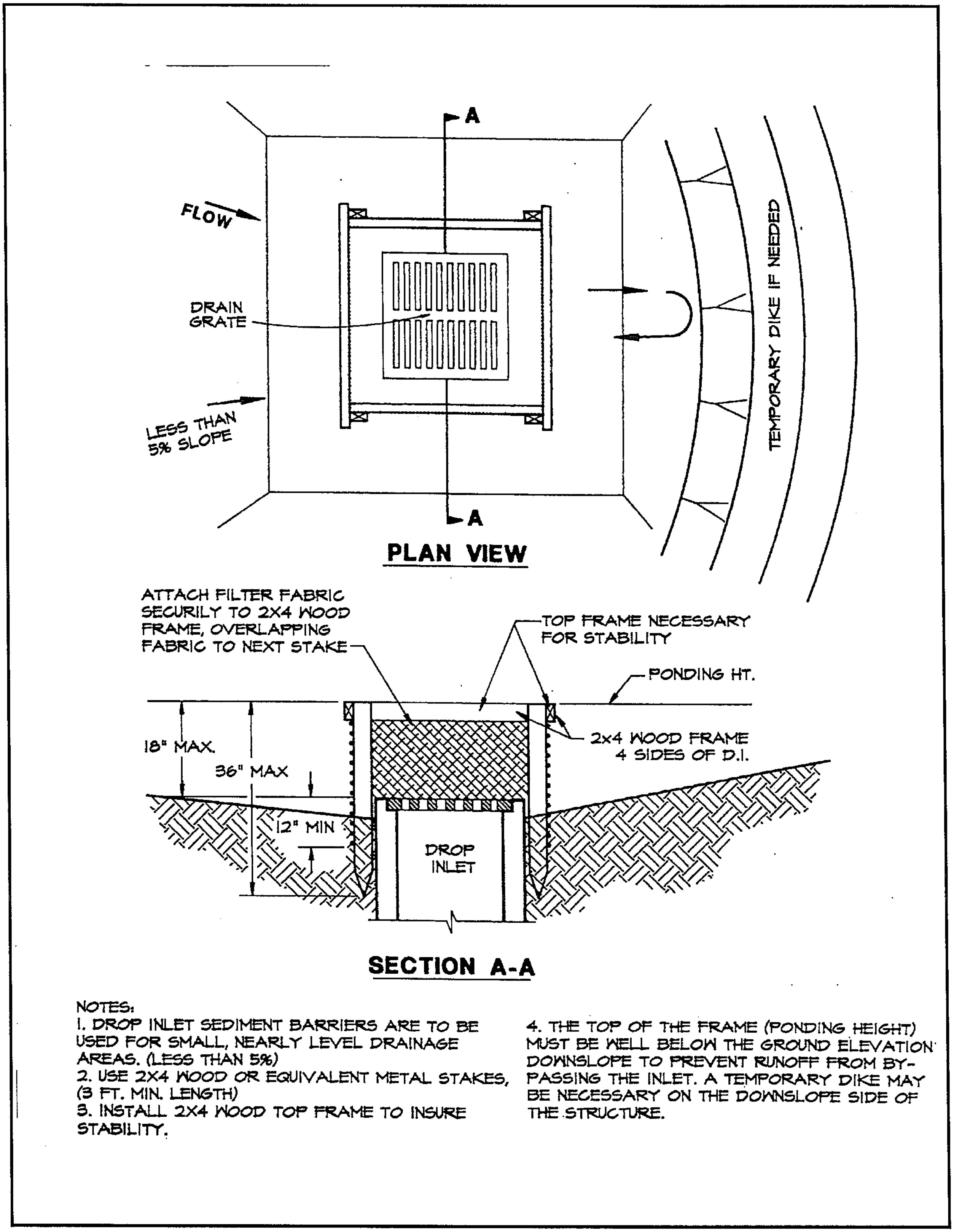
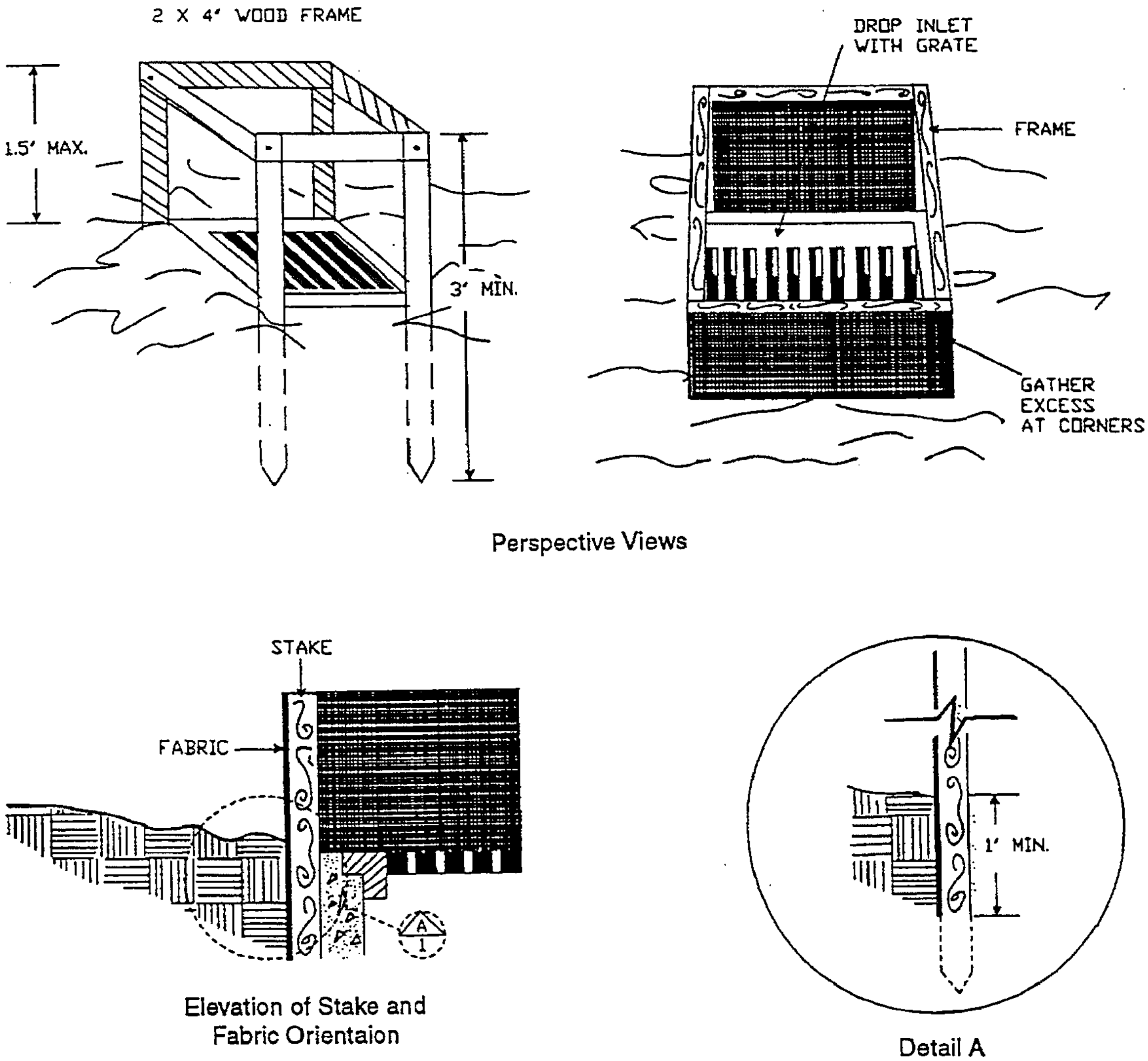


Figure 4.5a. Silt Fence Drop Inlet Sediment Barrier

Source: Erosion Draw



Specific Application

This method of inlet protection is applicable where the inlet drains a relatively flat area (slope no greater than 5%) where the inlet sheet or overland flows (not exceeding 1 c.f.s.) are typical. The method shall not apply to inlets receiving concentrated flows, such as in street or highway medians.

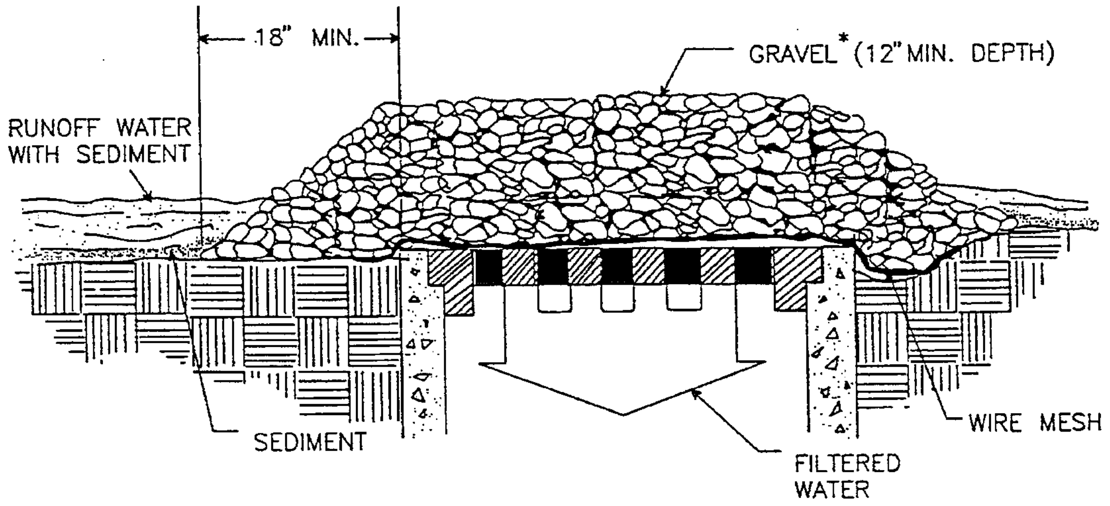
Figure 4.5b. Filter Fabric Drop Inlet Sediment Filter

Source: North Carolina Erosion and Sediment Control Manual

Gravel and Wire Mesh Drop Inlet Sediment Filter

1. *Wire mesh shall be laid over the drop inlet so that the wire extends a minimum of 1 foot (30 cm) beyond each side of the inlet structure. Hardware cloth or comparable wire mesh with ½ inch (13 mm) openings shall be used. If more than 1 strip of mesh is necessary, the strips shall be overlapped at least 1 foot (30 cm).*
2. *FDOT No. 1 Coarse Aggregate (1.5 to 3.5 inch) (4 to 9 cm) stone shall be placed over the wire mesh, as shown in **Figure 4.5c**. The depth of the stone shall be at least 12 inches (30 cm) over the entire inlet opening. The stone shall extend beyond the inlet opening at least 18 inches (45 cm) on all sides (see **Figure 4.5c**).*
3. *If the stone filter becomes clogged with sediment so that it no longer adequately performs its function, the stones must be pulled away from the inlet, cleaned, and replaced.*

NOTE: *This filtering device has no overflow mechanism. Therefore, ponding is likely, especially if sediment is not removed regularly. This type of device must **NEVER** be used where overflow may endanger an exposed fill slope. Consideration should also be given to the possible effects of ponding on traffic movement, nearby structures, working areas, adjacent property, etc.*



Specific Application

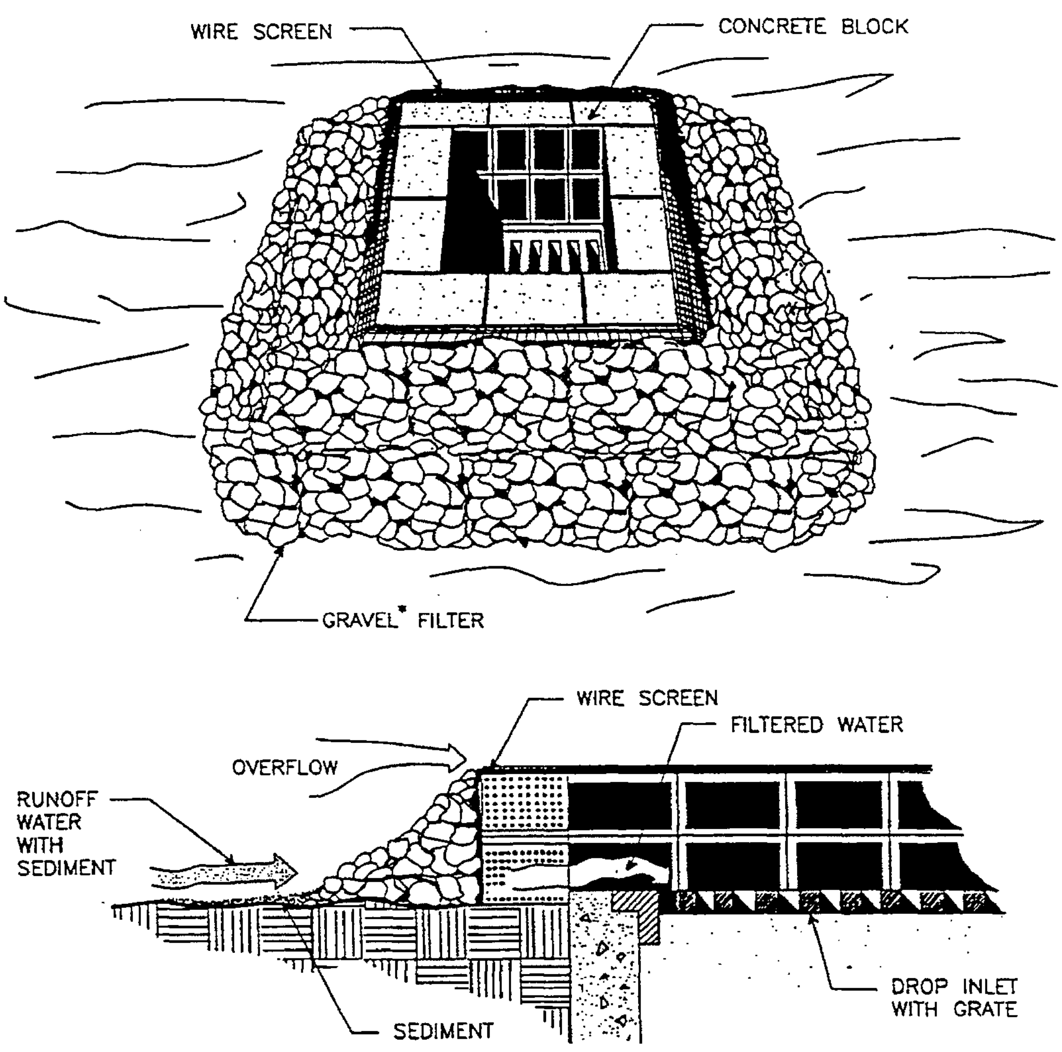
This method of inlet protection is applicable where heavy concentrated flows are expected, but not where ponding around the structure might cause excessive inconvience or damage to adjacent structures and unprotected areas.

* Gravel Shall be VDOT #3, #357, or #5 Coarse Aggregate.

Figure 4.5c. Gravel and Wire Mesh Drop Inlet Sediment Filter
Source: Virginia DSWC

Block and Gravel Drop Inlet Sediment Filter

1. *Place concrete blocks lengthwise on their sides in a single row around the perimeter of the inlet, with the ends of adjacent blocks abutting. The height of the barrier can be varied, depending on design needs, by stacking combinations of 4, 8, and 12 inch wide (10, 20, and 30 cm) blocks. The barrier of blocks shall be at least 12 inches (30 cm) high and no greater than 24 inches (60 cm) high.*
2. *Wire mesh shall be placed over the outside vertical face (webbing) of the concrete blocks to prevent stone from being washed through the holes in the blocks. Hardware cloth or comparable wire mesh with ½ inch (13 mm) openings shall be used (see **Figure 4.5d**).*
3. *Stone shall be piled against the wire to the top of the block barrier. Suitable coarse aggregate shall be used (see **Figure 4.5d**).*
4. *If the stone filter becomes clogged with sediment so that it no longer adequately performs its function, the stone must be pulled away from the blocks, cleaned, and replaced.*



Specific Application

This method of inlet protection is applicable where heavy flows are expected and where an overflow capacity is necessary to prevent excessive ponding around the structure.

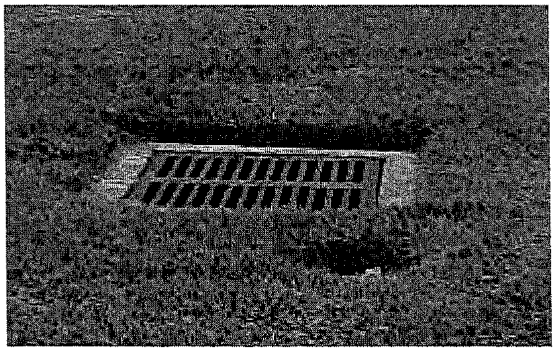
* Gravel Shall be FDOT #3, #357, or #5 Coarse Aggregate.

Figure 4.5d. Block and Gravel Drop Inlet Sediment Filter

Source: Michigan Soil Erosion and Sedimentation Control Guidebook

5. *As a very temporary alternative, pervious burlap bags filled with gravel may be placed around the inlet, provided that there are no gaps between the bags (see* ***Figure 4.5e****).*
6. *Either of these two practices may be installed on pavement or bare ground.*

Sod Drop Inlet Sediment Filter

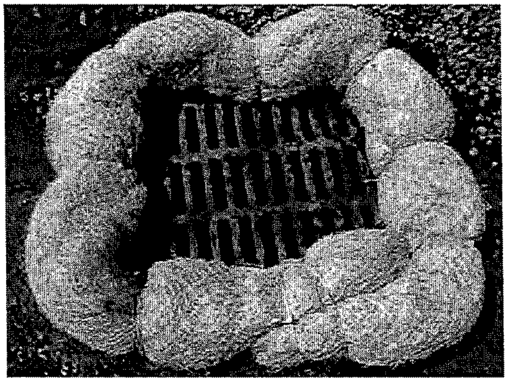


1. *Soil shall be prepared and sod installed according to the specifications in* ***SODDING*** *(****Chapter 7****).*
2. *Sod shall be placed to form a turf mat covering the soil for a distance of 4 feet (1.2 m) from each side of the inlet structure (see* ***Figure 4.5f****).*

Prefabricated Drop Inlet Internal Filter Bag

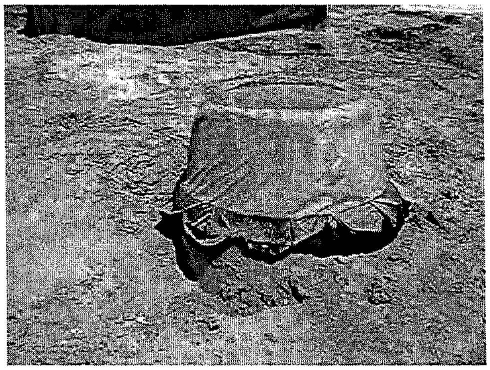
1. *Remove the grate over the catch basin and insert the filter device, then replace the grate to hold the device in position.*
2. *When sediments have accumulated to within 1 foot (30 cm) of the grate, the filter insert must be removed by a front-end loader or forklift. The filter may be discarded and replaced, or it may be emptied, cleaned, and reused.*

Filter Sock Drop Inlet Filter



1. *The filter sock should be placed around the entire circumference of the drop inlet and should allow for at least 1 foot of overlap on either side of the opening being protected. Stakes should be used to keep the sock in place.*
2. *Under low-flow conditions, a 9-inch or 12-inch sock diameter should suffice.*
3. *Sediment will collect around the outside of the filter sock and should be removed when the sediment reaches one-half of the sock height.*

Prefabricated Drop Inlet External Filter



1. *Place the device over the inlet. If the inlet has a grate, the device shall be secured to the grate by means of a long toggle bolt. If the grate is not present, the device shall be bolted directly to the concrete.*
2. *Sediments shall be removed when they have accumulated to within 1 foot (30 cm) of the top of the device. The filter fabric elements shall be cleaned or replaced at that time.*

NOTE: *This segment does not constitute a product endorsement.*

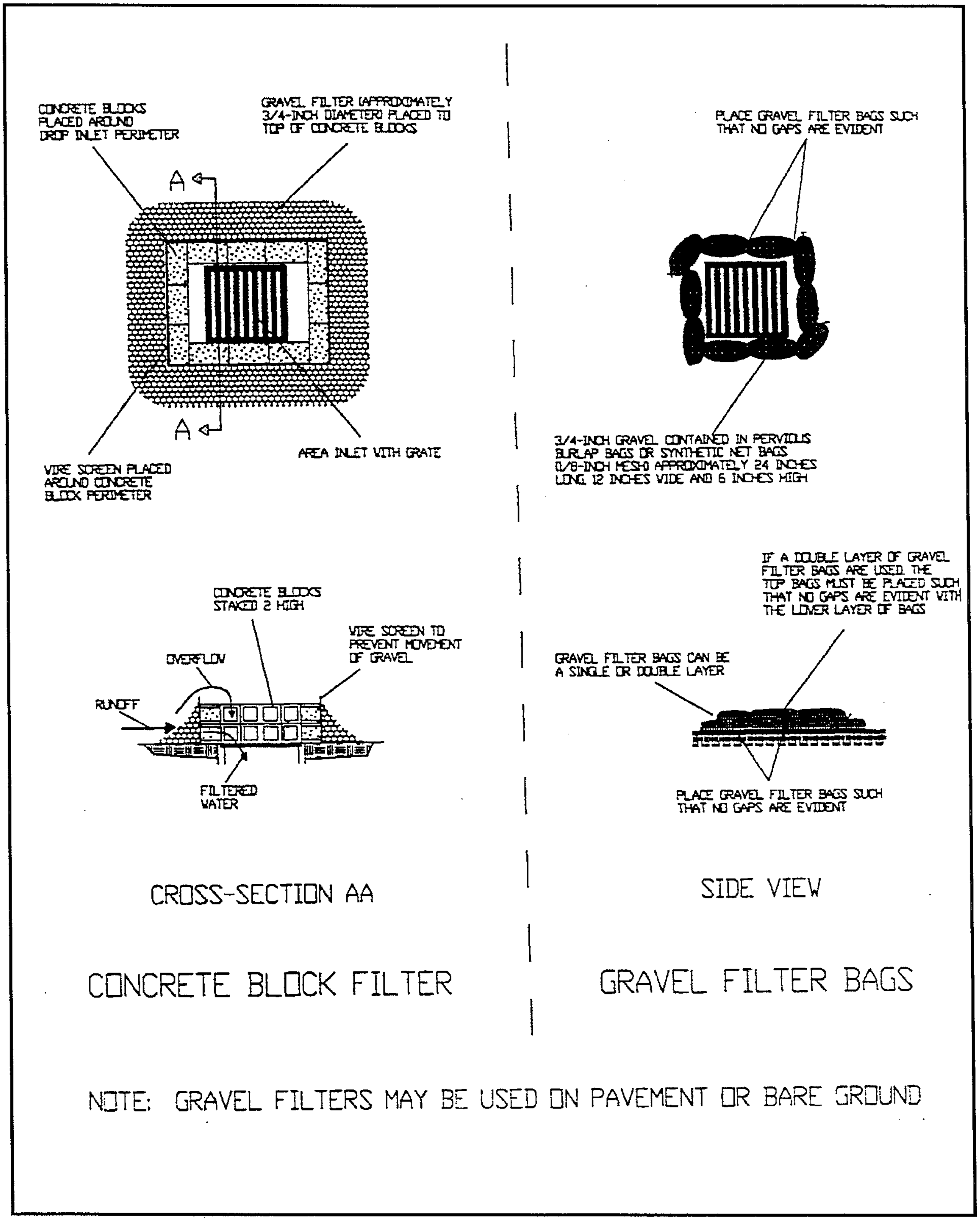


Figure 4.5e. Gravel Filters for Area Inlets

Source: HydroDynamics, Inc.

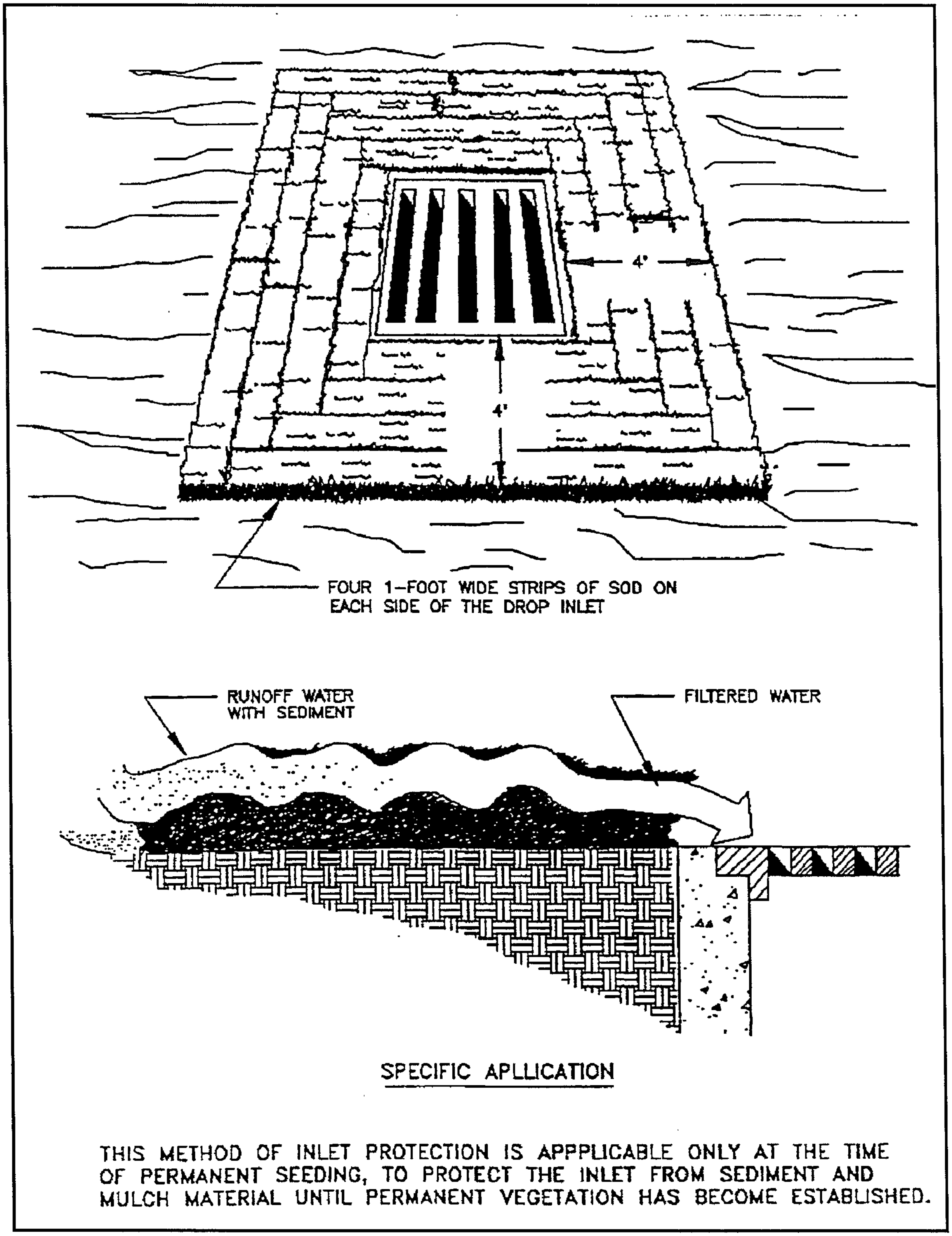


Figure 4.5f. Sod Drop Inlet Sediment Filter

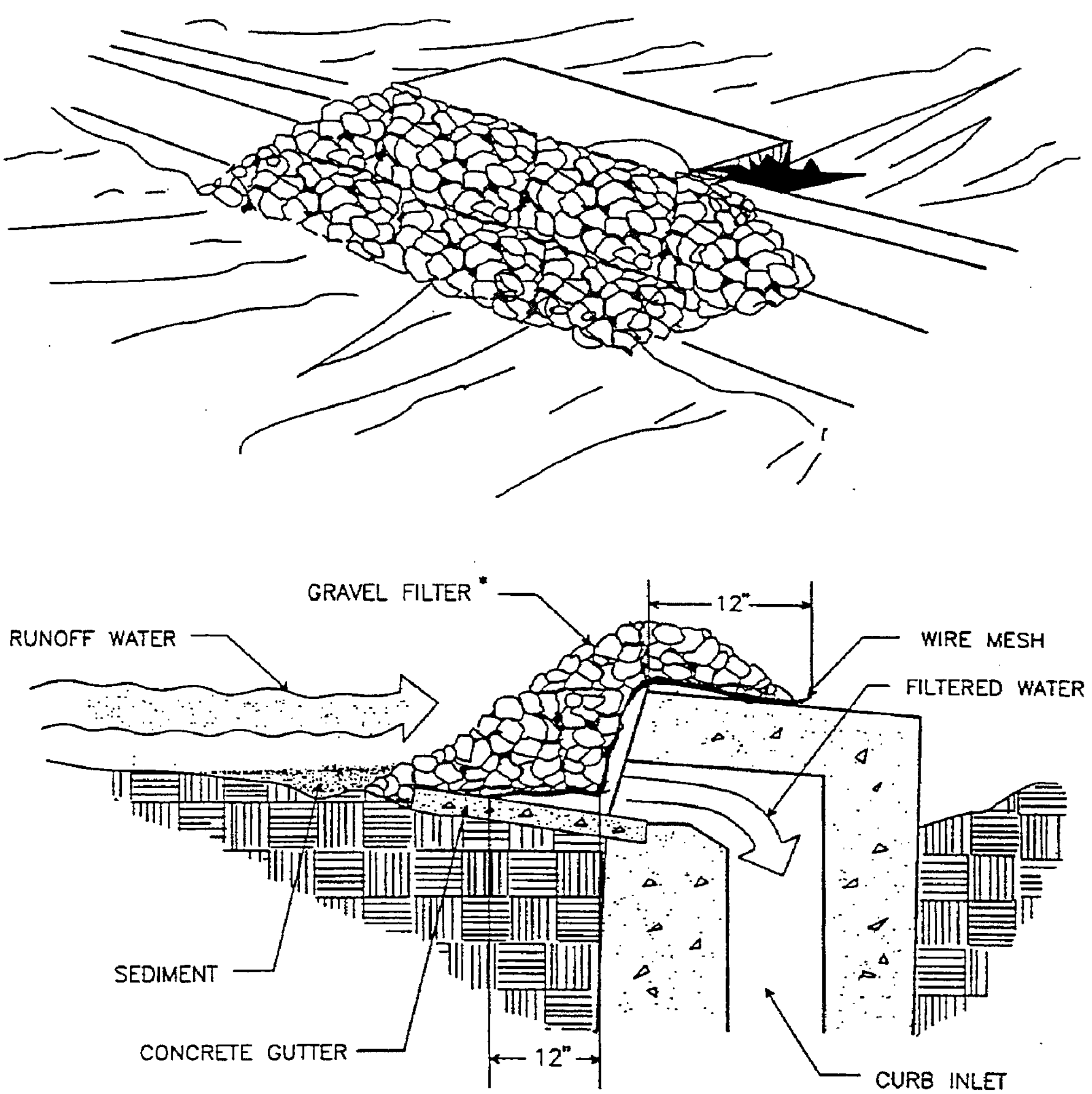
Source: Virginia DSWC

Gravel Curb Inlet Sediment Filter

1. *Hardware cloth or comparable wire mesh with ½ inch (13 mm) openings shall be placed over the curb inlet opening so that at least 12 inches (30 cm) of wire extends across the top of the inlet cover and at least 12 inches (30 cm) of wire extends across the concrete gutter from the inlet opening (see* ***Figure 4.5g****).*
2. *Stone shall be piled against the wire so as to anchor it against the gutter and inlet cover and to cover the inlet opening completely. FDOT No. 1 Coarse Aggregate shall be used.*
3. *An overflow weir can be constructed of 2 x 4 inch (5 x 10 cm) boards to lessen ponding from this practice (see* ***Figure 4.5h****).*
4. *If the stone filter becomes clogged with sediment so that it no longer adequately performs its function, the stone must be pulled away from the block, cleaned, and replaced.*

Block and Gravel Curb Inlet Sediment Filter

1. *Two concrete blocks shall be placed on their sides abutting the curb at either side of the inlet opening (see* ***Figure 4.5i****).*
2. *A 2 x 4 inch (5 x 10 cm) board shall be cut and placed through the outer holes of each spacer block to help keep the front blocks in place.*
3. *Concrete blocks shall be placed on their sides across the front of the inlet and abutting the spacer blocks (see* ***Figure 4.5j****).*
4. *Wire mesh shall be placed over the outside vertical face (webbing) of the concrete blocks to prevent stone from being washed through the holes in the blocks. Hardware cloth with ½ inch (13 mm) openings shall be used.*
5. *FDOT No. 1 Coarse Aggregate shall be piled against the wire to the top of the barrier.*



Specific Application

This method of inlet protection is applicable at curb inlets where ponding in front of the structure is not likely to cause inconvenience or damage to adjacent structures and unprotected ares.

* Gravel Shall be VDOT #3, #357, or #5 Coarse Aggregate.

Figure 4.5g. Gravel Curb Inlet Sediment Filter

Source: Virginia DSWC

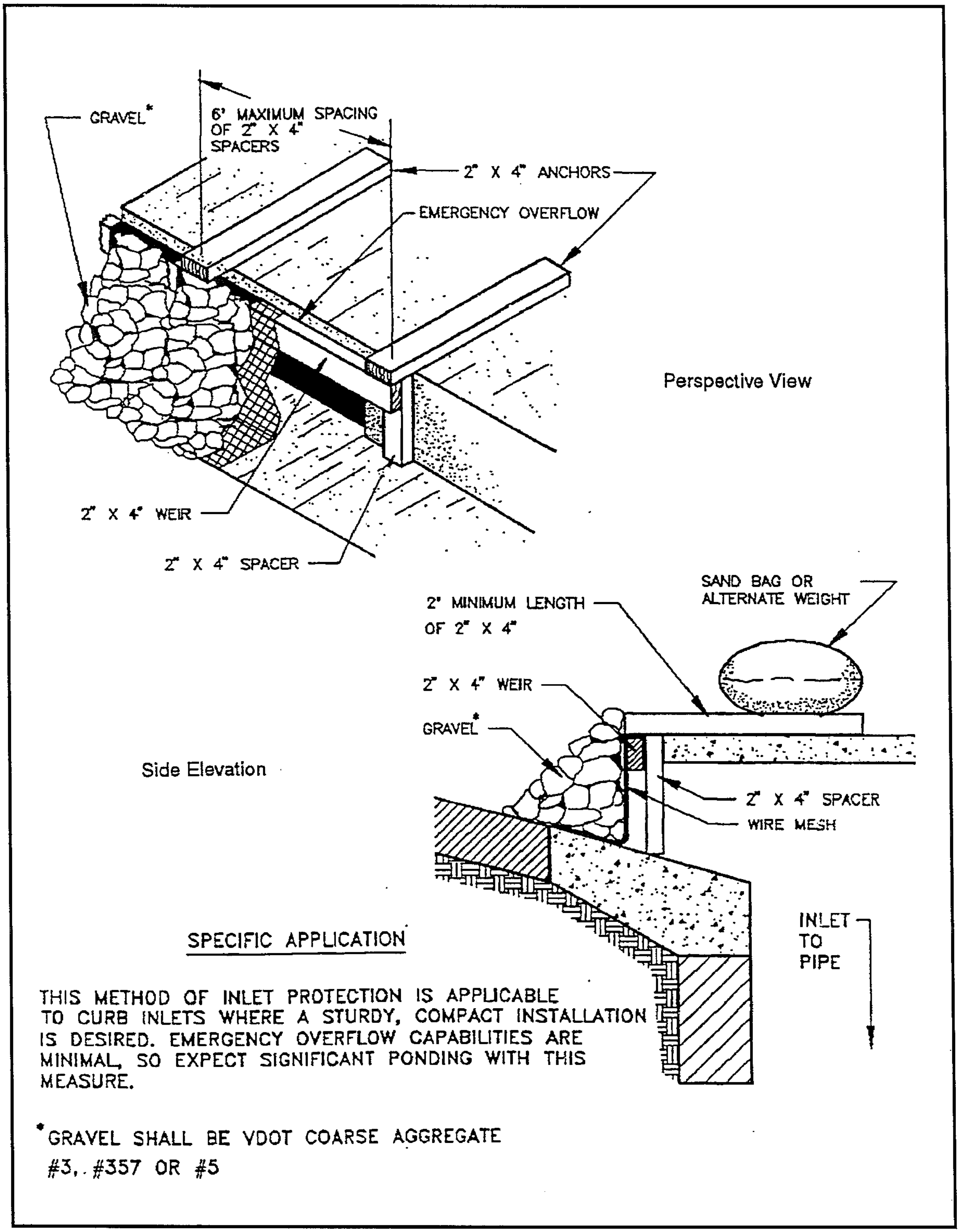
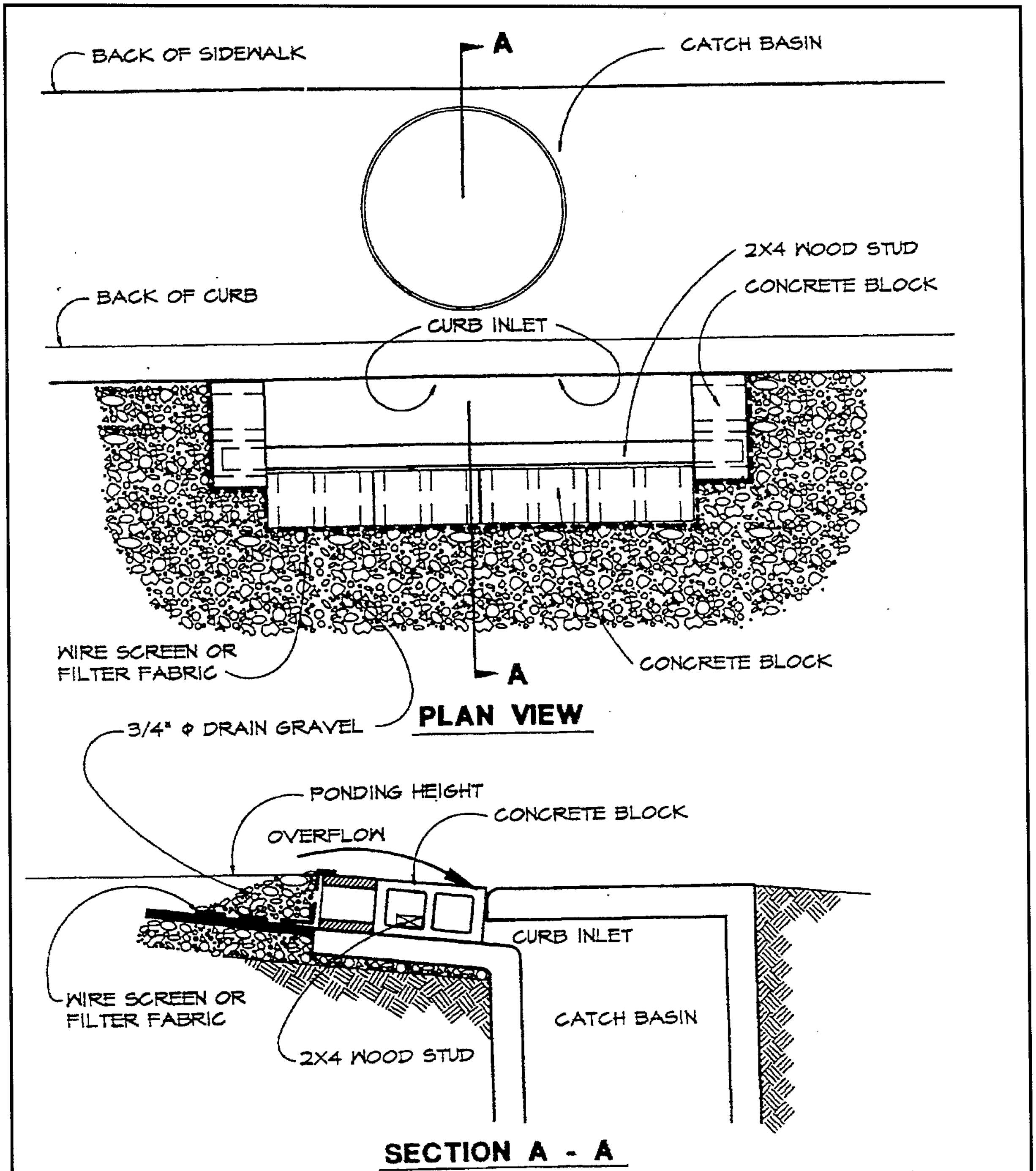


Figure 4.5h. Gravel Curb Inlet Sediment Filter with Overflow Weir

Source: Maryland Standards and Specifications for Soil Erosion and Sediment Control



NOTES:

1. USE BLOCK AND GRAVEL TYPE SEDIMENT BARRIER WHEN CURB INLET IS LOCATED IN GENTLY SLOPING STREET SEGMENT, WHERE WATER CAN POND AND ALLOW SEDIMENT TO SEPARATE FROM RUNOFF.
2. BARRIER SHALL ALLOW FOR OVERFLOW FROM SEVERE STORM EVENT.
3. INSPECT BARRIERS AND REMOVE SEDIMENT AFTER EACH STORM EVENT. SEDIMENT AND GRAVEL MUST BE REMOVED FROM THE TRAVELED WAY IMMEDIATELY.

Figure 4.5i. Block and Gravel Curb Inlet Sediment Barrier

Source: Erosion Draw

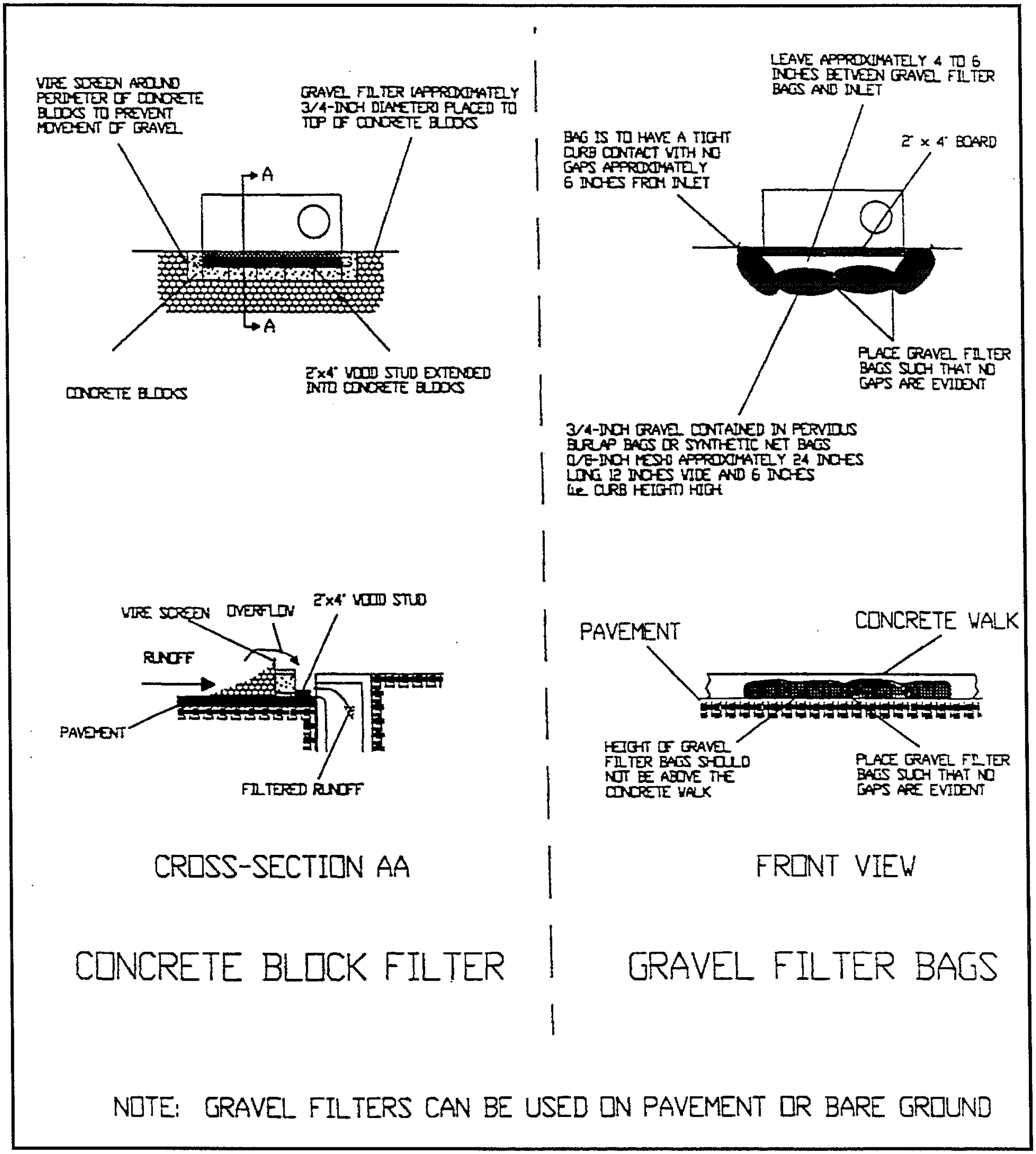
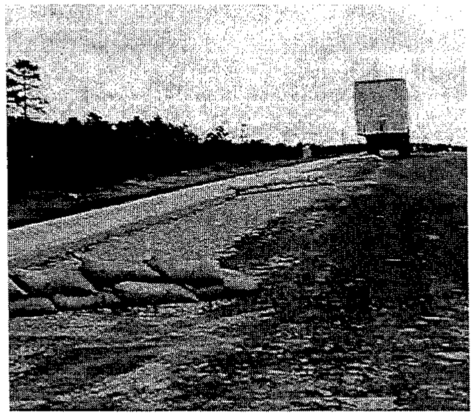


Figure 4.5j. Curb Inlet Gravel Filters

Source: HydroDynamics, Inc.

6. *If the stone filter becomes clogged with sediment so that it no longer adequately performs its function, the stone must be pulled away from the block, cleaned, and replaced.*
7. *As an alternative, gravel-filled burlap bags may be stacked tightly around the curb inlet (see* ***Figures 4.5k*** *and* ***4.5l****).*

Curb and Gutter Sediment Barrier



1. *Place gravel-filled burlap bags on gently sloping street segments according to the spacing chart (see* ***Figure 4.5m****).*
2. *Place two or more bags at each interval in a manner that provides maximum support.*
3. *When stacking several bags high, leave a one-bag gap to provide an overflow spillway (see* ***Figure 4.5m****).*
4. *Sediments must be removed after each rain event.*

Maintenance

1. *The structure shall be inspected after each rain and repairs made as needed.*
2. *The sediment shall be removed and the trap restored to its original dimensions when the sediment has accumulated to one-half of the design depth of the trap. The removed sediment shall be deposited in a suitable area and in such a manner that it will not erode.*
3. *Structures shall be removed and the area stabilized when the remaining drainage area has been properly stabilized.*

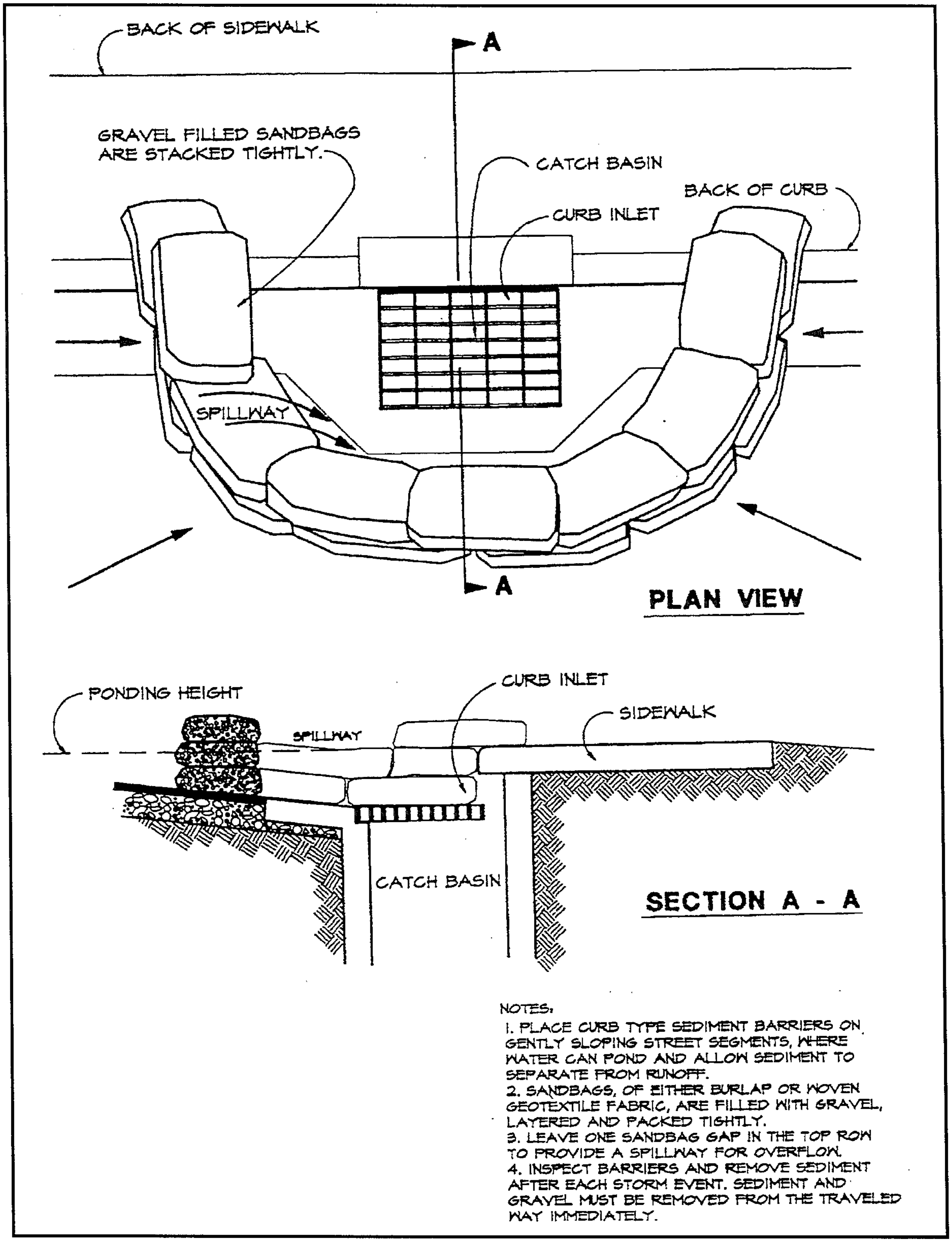


Figure 4.5k. Curb Inlet Sediment Barrier

Source: Erosion Draw

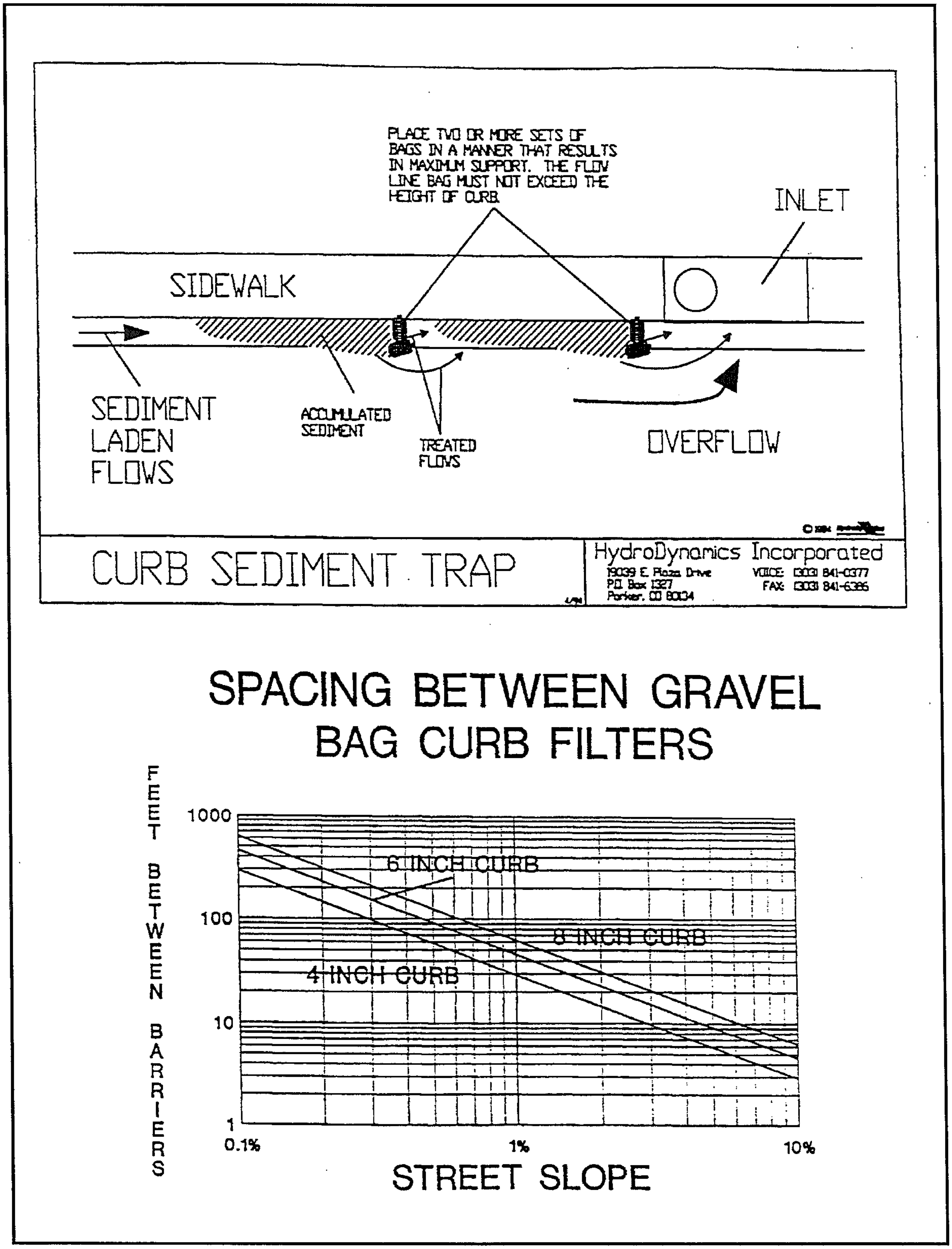
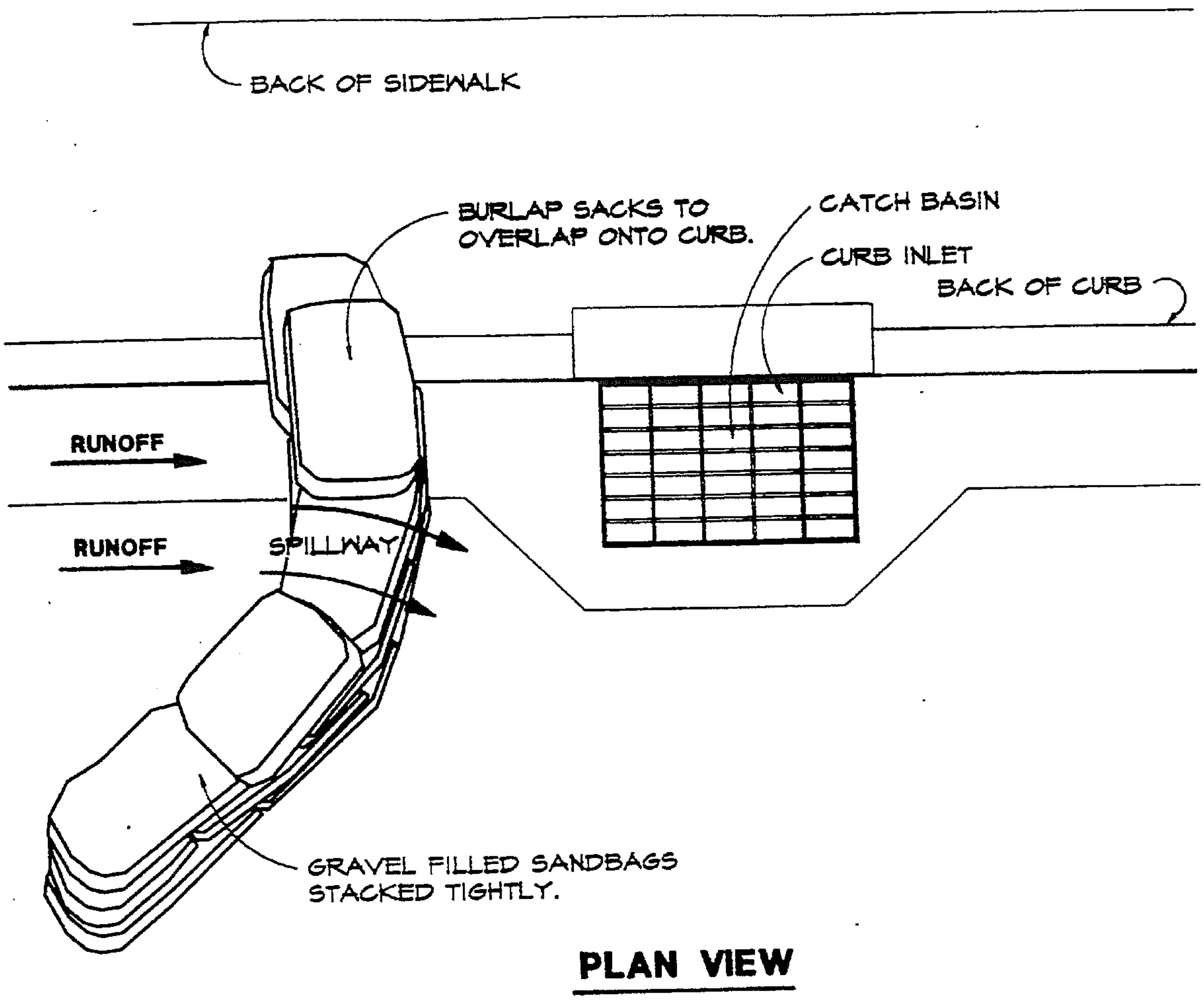


Figure 4.5l. Gravel Bag Curb Sediment Filters

Source: HydroDynamics, Inc.



NOTES:

1. PLACE CURB TYPE SEDIMENT BARRIERS ON GENTLY SLOPING STREET SEGMENTS, WHERE WATER CAN POND AND ALLOW SEDIMENT TO SEPARATE FROM RUNOFF.
2. SANDBAGS OF EITHER BURLAP OR WOVEN 'GEOTEXTILE' FABRIC, ARE FILLED WITH GRAVEL LAYERED AND PACKED TIGHTLY.
3. LEAVE A ONE SANDBAG GAP IN THE TOP ROW TO PROVIDE A SPILLWAY FOR OVERFLOW.
4. INSPECT BARRIERS AND REMOVE SEDIMENT AFTER EACH STORM EVENT. SEDIMENT AND GRAVEL MUST BE REMOVED FROM THE TRAVELED WAY IMMEDIATELY.

Figure 4.5m. Curb and Gutter Sediment Barrier

Source: Erosion Draw