Gmail

Miriam DeFant <mdefant.shutesbury@gmail.com>

Request for Revision to Order of Conditions for Lock Pond Road Culvert Replacement (DEP FILE #286-0279)

1 message

Matthew Styckiewicz <mstyckiewicz@nitscheng.com> Thu, Aug 17, 2023 at 9:08 PM
To: Miriam DeFant <mdefant.shutesbury@gmail.com>, Shutesbury Conservation Commission <concom@shutesbury.org>
Cc: "Echandi, Alexandra (FWE)" <alexandra.echandi@state.ma.us>, Town Administrator <townadmin@shutesbury.org>, Select Board <selectboard@shutesbury.org>, Scott Mercier <SMercier@masbuildingandbridge.com>

Good Evening,

I am writing on behalf of the Town of Shutesbury to formally request a revision to the Order of Conditions for the Locks Pond Road Culvert Replacement, DEP File #286-0279. The Town is also formally notifying the Commission that there will be an increase to the size of the temporary bypass pipe in the Contractor’s previously approved Control of Water plan. Finally, the Town is requesting an extension to the existing Order of Conditions.

The Town is requesting a revision to General Condition No. 6 in the Order of Conditions issued on November 12, 2020 and amended on July 7, 2023.

The referenced condition requires that work in the resource areas be performed during a “period of low flow” between August 1 and September 30. On July 7, 2023 this condition was revised to allow work to be performed in the 100-foot Adjacent Upland Resource Area (AURA) outside of the time of year (TOY) restrictions, but the TOY restrictions still apply to wetland resource areas.

Due to the above average rainfall in June and July which has resulted in higher than anticipated flow conditions at the site, construction in the wetland resource areas was not able to begin on August 1 as planned. The soonest that construction could resume (pending design and approval of the increased bypass) is currently September 4th. The anticipated timeframe to complete the work within the wetland resource areas is six to eight weeks, which if started in September would extend beyond the current TOY restrictions. In order to complete the project this year the Town is requesting that the TOY restrictions be revised to allow work to be performed in the wetland resource areas up until November 17.

The intent of the TOY restrictions, as we understand, was for the culvert replacement to be performed during the least flow conditions, which has always been our stated intent for this project. Unfortunately, the anticipated period of low flow did not occur as expected. The alternative to extending the TOY restrictions would be to delay the project an additional year. There is considerable risk to delaying the project, most notably, the risk to public safety by allowing the existing culvert to remain in poor condition an additional year. There are also other unnecessary impacts that could be avoided such as repaving then re-excavating the site next year, clearing any re-growth next year, and leaving existing erosion controls in place throughout the year. Delaying the project would also add considerable costs to the project.

As mentioned above, resuming construction in September will also be contingent on the approval of the change to the temporary bypass system. The design of the new bypass pipe is currently being finalized by the Contractor and the Contractor’s Hydraulic Engineer. We anticipate receiving the revised Control of Water Plan showing the new bypass in the next few days and will provide the documents to the Commission as soon as they are available. The new Control of Water Plan will utilize the same approach as before; A gravity fed bypass pipe will be installed adjacent to the existing culvert to temporarily divert the stream out of the existing culvert. Previously, the bypass was to consist of two 18” diameter pipes capable of handling a stream flow of 19 cubic feet per second. The proposed bypass will instead consist of a single 48” diameter pipe capable of handling a flow upwards of 40 cubic feet per second. The increased capacity will greatly reduce the risk of flooding, reduced the need to operate emergency pumps, and reduce the velocity of the water in the bypass.

The Town is also requesting an extension to the Order of Conditions. We understand that the current OOC will expire on November 12, 2023. The Town in requesting an additional 3-year extension from the date of expiration. The extension will allow for additional time to complete construction this year as well as 3 years to monitor the newly established natural stream bed for erosion or sedimentation, or for re-seeding and re-vegetation of the embankments if they are not fully established immediately following construction.

I am copying MassWildlife's Natural Heritage & Endangered Species Program (NHESP) to inform them of this request and allow them to review the request as a minor project change per their previous guidance regarding a change to the OOC for this project.

We appreciate your consideration of this request and hope that it can be included on the soonest available agenda.

Thank you,

Matt

Matthew Styckiewicz, PE | Project Manager

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August 10, 2021
Revised August 21, 2023

Mr. Tom Fantoni
MAS Building & Bridge, Inc.
18 Sharon Avenue
Norfolk, MA, 02056

Subject: **Locks Pond Road Bridge Replacement**
Control of Water Plan
Shutesbury, Massachusetts
Pare Project No.: 21139.00

Dear Mr. Fantoni:

Please find the attached design information for the Control of Water submittal to support the proposed repairs to the bridge over the Sawmill River along Locks Pond Road in Shutesbury, Massachusetts. Included with the letter are:

1. Plans
2. Bulk Bag Cofferdam Design Calculations
3. Pipe Flow Capacity Calculations
4. Scour Calculations
5. Stream Flow Calculations

REVISION NOTES

As part of this revision Pare offers the following notes:

1. Per the recommendation of the Project Design Engineer, and as stated by MAS in an email dated July 27, 2023, the control of water design has been updated to accommodate flows up to 40 cfs at the Locks Pond Road Bridge Replacement site.
2. MAS has requested that the design assume a 30 cfs normal flow and be designed to accommodate up to 40 cfs without overtopping.

GENERAL METHODOLOGY

The following section describes the general methodology used to determine the parameters required to develop this control of water plan.

Survey

Elevation information was obtained from the project drawings and documentation.

In general, the channel elevation at the upstream limits of the work area varied between 822.0 and 822.5. The channel elevation at the downstream limits of the work area was near elevation 821.2.

The Lake Wyola Dam (MA00510) is located approximately 130-feet upstream of the project site. The dam has a toe elevation of approximately 826.0 feet, a spillway elevation of 830.8 feet, a top of dam elevation of 834.0 feet, and a low level outlet invert elevation of 822.87 feet. The low-level outlet is an approximately 35-inch diameter PVC conduit.

Flow Requirements

Based on Section/Item 991.1 of the specifications and the Order of Conditions (DEP File #286-0270) from the Shutesbury Conservation Commission the dewatering system shall be "capable of re-routing the typical base flow through the adjacent dam of 8 cubic feet per second, with a contingency plan to increase the capacity of the dewatering system in the event of higher than expected seasonal flow or a large storm event". *Given the increased rainfalls observed in Shutesbury this year, MAS requested that the dewatering system instead be designed to pass a higher base flow of 30 cfs with a contingency of 10 cfs, for a combined total capacity of 40 cfs.*

According to the Streamstats regression equations for the site the average expected 50% duration flows are 6.8 cfs year-round and 2.5 cfs for the month of August.

MAS intends to cofferdam the river to elevation 825.33 feet and install a pipe by-pass system to accommodate the required flows. With one 48-inch ID double wall corrugated HDPE pipe (54-inch OD, ADS pipe), the dewatering system is expected to be able to handle 40 cfs of flow without overtopping the cofferdam. This will allow for approximately 0.44 feet of freeboard at the base flow of 30 cfs and 0.01 feet of freeboard at the design flow of 40 cfs. Beyond these flow rates the cofferdam can be expected to overtop and flood the work area.

Flow Rate (cfs)	Peak Water Surface El. (ft.)	Freeboard (ft)
8	823.70	1.63
30	824.89	0.44
40	825.32	0.01
244 (2-yr storm event)	826.51	-1.18

Cofferdam elevations were set to limit upstream water surface elevations to 826.5 during the 2-year storm event to limit the development of a tailwater along the Lake Wyola Dam. Additional details on elevation determination are stated in the "Upstream Cofferdam Elevation" section of this letter.

Upstream Cofferdam Elevation

Channel surface elevations in the proposed location of the upstream cofferdam vary between 822.0 and 822.5 feet. It was assumed that bulkbags used to create the cofferdam could be filled such that they would measure 2'-8" tall, by 3'-0" wide, by 3'-0" deep. Only filling to 2'-8" tall fills the bag with less material than it can hold, allowing the bag to conform to the channel and the bags surrounding.

Pare modeled the capacity of the pipes in HydroCAD (Version 10.20-3c). As per the ADS Drainage Handbook, a Manning's "n" value of 0.012 was used when modeling flow through the pipes. Based on the alignment of the by-pass system, as shown on Sheet 2, the overall length of the pipes was assumed to be approximately 186 feet. Within the alignment of the pipe there are three proposed 45-degree bends. Based on Pare's interpolation of the attached reference for equivalent lengths for pipe fittings, an equivalent length of 168.9 feet has been assumed[1] for all the bends in a single pipe, resulting in an

[1] Note that the provided reference is for copper piping which has a Manning's coefficient of 0.011, similar to that of the HDPE

effective pipe length of 354.9 feet and an assumed slope of 0.00282 ft/ft. The resulting upstream water elevations were compared to proposed cofferdam elevations.

Using available survey data included within the project plans, Pare modeled the capacity of the downstream riverbed in HydroCAD (Version 10.20-3c) to evaluate tailwater conditions at the bypass pipe outlet. Two sections of riverbed were modeled, and it was determined that the section immediately downstream of the proposed riprap scour protection to be the critical riverbed section with the least capacity. From this analysis, Pare determined the downstream tailwater elevations under a variety of flow conditions. Under normal flow conditions (30 cfs or less), Pare determined that the downstream tailwater elevation was 821.71 ft. Under design flow conditions (40 cfs), Pare determined that the downstream tailwater elevation was 821.83 ft. Under the 2-year storm event flows, it is expected that the downstream channel would overtop the surveyed bank and a downstream tailwater of 825 feet was assumed for the 2-year storm event condition.

An upstream cofferdam elevation of 825.33 feet has been established. Note that when flows exceed 40 cfs it is likely that there is limited time (less than 1 hour) before the cofferdam would be subject to overtopping. In the event of a significant storm event overtopping of the cofferdam will occur. The upstream cofferdam elevation has been set in part to allow for overtopping of the cofferdam for events up to the 2-year storm event without creating an upstream pool that would form a significant tailwater on the upstream dam. As such the elevation of the Sawmill River during a 2-year event is estimated to be 826.50 feet. In reviewing available survey of the upstream areas, it appears that the toe of the downstream slope for the Lake Wyola dam is near 826.5 feet. Further impacts to the discharge capacity of the dam were not evaluated.

2-year storm flow events were taken as defined in the StreamStats regression equations for the site.

At this elevation, all cofferdam configurations have a factor of safety against sliding of 2.0 or greater and the resultant force is within the middle-third indicating that all configurations are stable against overturning. If bottom of cofferdam elevations are below that stated within these procedures Pare must be contacted to re-evaluate the cofferdam configuration in those areas.

Pipe Alignment

Based on a 48-inch diameter ADS pipe the overall pipe length will be approximately 186 feet. With an invert elevation of no higher than 822.5 and an outlet elevation of no higher than 821.5 the pipe will have an average slope of approximately 0.00282 ft/ft. It is estimated that six 22.5-degree bends will be required for the pipe. If available, bends up to 45-degrees may be used. Pipes must maintain a constant downward slope from upstream to downstream; however a steeper slope than the average 0.00282 ft/ft is permissible.

Note that pipe lengths are approximate based on the proposed alignment shown on the attached drawings. Changes in slope and/or pipe location will affect the overall length of the pipe. Pipe lengths as presented herein shall only be used for estimating overall quantities required.

Pipe Burial and Thrust Resistance

After passing through the upstream cofferdam the by-pass pipe is proposed to be buried along the alignment. Several sections of pipe may be exposed depending on natural grades through the in-field pipe

pipe. Additionally the assumed equivalent length of 112.6 feet is for a single mitered 60 degree bend, which has been assumed to be roughly equivalent to three 22.5 degree bends.

alignment. Exposed sections of pipe shall be anchored as detailed at pipe joints. Pipe anchoring may consist of three bulk bags along the same alignment with one bag along each side of the pipe and a single bag set atop the pipe. If the pipe exhibits deflection from the bag set atop the pipe, a plate may be laid across the top of the pipe or material removed from the bag until deflection is negligible.

At buried bends along the alignment of the proposed 48-inch diameter pipe a two 2.5'x 2.5'x5' concrete blocks or three sand filled bulk bags can be placed for thrust resistance.

Pipes must be buried with a minimum of 12-inches of material to support up to H-25 loading. Backfill must be either Class I material or Class II material compacted to no less than 90% of the modified proctor value. For descriptions on fill classes see the table below.[2]

AVERAGE VALUES OF MODULUS OF SOIL REACTION, E' (FOR INITIAL FLEXIBLE PIPE DEFLECTION)					
	PIPE BEDDING MATERIALS	E' FOR DEGREE OF COMPACTION OF PIPE ZONE BACKFILL (PSI)			
SOIL CLASS	SOIL TYPE (Unified Classification System[a])	Loose	Slight < 85% Proctor, < 40% relative density	Moderate 85% - 95% Proctor, 40% - 70% relative density	High > 95% Proctor, > 70% relative density
Class V	Fine-grained Soils (LL>50)[b] Soils with medium to high plasticity CH, MH, CH-MH	No data available; consult a competent soils engineer; Otherwise use E' = 0			
Class IV	Fine-grained Soils (LL < 50)Soils with medium to no plasticity CL, ML,ML-CL, with less than 25% coarse-grained particles	50	200	400	1,000
Class III	Fine-grained Soils (LL < 50)Soils with medium to no plasticity CL, ML,ML-CL, with more than 25% coarse-grained particles 1004001,0002,000 Coarse-grained Soils with Fines GM, GC, SM, SCC contains more than 12% fines	100	400	1,000	2,000
Class II	Coarse-grained Soils with Little or No Fines GW, GP, SW, SPC contains less than 12% fines	200	1,000	2,000	3,000
Class I	Crushed Rock	1,000	3,000	3,000	3,000
	Accuracy in Terms of Percentage Deflection	±2	±2	±1	±0.5

Flow into Work Area

During preparation of this Control of Water Plan, three potential sources of water infiltration to the work area were identified: seepage under the upstream/downstream cofferdams, seepage into the excavation, and overland flow from precipitation events. To address seepage under the cofferdams, Pare completed a seepage model in the Seep/w module of GeoStudio (version 11.1.0.22070). Using available subsurface information provided in the drawing set, Pare modeled the seepage expected to flow under the cofferdam. Pare modelled the effects of extending an impermeable membrane (i.e. polyethylene sheet) 20-feet upstream of the cofferdam to provide cutoff capacity. In general, at the base of the cofferdam a seepage rate of 0.0015 cfs/ft of cofferdam was calculated assuming a maximum water surface elevation of 825 feet. With a cofferdam length of approximately 50 feet exposed to excavation, the estimated inflow from seepage under the cofferdam is 34 gpm (this value is acceptable for use on the downstream cofferdam as well).

It is assumed that runoff water from the site will be limited due to the small footprint of the site. If drains from exiting roadway drainage structures remain active during construction, pipes with couplings should be attached and run to the upstream or downstream cofferdams and discharge flows directly into the Sawmill River should be handled by the by-pass system.

Pare recommends that MAS have a variety of 2- and 3-inch diameter sumps onsite capable of pumping and discharging the stated flows. At a minimum, sumps shall be placed at 20-foot intervals within the drainage trenches as shown on the plans.

[2] "Depth of Burial for PVC Pipe", Technical Bulletin, JM Eagle, January 2009.

Pare recommends that MAS have on-site 3 additional 2-inch diameter pumps to handle flows more than those calculated or to supplement pumps in areas of concentrated flow. The excavation of small diversion trenches or sandbag barriers (see Cofferdam Detail C-1) to collect surface waters and divert flow towards unwatering trenches and pumps may be required and should be completed by MAS at their discretion based on channel surface elevations and the exact location of outfalls.

Groundwater during Excavations

See "Flow into Work Areas" for expected groundwater flows.

Seepage & Slope Stability

Utilizing data from the existing boring logs provided in the Contract Drawings, soil properties were developed for the in-situ soils using references which correlate blow count data from SPT sampling with geotechnical properties of soil. These properties were used to develop a seepage and slope stability model of the proposed cofferdam geometry. Seepage rates were calculated assuming a drainage trench along the base of the cofferdam and base of the excavation and results are presented in the "Flow into Work Areas" section of this letter. Drainage trenches were installed at these locations to reduce the water pressure on the excavation slope and lower the groundwater table below the bottom of excavations. Slope stabilities were calculated utilizing the pore water pressures developed in the seepage models. Factors of safety for slope stability above 1.2 were considered acceptable for temporary construction conditions. Critical to maintaining the presented slope stabilities are the following conditions:

- The excavated slope can be no steeper than 2H:1V.
- Drainage trenches must be installed as shown on the dewatering plans.

Scour Considerations

During an overtopping event it can be expected that flow will slowly rise above the cofferdam and spill onto the downstream toe of the cofferdam. This process will be a slow progression and it is expected that the work area will flood to the tailwater elevation prior to the development of significant flows. Based on an estimated flood elevation of 2-inches above the cofferdam it will take less than 30 minutes to flood the work area. The presence of a tailwater will limit the development of scour forces. However, to deal with initial overtopping reinforced polyethylene sheets lined with M2.02.2 riprap extending 4 feet beyond the toe of the cofferdam will be sufficient to prevent scour at the toe of the cofferdam. MAS will also implement actions within the Construction Flood Contingency Plans (under a separate cover). Once the work area has been flooded, risk of scour is reduced.

Scour Force Calculations were based upon two methodologies: Veronese (1973) and Schoklitsch (1932). The Veronese method is based solely upon the differential height between the upstream and downstream water elevations and flow, while the Schoklitsch method considers the size of the subgrade within the scour area. During the start of a flood event the downstream side of a cofferdam is "in the dry" and as such would be the point at which the scour energy is at its greatest. However, overtopping flows will increase slowly allowing for the work area to flood and a tailwater to develop. As the tailwater develops the differential height between the overtopping flow and the tailwater will reduce and in turn reduce the potential scour depth. As noted in the preceding paragraph the time in which the excavation is anticipated to be filled with water is assumed to occur prior to extensive scour forces being able to develop. Based on this methodology, should overtopping occur or be about to occur, it is recommended that MAS use available riprap on-site to line the downstream side of both cofferdams.

The calculations performed are for overtopping flows at the cofferdam, soils to the left and right of the cofferdam will still be subject to scour from flows due to overland flows. To avoid scour related to overland flow MAS shall follow the notes set forth in the Construction Flood Contingency section of the Contract Drawings and General Notes sheet.

At the outlet of the proposed 48-inch bypass pipe, 6-to-8-inch riprap will need to be placed 8 feet long by 12 feet wide to address initial discharge from the pipes. Following that distance, the natural river channel bedding will be sufficient to resist discharge velocities given expected elevated tailwater conditions at the point of discharge. If existing channel bedding meets these requirements additional riprap is not needed. If riprap is not available, MAS can used rubber tire blast mats at the pipe outfalls.

CONTROL OF WATER PROCEDURES

The descriptions and sequences for the construction of the anticipated control of water elements can be found on Sheet 1.0 General Notes of the attached drawings. Sequences include installation of the bulk bag temporary cofferdams, installation of sumps for water control within the cofferdams, and the removal of the installed control of water systems at the completion and acceptance of the work.

Material Notes

The attached calculations were completed using the following materials. If MAS plans to use other materials to complete the work the materials shall at a minimum meet the product specifications for these materials. If it cannot be confirmed or it is known that the proposed product does not meet the minimum specifications of the stated items, then Pare shall be contacted to review the calculations with the material properties of the proposed products.

1. By-Pass Pipe:
    a. All double wall corrugated pipe to be HDPE push fitting meeting ADS N-12 ST IB.
    b. All pipe to have an inside diameter of 48-inches.
    c. All solid wall HDPE to be PE2XXX, PE3XXX or PE4XXX pipe.
2. Bulk Bags
    a. All Bulk Bags to be as Manufactured by Mutual Industries, Inc. or equal.
    b. All Bulk Bags to have a 5:1 Safety Factor.

MONITORING PROCEDURES

During the progression of the project the site will be exposed to a variety of environmental, meteorological, and man-made conditions. The site foreman or superintendent should inspect the cofferdam at the beginning of each shift. Prior to using the cofferdam, any damaged portions or potentially hazardous conditions within the cofferdam should be remedied. Potential hazards to look for include, but are not limited to:

- Piping or boiling water rising from the ground surface within the cofferdam area;
- Displacement/gaps between super sack sandbag sections of the cofferdam;
- Sliding or leaning sections of the cofferdam;
- Rips in sandbags that are allowing or have the potential to allow the contents to spill out (on lower sections this could result in destabilization of stacked bags);
- Rips in polyethylene sheeting (reducing the cutoff ability of the cofferdam system);
- Increased river flow and/or forecasted flows;
- Increased amounts of water within the cofferdam area;
- Increased discharge rates of dewatering pumps without a change in river flow conditions;

- Debris within the cofferdam area;
- Change in any of the above conditions due to construction induced vibrations; and
- Contractor equipment striking the cofferdam.

Conditions that may lead to heightened levels of monitoring include, but are not limited to:

- Weather forecasts indicating precipitation events; and
- Upstream dam owners discharging elevated amounts of water (MA00510 Lake Wyola Dam, owned by the Town of Shutesbury) in response to or anticipation of a significant rainfall event or to implement a winter drawdown.

The Contractor should be aware of these events and how they relate to rising water levels. Throughout the duration of the project, water levels and the effects of varying water levels on the cofferdam should be monitored. Modifications made to the cofferdam should be logged and reported to the Engineer.

The Owner of the Lake Wyola dam is the Town of Shutesbury. In the event of an emergency that may impact the dam, the primary contact is the Town Administrator, Ms. Becky Torres, who can be reached at 413-259-1214.

The Operator of the Lake Wyola dam is the Lake Wyola Advisory Committee. The primary contact is Mr. Mark Rivers and can be reached at 413-367-9945. The dam keeper is Mr. Howard Kinder and can be reached at 413-367-9515.

Please call us at 508-543-1755 if you have questions or need additional information.

Sincerely,

PARE CORPORATION

COMMONWEALTH OF MASSACHUSETTS
DAVID R. CAOUETTE
CIVIL
No. 54023
REGISTERED
PROFESSIONAL ENGINEER

David R. Caouette, P.E.
Managing Engineer

PLANS AND NOTES

SHEET 1: General Notes
SHEET 2.0: Site Plan
SHEET 3.0: Cofferdam Details

UP/DOWNSTREAM BULKBAG COFFERDAM INSTALLATION:

A BULKBAG COFFERDAM WILL BE USED UPSTREAM AND DOWNSTREAM OF THE BRIDGE TO ALLOW FOR DRY WORKING CONDITIONS. BULKBAG COFFERDAM INSTALLATION SHALL BE AS FOLLOWS:

1. THE BULKBAG SACKS WILL CONSIST OF 3-FOOT WIDE BY 3-FOOT LONG BY 2-FOOT 8-INCH (MAX.) TALL, WOVEN POLYPROPYLENE, BAGS FILLED WITH A UNIFORM SAND OR SAND GRAVEL FILL THAT HAS A MINIMUM UNIT WEIGHT OF 115 POUNDS PER CUBIC FOOT.
   a. BAGS SHOULD NOT BE FILLED SUCH THAT THEIR HEIGHT EXCEEDS 2-FEET 8-INCHES, AS THIS WILL FILL THE BAG TO CAPACITY AND WILL LIMIT THE ABILITY OF THE BAG TO CONFORM TO THE CHANNEL SURFACE AND/OR THE SURROUNDING BAGS.
   b. IF NECESSARY, TO ACHIEVE SHAPE TO FIT, BAGS MAY BE FILLED LESS THAN THE STATED DIMENSIONS; HOWEVER, EXCESS BAG MATERIAL MUST BE CAREFULLY PULLED TAUNT AND FOLDED OVER TO CREATE A UNIFORM SURFACE FOR ADJACENT BAGS TO CONTACT.
   c. IF BAGS ARE FILLED TO LESS THAN THE STATED DIMENSIONS UP TO ONE ADDITIONAL VERTICAL BAG MAY BE PLACED TO ACHIEVE THE STATED ELEVATIONS FOR ANY GIVEN COFFERDAM CONFIGURATION.
2. PRIOR TO PLACING BULKBAGS THE CONTRACTOR SHALL REMOVE DEBRIS, IN SO MUCH AS POSSIBLE, TO PROVIDE A UNIFORM CHANNEL BOTTOM ALONG THE COFFERDAM ALIGNMENT.
3. IF REQUIRED, DUE TO UNEVEN CHANNEL SURFACE, THE BULKBAG CAN BE PLACED ON A CUSHION OF STANDARD 14 INCH BY 26-INCH WOVEN POLYETHYLENE SANDBAGS. SANDBAGS SHALL BE PLACED SUCH THAT A CONTINUOUS SURFACE IS CREATED. THE SANDBAG CUSHION SHOULD NOT EXCEED 6 INCHES IN HEIGHT.
4. THE UPSTREAM COFFERDAM SHALL HAVE A TOP ELEVATION OF 825.33 FEET TO ALLOW FOR AT LEAST 5.0-INCHES OF FREEBOARD TO BE MAINTAINED, BASED ON A 13,465 GPM (30 CFS) REQUIRED BASE FLOW RATE. THE COFFERDAM BAG CONFIGURATION SHALL FOLLOW THE TABLE ON SHEET 3.0.
5. THE BULKBAGS MUST BE STACKED IN CONFIGURATIONS AS SHOWN ON THE CONTROL OF WATER PLANS UNLESS OTHERWISE SUBMITTED AND APPROVED BY PARE.
6. BULKBAGS SHALL BE PLACED ABUTTING ONE ANOTHER SUCH THAT THERE ARE NO GAPS BETWEEN THE BAGS.
7. UPPER BULKBAG ROWS SHALL BE OFFSET HALF A BAG FROM SUPPORTING ROW, SUCH THAT VERTICAL SEEMS DO NOT ALIGN.
8. REINFORCED POLYETHYLENE SHEETS SHALL BE PLACED FROM 4 FEET BEYOND THE DOWNSTREAM TOE OF THE BULK BAGS, UP AND OVER THE COFFERDAM, AND DOWN ALONG THE CHANNEL BOTTOM AND SHALL EXTEND AT LEAST 20 FEET INTO THE CHANNEL. THE PERIMETER OF THE POLYETHYLENE SHEETS SHALL BE WEIGHED DOWN WITH SANDBAGS PLACED SIDE BY SIDE.
   a. ALTERNATIVELY, THE UPSTREAM END OF THE POLYETHYLENE SHEET MAY BE TOED INTO THE CHANNEL VIA EXCAVATION AND BACKFILL.
   b. SEAMS IN REINFORCED POLYETHYLENE SHEETS SHOULD BE ORIENTED IN THE LEFT/RIGHT DIRECTION NOT UPSTREAM/DOWNSTREAM.
   c. SEAMS SHOULD OVERLAP A MINIMUM OF 5 FEET WITH THE UPSTREAM SHEET ON TOP OF THE DOWNSTREAM SHEET.
   d. A CONTINUOUS LINE OF SANDBAGS SHALL BE PLACED ON THE UPSTREAM AND DOWNSTREAM ENDS OF THE OVERLAPPED SECTIONS.
9. WHEN SETTING THE BULK BAG COFFERDAM AGAINST A SLOPE, THE CONTRACTOR SHALL SET THE BULK BAGS TO AT LEAST ELEVATION 825.33. POLYETHYLENE SHEETING SHALL EXTEND TO AT LEAST ELEVATION 827.0 ALONG THE CHANNEL SLOPES. IF TREES ARE PRESENT, THE POLYETHYLENE SHEET SHOULD BE CUT AND SANDBAGS INSTALLED AROUND THE TREE AND ATOP THE CUT SEAM. THE POLYETHYLENE SHEETS SHALL CONTINUE ALONG THE SLOPE FOR AT LEAST 20 FEET UPSTREAM OF THE END OF BULK BAGS.
10. THE POLYETHYLENE SHEETS SHALL BE INSTALLED WITH ENOUGH SLACK AT CORNERS AND POTENTIAL HARD POINTS SO THAT WHEN WATER PRESSURE IS APPLIED THE SLACK IS SUFFICIENT TO MOLD TO THE BACKSTOP SURFACE. IF ENOUGH SLACK IS NOT GIVEN THE SHEET MAY TEAR AND ALLOW WATER THROUGH THE SHEET, COMPROMISING THE COFFERDAM.
11. MAS MUST MONITOR ACTUAL FLOW DEPTHS WITHIN THE CHANNEL, WIND AND WAVE ACTION CONDITIONS, COFFERDAM SETTLEMENT, STORM CONDITIONS, AND OTHER MONITORING REQUIREMENTS IDENTIFIED WITHIN THE FLOOD CONTINGENCY PLAN. IF A STORM THAT WOULD RESULT IN A HIGHER WATER LEVEL WITHIN THE CHANNEL IS FORECASTED, IT IS RECOMMENDED THAT THE AREA BEHIND THE COFFERDAM BE EVACUATED OF ALL PERSONNEL, EQUIPMENT, AND MATERIALS.
12. MAS WILL MONITOR THE PERFORMANCE OF THE COFFERDAM FOR THE DURATION OF ITS USE, SPECIFICALLY FOR INDICATIONS OF MOVEMENT OR INCREASED LEAKAGE.
   a. IF MOVEMENT, INCREASED LEAKAGE, OR ANY OTHER CONDITION INDICATING POTENTIAL FAILURE OF THE COFFERDAM SYSTEM IS OBSERVED, MAS WILL ADDRESS THE ISSUE BEFORE RETURNING TO WORK.
   b. A SITE SUPERINTENDENT FROM MAS WILL INSPECT THE COFFERDAM AT THE START OF EACH WORKING DAY TO DETERMINE IF THERE IS DAMAGE TO THE COFFERDAM OR IF ANY MODIFICATIONS ARE REQUIRED.
   c. PERSONNEL WORKING WITHIN THE COFFERDAM WILL BE INSTRUCTED TO REPORT ANY DAMAGE OR CHANGE IN CONDITIONS OF THE COFFERDAM PERFORMANCE.
   d. IF THE BULKBAG COFFERDAM IS STRUCK BY EQUIPMENT OR IS DAMAGED DURING CONSTRUCTION ACTIVITIES, THE COFFERDAM ELEMENT SHALL BE INSPECTED, REPAIRED OR REPLACED PRIOR TO CONTINUING WORK.

COFFERDAM INSTALLATION

THE FOLLOWING SEQUENCE DESCRIBES THE PROPOSED METHOD OF INSTALLING THE COFFERDAM:

1. EXCAVATE THE ROADWAY TO THE REQUIRED ELEVATIONS AND SET THE BURIED SECTIONS OF BY-PASS PIPE AND TRUST BLOCKS.
2. BACKFILL THE PIPE WITH CLASS II FILL TO 92% OF THE MODIFIED PROCTOR VALUE OF THE FILL MATERIAL.
3. PLACE SANDBAGS IN THE DOWNSTREAM CHANNEL TO REDIRECT STREAM FLOWS AND ALLOW THE PARTIAL INSTALLATION OF THE DOWNSTREAM RIPRAP APRON.
4. INSTALL THE DISCHARGE SECTIONS OF BY-PASS PIPE IN THE DOWNSTREAM CHANNEL. ALIGN THE DISCHARGE PIPE TO DIRECT FLOWS ALONG THE PARTIALLY CONSTRUCTED RIPRAP APRON.
5. ON THE UPSTREAM SIDE SET THE SANDBAG CUSHION BEGINNING FROM NORTH TO SOUTH ACROSS THE CHANNEL. AS SANDBAG CUSHION PROGRESSES SET THE FIRST ROW OF BULK BAG SACKS ATOP THE CUSHION UNTIL THE BYPASS PIPE LOCATION HAS BEEN REACHED.
6. SET A BED OF SMALL SANDBAGS TO A MAXIMUM ELEVATION OF 822.5 BENEATH THE PROPOSED PIPE ALIGNMENT. THE INVERT OF THE BY-PASS PIPE SHALL BE NO HIGHER THAN ELEVATION 822.5.
7. CONSTRUCT/INSTALL THE INLETS FOR THE ADS PIPE AND SET IN PLACE WITHIN THE RIVER CHANNEL AND WITHIN THE UPSTREAM COFFERDAM. FLOOD THE PIPE AND ANCHOR INTO PLACE WITH BULK BAGS PLACED AS NEEDED ALONG THE DOWNSTREAM SECTIONS TO PREVENT MOVEMENT.
8. ONCE THE PIPE IS SET IN PLACE, HAND PACK SANDBAGS AROUND THE PIPE WITHIN THE FOOTPRINT OF THE COFFERDAM. DUE TO THE CORRUGATED EXTERIOR OF THE ADS PIPE, FILLING OF THE CORRUGATIONS WITH OAKUM OR OTHER WATERTIGHT SEALANT MATERIAL WILL BE REQUIRED TO ADEQUATELY SEAL THE PIPE AGAINST THE SANDBAGS.
9. ONCE THE PIPE IS ANCHORED CONTINUE CONSTRUCTING THE FIRST LINE OF BULK BAGS ACROSS THE CHANNEL, THEN SET THE SECOND ROW OF BULK BAGS ATOP THE INTAKE PIPE TO ANCHOR THE PIPE. MAS MAY ELECT TO CONSTRUCT THE COFFERDAM OF SIMILIAR GEOMETRY TO THE A OR B BAG CONFIGURATIONS FROM SMALL SAND BAGS ALONG THE SLOPE AS THE TOP OF COFFERDAM ELEVATION IS BEING APPROACHED.
10. IF THE UPSTREAM DAM OWNER ALLOWS A HIGHER COFFERDAM ELEVATION, CONTINUE EXTENDING THE SECOND ROW OF BULK BAGS BEYOND THOSE USED TO ANCHOR THE PIPE INTAKE.
11. INSTALL POLYETHYLENE SHEETING UPSTREAM OF THE COFFERDAM. WHEN INSTALLING THE PIPE THE POLYETHYLENE SHEETING SHALL BE CUT TO ALLOW THE PIPE PENETRATION. SUFFICIENT SLACK SHOULD BE PRESENT AROUND THE SHEETING TO ALLOW FOR SOME OVERLAP ON THE PIPE IN THE UPSTREAM DIRECTION. SANDBAGS SHALL THEN BE PLACED AROUND THE UPSTREAM SIDE OF THE SHEETING TO FORM A SEAL AGAINST THE PIPE. IF EXCESS LEAKAGE CONTINUES, MAS MAY CUT AND FIT A NEOPRENE GASKET (OR OTHER CLOSED CELL/SOLID MATERIAL) AROUND THE PIPE TO BE PLACED BETWEEN THE UPSTREAM SIDE OF THE POLYETHYLENE SHEETS AND THE HAND PACKED SAND BAGS.
12. ONCE THE COFFERDAM HAS BEEN INSTALLED AND FLOWS ARE CONTROLLED, INSTALL SUMP PITS/PUMPS AT 20-FOOT SPACING ALONG THE DOWNSTREAM SIDE OF THE COFFERDAM WITHIN THE NORMAL RIVER CHANNEL. CONNECTING THE SUMP PITS WITH A SHALLOW CRUSHED STONE TRENCH MAY BE BENEFICIAL IF WATER CONTINUES TO SEEP THROUGH THE SANDBAGS BETWEEN SUMP PITS.

COFFERDAM INSTALLATION <CONT.>

13. INSTALL THE DOWNSTREAM COFFERDAM BY PLACING A SINGLE ROW OF BULK BAGS ACROSS THE CHANNEL. AT THE BY-PASS PIPE LOCATION INSTALL A BED OF SMALL SANDBAGS AND SET THE BY-PASS PIPE.
14. ONCE INSTALLED HAND PACK SAND BAGS AROUND THE BY-PASS PIPE.
15. INSTALL POLYETHYLENE SHEETING AND INSTALL RIPRAP SCOUR PROTECTION AT THE PIPE OUTFALL AS SHOWN ON THE DRAWINGS.
16. IT IS RECOMMENDED THAT PRIOR TO STARTING/COMPLETING THE COFFERDAM INSTALLATION. MAS INSTALL THE POLYETHYLENE SHEETING UNDER LOW FLOW CONDITIONS WHERE PRACTICAL. PRIOR TO COFFERDAM INSTALLATION FLOW WILL BE AT A SHALLOWER MORE MANAGEABLE LEVEL OF ±3 FEET. IN AREAS WHERE PE SHEETING CANNOT BE INSTALLED PRIOR TO COFFERDAM INSTALLATION, A DIVER MAY BE REQUIRED TO INSTALL THE SHEETING AFTER WATER LEVELS RISE. IF NECESSARY THE PIPE INTAKE CAN BE TEMPORARILY BLOCKED TO ACCOMMODATE A DIVER. IF THE PIPE IS BLOCKED MAS WILL NEED TO MONITOR THE RIVER ELEVATIONS TO PREVENT COFFERDAM OVERTOPPING.
17. THE PIPE SHALL REMAIN UNOBSTRUCTED AT BOTH THE INTAKE AND DISCHARGE AREAS ACROSS THE FULL DIAMETER. NO DEBRIS GUARDS, FILTERS, OR SCREENS SHALL BE INSTALLED.
18. COFFERDAM LOCATIONS AS SHOWN ON SHEET 2.0 ARE INTENDED TO BE GENERAL IN NATURE. THE CONTRACTOR SHALL RESERVE THE RIGHT TO CHANGE THE ALIGNMENT OF THE PIPE AS NEEDED TO MEET FIELD CONDITIONS. CHANGES IN ALIGNMENT SHALL BE REPORTED TO PARE TO ASSESS FOR CHANGES IN FLOW CAPACITY.

REMOVAL OF WATER CONTROLS

REMOVAL OF COFFERDAMS WILL BE AS FOLLOWS:

1. REMOVE ALL EQUIPMENT, MATERIALS, AND CONSTRUCTION DEBRIS WITHIN COFFERDAM AFTER WORK HAS BEEN COMPLETED AND ACCEPTED.
2. REMOVE THE DEWATERING BASINS.
3. REMOVE AND FILL SUMPS AND FLOOD THE COFFERDAM AREA.
4. REMOVE THE DOWNSTREAM COFFERDAM PROGRESSING FROM THE SOUTH SIDE OF THE CHANNEL TO THE NORTH.
5. REMOVE THE TOP LAYER OF SANDBAGS FROM THE UPSTREAM COFFERDAM PROGRESSING FROM THE SOUTH SIDE OF THE CHANNEL TO THE NORTH.
6. REMOVE THE DISCHARGE PIPE TO THE STREAM SLOPE. RESET SANDBAGS AS NEEDED TO ISOLATE PIPE SECTION IN THE CHANNEL SLOPES FOR EXCAVATION AND REMOVAL.
7. REMOVE THE INTAKE PIPE TO THE STREAM SLOPE AND ALLOW FLOW THE RETURN TO THE CHANNEL. RESET SANDBAGS AS NEEDED TO ISOLATE PIPE SECTION IN THE CHANNEL SLOPES FOR EXCAVATION AND REMOVAL.
8. EXCAVATE AND REMOVE THE BURIED SECTIONS OF BY-PASS PIPING. BACKFILL THE ROADWAY EMBANKMENT IN ACCORDANCE WITH PROJECT SPECIFICATIONS.
9. REMOVE THE TEMPORARY SANDBAGS USED TO REDIRECT RIVER FLOWS DURING PIPE REMOVAL.
10. REMOVE THE REMAINING COFFERDAM COMPONENTS PROGRESSING FROM THE EAST SIDE OF THE CHANNEL TO THE WEST.

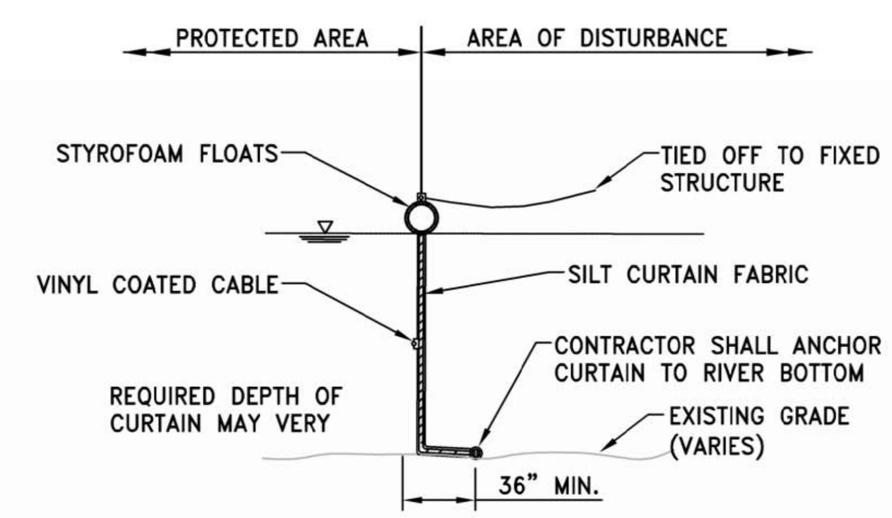
UNWATERING WITHIN INSTALLED COFFERDAMS

UNWATERING SUMP PITS AND SANDBAG/POLYETHYLENE DIVERSION SWALES WILL BE CONSTRUCTED TO COLLECT AND REMOVE WATER THAT ENTERS THE WORK AREA BY MEANS OF SEEPAGE AROUND THE COFFERDAM, RAINFALL, AND STORMWATER DISCHARGE FROM THE SURROUNDING AREA. THE PURPOSE OF THE SUMP PIT IS TO REMOVE WATER FROM THE WORK AREA. IT IS ANTICIPATED THAT WATER ENTERING THE WORK AREA VIA THE PREVIOUSLY MENTIONED MEANS WILL BE PUMPED BACK INTO THE CANAL DIRECTLY FROM THE SUMP LOCATIONS TO ENTER THE BY-PASS SYSTEM, OR BE PASSED INTO THE DOWNSTREAM AREA.

1. SUMP PUMPS SHALL BE INSTALLED WITHIN DRAINAGE TRENCHES LOCATED AT THE BASE OF THE COFFERDAM AND THE TOE OF THE EXCAVATION TO ALLOW BOTH INITIAL REMOVAL OF WATER WITHIN THE COFFERDAM AND CONTINUED REMOVAL OF WATER ENTERING THE COFFERDAM THROUGH LEAKS, SEEPS, STORM RELATED RAINFALL, AND GROUNDWATER.
   a. IT IS ESTIMATED THAT 0.0015 CFS PER FOOT OF DRAINAGE TRENCH ALONG THE BASE OF THE COFFERDAM (APPROXIMATELY 34 GPM) WILL SEEP THROUGH THE SOILS BENEATH THE UPSTREAM COFFERDAM IF THE WATER REACHES THE TOP OF COFFERDAM ELEVATION.
2. SUMP PUMPS WILL CONSIST OF 2-INCH AND 3-INCH SUBMERSIBLE PUMPS PLACED IN 1-FOOT WIDE BY 24-INCH TO 36-INCH DEEP TRENCHES FILLED WITH CRUSHED STONE.
   a. IF REQUIRED (DUE TO EXCESSIVE FINE SEDIMENT OR DEBRIS INTAKE), THE CONTRACTOR SHALL ENCLOSE THE PUMP IN A PERFORATED PIPE SURROUNDED BY CRUSHED STONE.
   b. SUMPS SHALL BE PLACED AS SHOWN ON THE PLANS.
   c. THE PLAN CALLS FOR 6, 2 OR 3-INCH DIAMETER SUMPS (CAPABLE OF 370 GPM) AT THE UPSTREAM COFFERDAM AND EXCAVATION, AND 2, 2- OR 3-INCH DIAMETER PUMPS CAPABLE OF 120 GPM AT THE DOWNSTREAM COFFERDAM. MAS SHALL BE PREPARED TO MOBILIZE ADDITIONAL 2-INCH PUMPS AS NEEDED TO MEET POTENTIAL INFLOWS.
3. ONCE GROUNDWATER FLOWS HAVE STABILIZED THE SUMPS WILL BE COLLECTING FILTERED GROUNDWATER THAT HAS ENTERED THE WORK AREA AND WAS COLLECTED IN DRAINAGE TRENCHES. IT IS ASSUMED THAT THE WATER WILL BE FLOWING CLEAN AND CAN BE PUMPED DIRECTLY BACK TO THE CHANNEL. DEWATERING BASINS ARE NOT ANTICIPATED FOR PUMPING OF GROUNDWATER.
4. DURING INITIAL EXCAVATION AND AFTER PRECIPITATION EVENTS THAT CAUSE EROSION OF EXPOSED SOILS PRETREATMENT WILL LIKELY BE REQUIRED. DISCHARGES FROM PUMPS SHALL BE PUMPED THROUGH DEWATERING BAG(S) OR A HAY/STRAW BALE LINED DEWATERING BASIN PRIOR TO DISCHARGING TO THE UPSTREAM OR DOWNSTREAM CHANNELS.
5. SANDBAG/POLYETHYLENE DIVERSION SWALES SHALL FOLLOW THE C-1 BAG CONFIGURATION AND SHALL BE ERECTED AS NEEDED TO DIVERT SURFACE FLOWS AROUND CRITICAL WORK AREAS OR DIRECT DRAINAGE SYSTEMS THAT ENTER THE WORK AREA TO DRAINAGE TRENCHES.

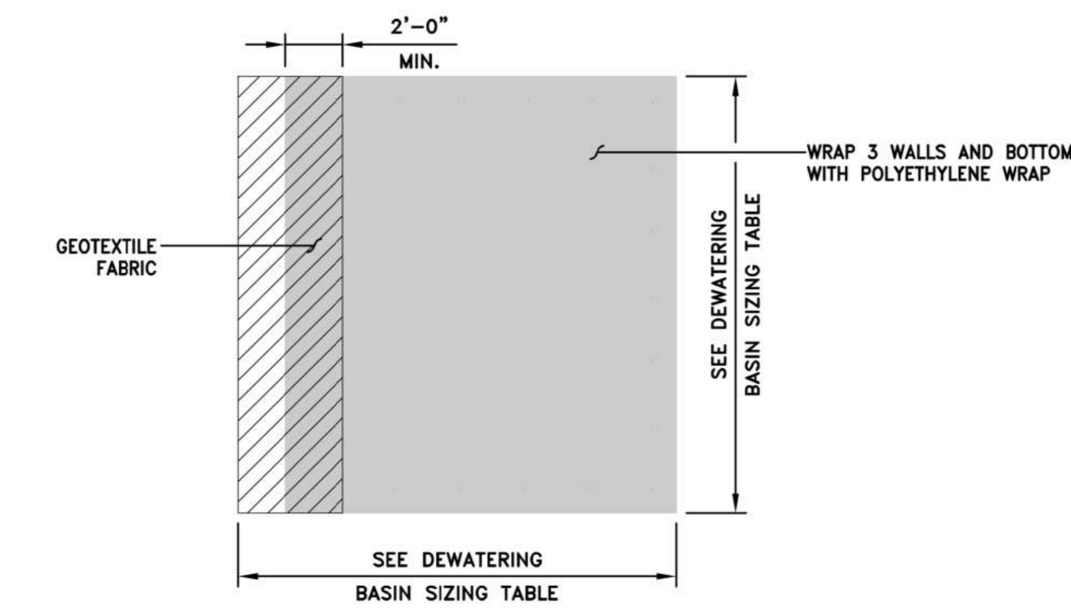
ADDITIONAL COFFERDAM HEIGHT

THE PROPOSED HEIGHT OF ELEVATION 825.33 WILL ALLOW FOR THE TAILWATER POOL TO DEVELOP AT THE DOWNSTREAM TOE OF THE DAM. DUE TO THE LIMITING EFFECTS ADDITIONAL TAILWATER MAY HAVE ON THE DISCHARGE OF THE DAM AND POTENTIAL FLOODING OF ADJACENT RESIDENTIAL PROPERTIES DURING EVENTS LARGER THAN A 2-YEAR STORM, A COFFERDAM HEIGHT ABOVE 825.33 IS NOT RECOMMENDED.

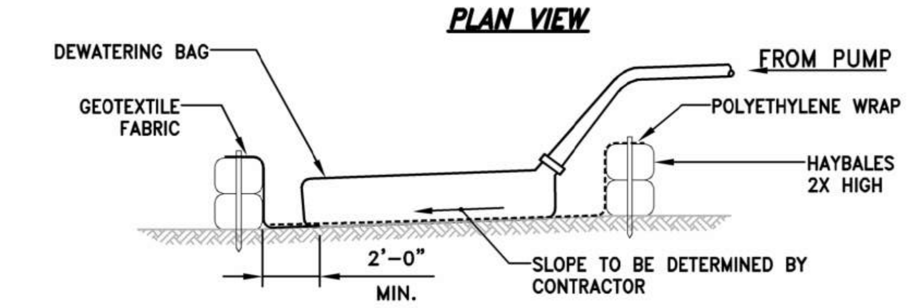


TYPICAL TURBIDITY BARRIER

NOT TO SCALE



PLAN VIEW



SECTION VIEW

NOTES

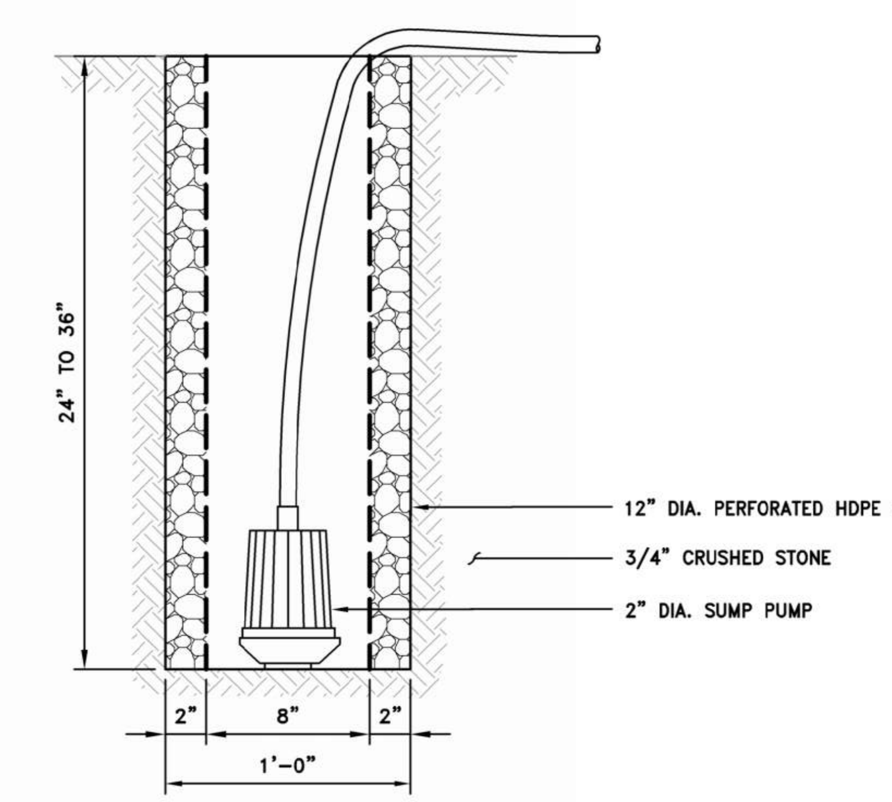
1. IF A DEWATERING BAG IS USED, CONTRACTOR TO PERIODICALLY REPLACE DEWATERING BAG AS NEEDED PER MANUFACTURE RECOMMENDATIONS AND AS FLOW CONDITIONS WARRANT. DEWATERING BAGS SHOULD BE PLACED ON EXPOSED SOIL AND NEED NOT BE PLACED IN HAY/STRAWBALE LINED BASINS.
2. ALTERNATE TO USING A DEWATERING BAG A HAY/STRAW BALE LINED DEWATERING BASIN MAY BE CONSTRUCTED IN ACCORDANCE WITH THE DEWATERING BASIN SIZING TABLE BELOW.
3. IF A HAY BALE LINED DEWATERIN BASING IS USED, CONTRACTOR TO PERIODICALLY REMOVE SILT IN BASIN TO PROMOTE FLOW OF WATER FROM BASIN.

DEWATERING BASIN

NOT TO SCALE

AVG. PUMP RATE	BASIN SIZE
10 GPM	8FT X 9FT
50 GPM	18FT X 18FT
100 GPM	25FT X 26FT
150 GPM	31FT X 32FT
200 GPM	36FT X 36FT

DEWATERING BASIN SIZING TABLE



SUMP DETAIL

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

FOR CONSTRUCTION

PARE CORPORATION

SCALE ADJUSTMENT GUIDE

0" 1"

BAR IS ONE INCH ON ORIGINAL DRAWING.

LOCKS POND ROAD BRIDGE REPLACEMENT

CONTROL OF WATER AT LOCKS POND ROAD

SHUTESBURY, MASSACHUSETTS

PREPARED FOR: MAS BUILDING & BRIDGE

OWNERS:TOWN OF SHUTESBURY - DEPARTMENT OF PUBLIC WORKS

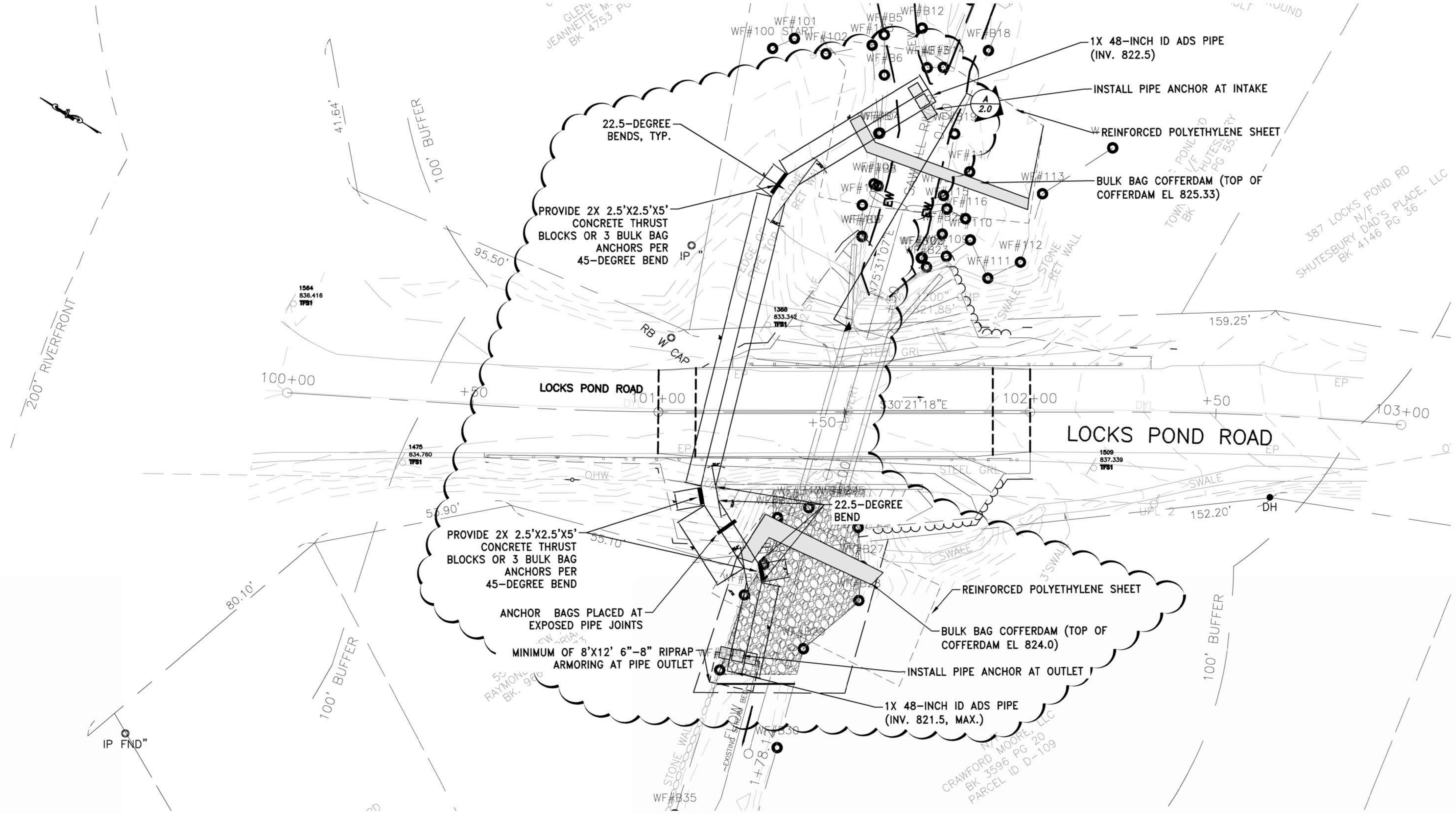
REVISIONS:

1	8-19-21	NOTE UPDATES
2	8-16-23	NOTE UPDATES

PROJECT NO.:	21139.00
DATE:	AUGUST 2023
SCALE:	NOT TO SCALE
DESIGNED BY:	DJM
CHECKED BY:	DRC
DRAWN BY:	LMC
APPROVED BY:	DRC

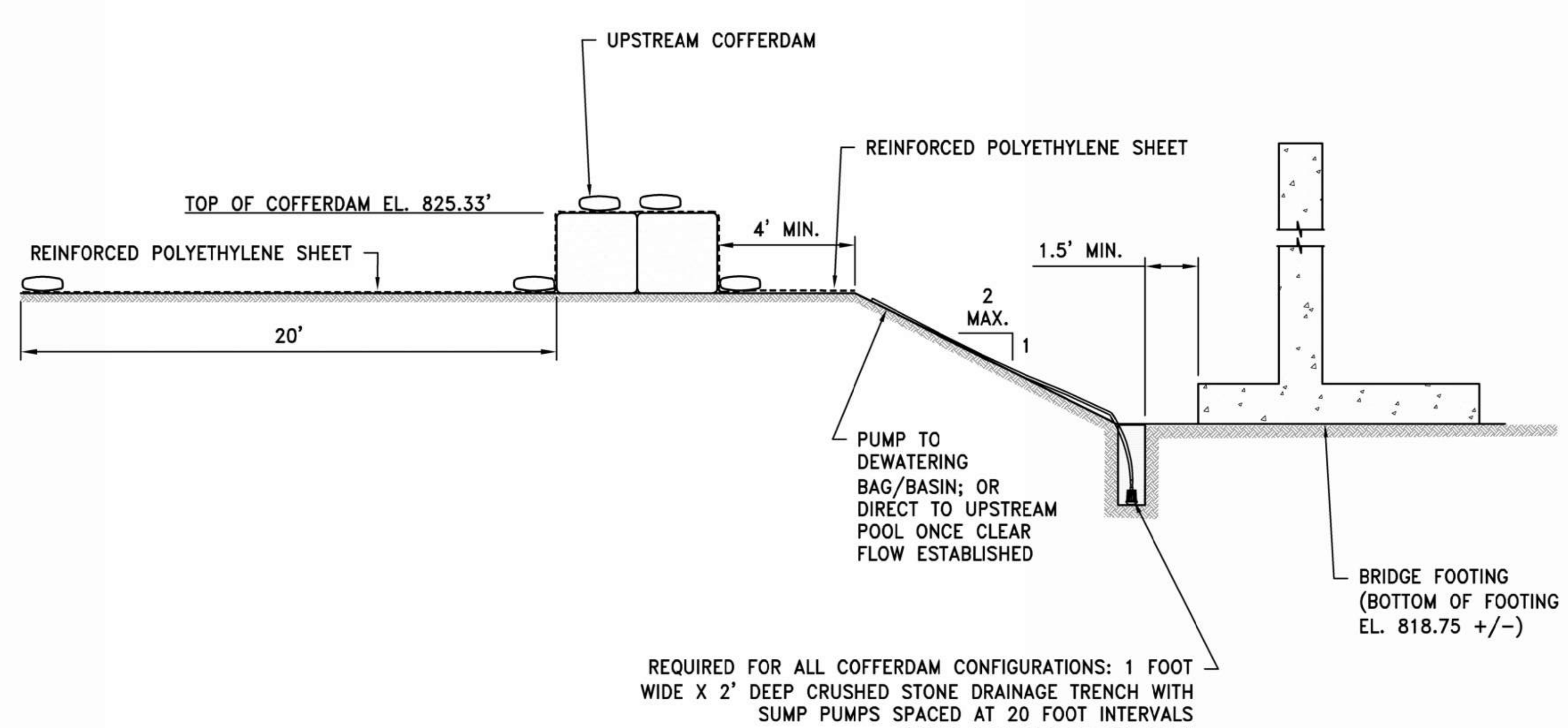
GENERAL NOTES

SHEET NO.: 1.0



CONTROL OF WATER PLAN

SCALE: 1"=20'-0"



A/2.0 ***SECTION A***

SCALE: 1"=5'

NOTES:

1. PIPE TO MAINTAIN A 0.00282 FT/FT DOWNWARD SLOPE FROM THE UPSTREAM TO DOWNSTREAM DIRECTION
2. HDPE PIPE CONNECTIONS ARE TO BE PUSH ON FITTINGS. ALL JOINTS SHALL BE BURIED OR ANCHORED WITH BALLAST BAGS.
3. PIPES TO BE BURIED WITH A MINIMUM OF 1 FOOT OF CLASS I MATERIAL OR CLASS II MATERIAL COMPACTED TO 90% OF THE MODIFIED PROCTOR VALUE TO SUPPORT H-25 LOADING. PIPE SECTIONS NOT MEETING MINIMUM BURIAL CRITERIA SHALL NOT BE TRAVERSED WITH EQUIPMENT.
4. THE SURFACE OF THE CHANNEL SHALL BE EXCAVATED AS NECESSARY TO PROVIDE A SMOOTH SURFACE TO SEAT THE SANDBAGS.
5. THE ALIGNMENT OF THE BYPASS PIPES AND COFFERDAM AS SHOWN ON THIS DRAWING IS INTENDED TO BE GENERAL IN NATURE. PIPE LOCATIONS MAY BE ADJUSTED IN THE FIELD AS SURFACE CONDITIONS PERMIT.
6. BENDS ARE NOT TO EXCEED 22.5-DEGREES AND THRUST BLOCKS OR BULK BAGS SHALL BE INSTALLED AT EACH BEND LOCATION. A SINGLE 5.5'X5.5'X8' CONCRETE BLOCK OR TWO SAND FILLED BULK BAGS WILL PROVIDE SUFFICIENT THRUST RESTRAINT PER A 45-DEGREE BEND.

FOR CONSTRUCTION

PARE CORPORATION

SCALE ADJUSTMENT GUIDE
0" 1"
BAR IS ONE INCH ON ORIGINAL DRAWING.

LOCKS POND ROAD BRIDGE REPLACEMENT

CONTROL OF WATER AT LOCKS POND ROAD

SHUTESBURY, MASSACHUSETTS

PREPARED FOR: MAS BUILDING & BRIDGE

OWNERS:TOWN OF SHUTESBURY - DEPARTMENT OF PUBLIC WORKS

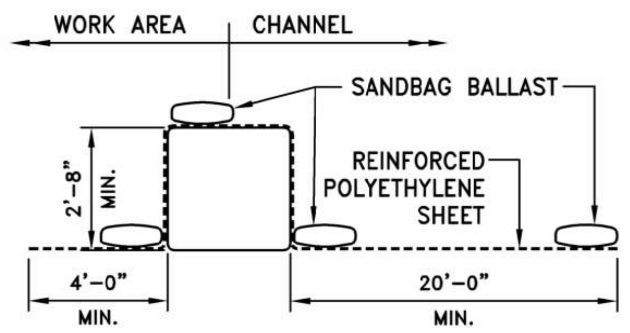
REVISIONS:

1	8-19-21	REVISED BYPASS PIPE ALIGNMENT & D/S DAM
2	8-16-23	REVISED BYPASS PIPE SIZE AND ALIGNMENT

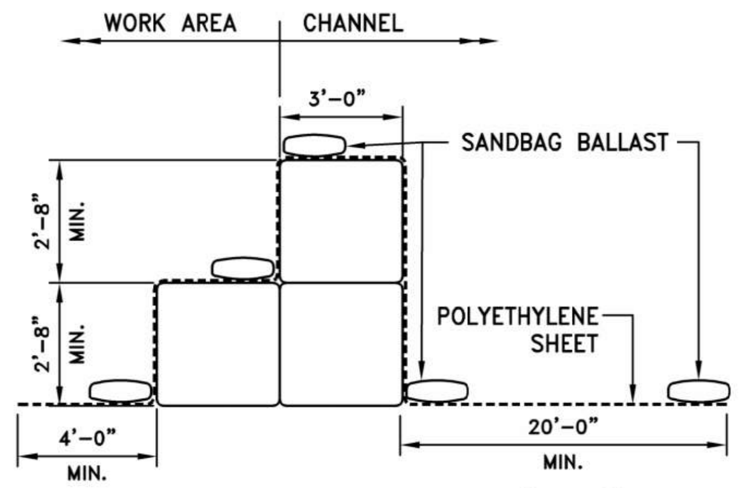
PROJECT NO.:	21139.00
DATE:	AUGUST 2023
SCALE:	NOT TO SCALE
DESIGNED BY:	DJM
CHECKED BY:	DRC
DRAWN BY:	LMC
APPROVED BY:	DRC

CONTROL OF WATER PLAN

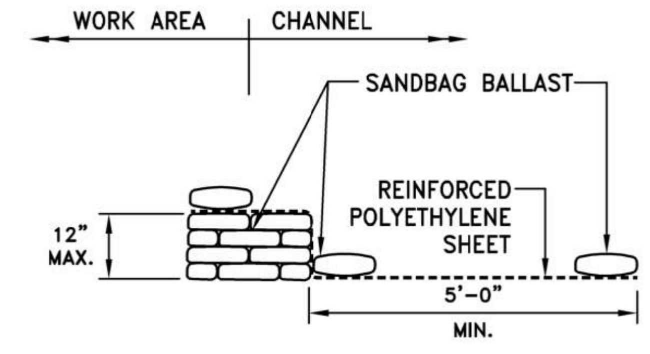
SHEET NO.: 2.0



BAG CONFIGURATION "A-1"



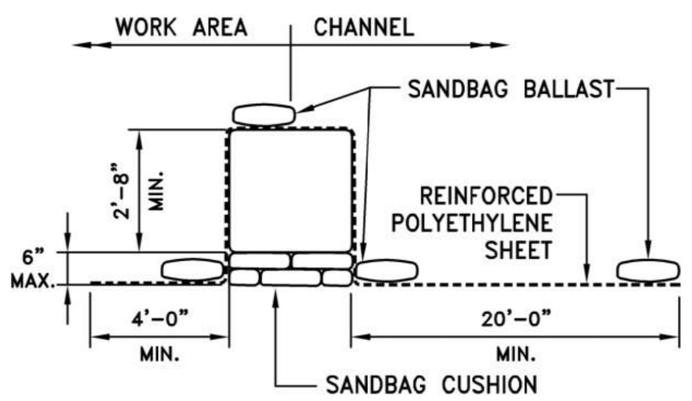
BAG CONFIGURATION "B-1"



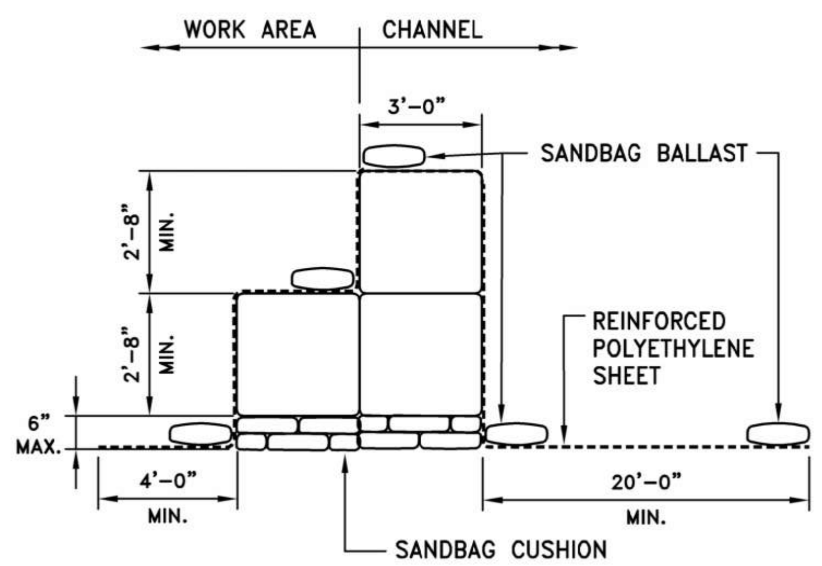
BAG CONFIGURATION "C-1"

UPSTREAM COFFERDAM CONFIGURATION TABLE	
BOTTOM OF CHANNEL ELEVATION	BAG CONFIG.
HIGHER THAN 822.67	A-1, A-2
HIGHER THAN 822.17	A-2
BETWEEN 822.17 & 820.00	B-1, B-2
BETWEEN 820.00 & 819.50	B-2
LOWER THAN 819.50	CONTACT PARE

DOWNSTREAM COFFERDAM CONFIGURATION TABLE	
BOTTOM OF CHANNEL ELEVATION	BAG CONFIG.
HIGHER THAN 821.33	A-1, A-2
HIGHER THAN 820.83	A-2
BETWEEN 820.83 & 818.67	B-1, B-2
LOWER THAN 818.67	CONTACT PARE

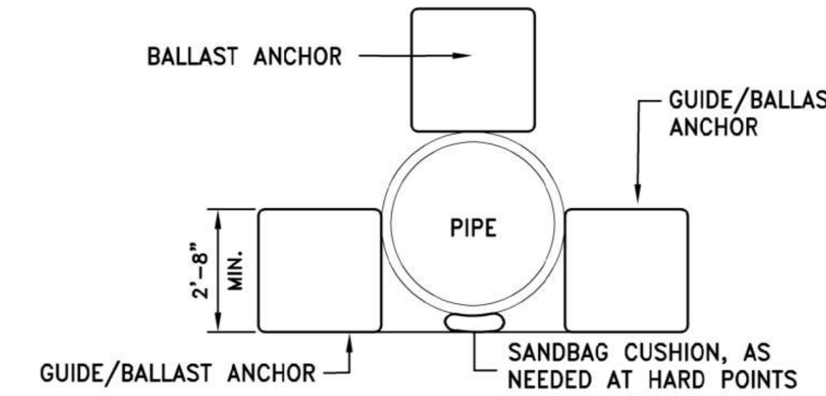


BAG CONFIGURATION "A-2"

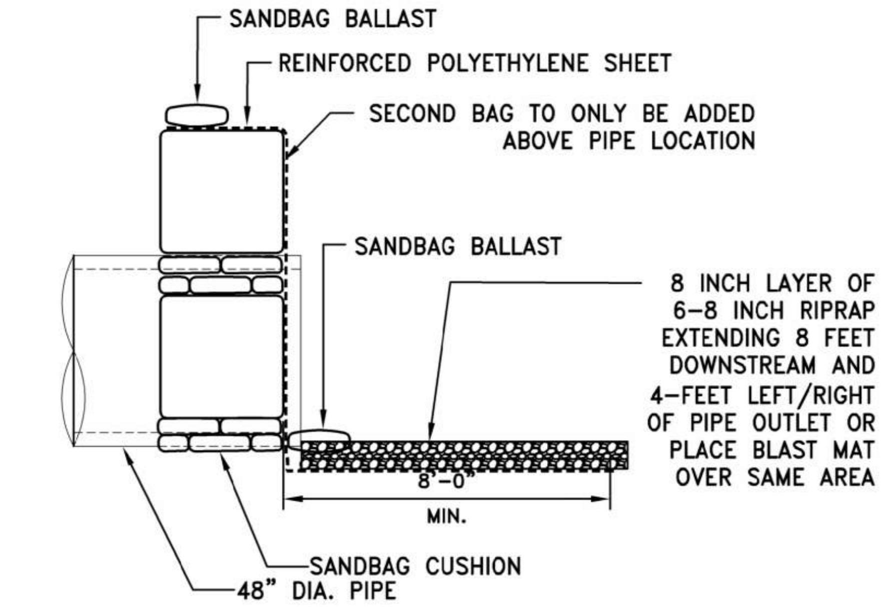


BAG CONFIGURATION "B-2"

SUPER SACK DETAILS



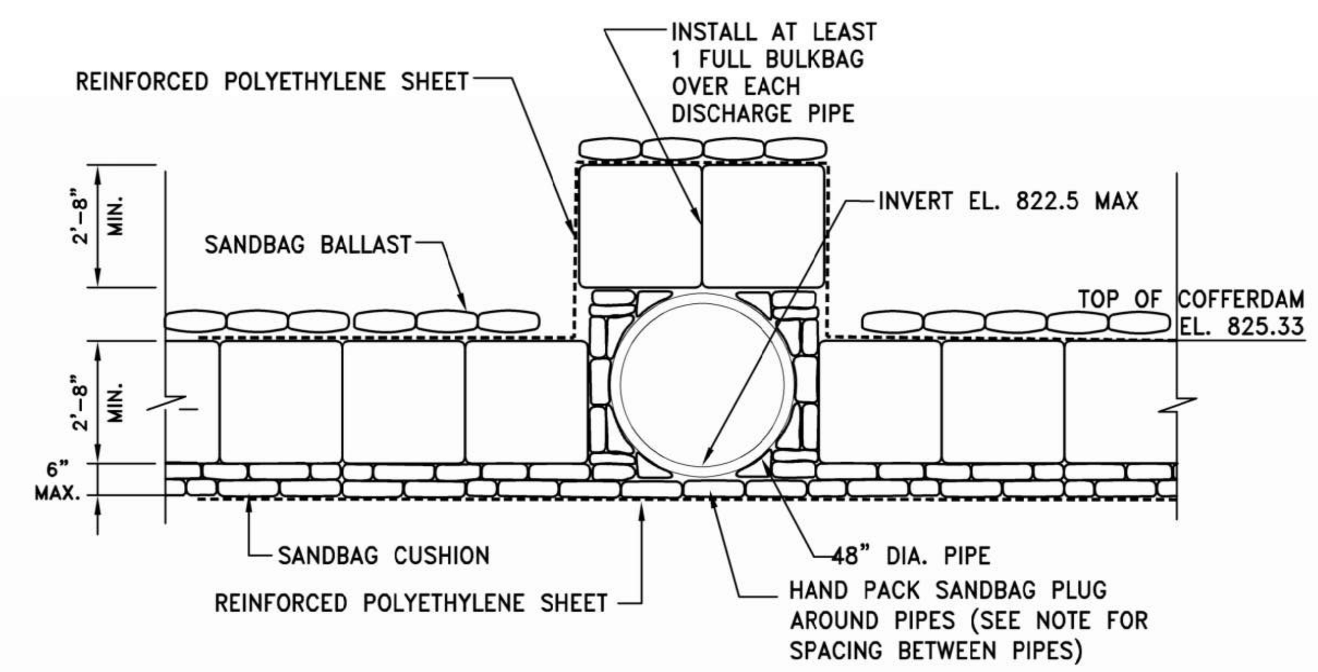
BY-PASS PIPE ANCHOR DETAIL



BY-PASS PIPE DISCHARGE DETAIL - FLOWING PIPE

NOTES:

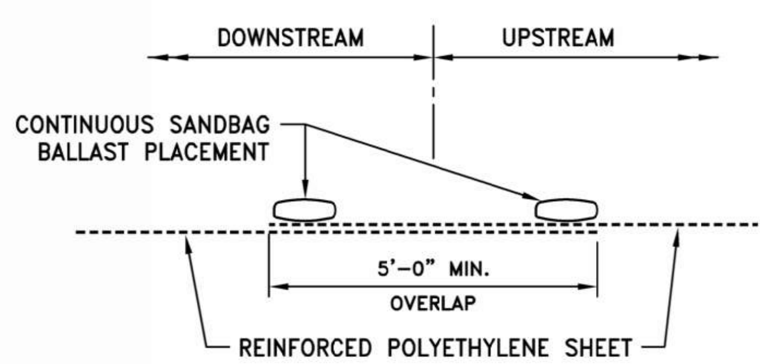
1. BULKBAG GUIDE ANCHORS TO BE LOCATED AT JOINTS AT NON-BURIED SECTIONS OF PIPE.
2. TWO BULKBAG BALLAST ANCHORS OR A SINGLE 5.5'X5.5'X8' CONCRETE BLOCK ARE TO BE PLACED ON THE OUTSIDE OF PIPE BENDS, EVEN IF BURIED.
3. BOTTOM SAND BAG CUSHION OR OTHER FORM OF SUPPORT TO BE PROVIDED AS NEEDED AT HARD POINTS.
4. IF CHANNEL BEDDING MEETS SCOUR RIPRAP SIZE REQUIREMENTS, ADDITIONAL SCOUR RIPRAP IS NOT REQUIRED.



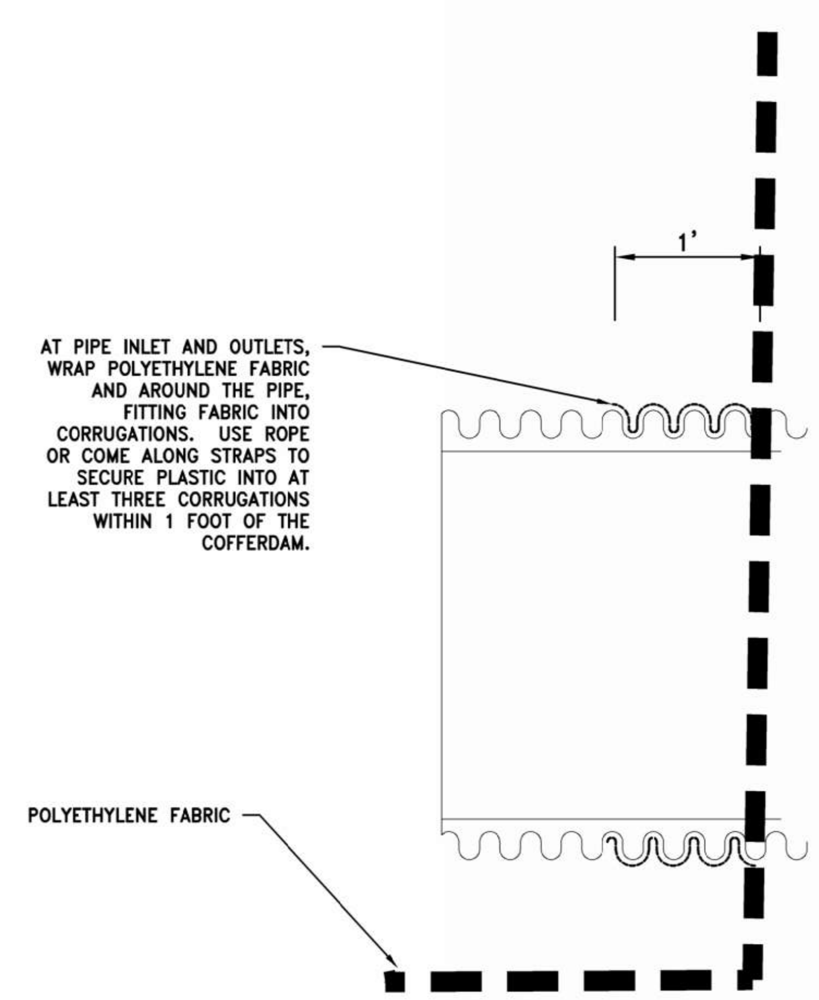
BY-PASS PIPE INTAKE/DISCHARGE PROFILE

NOTES:

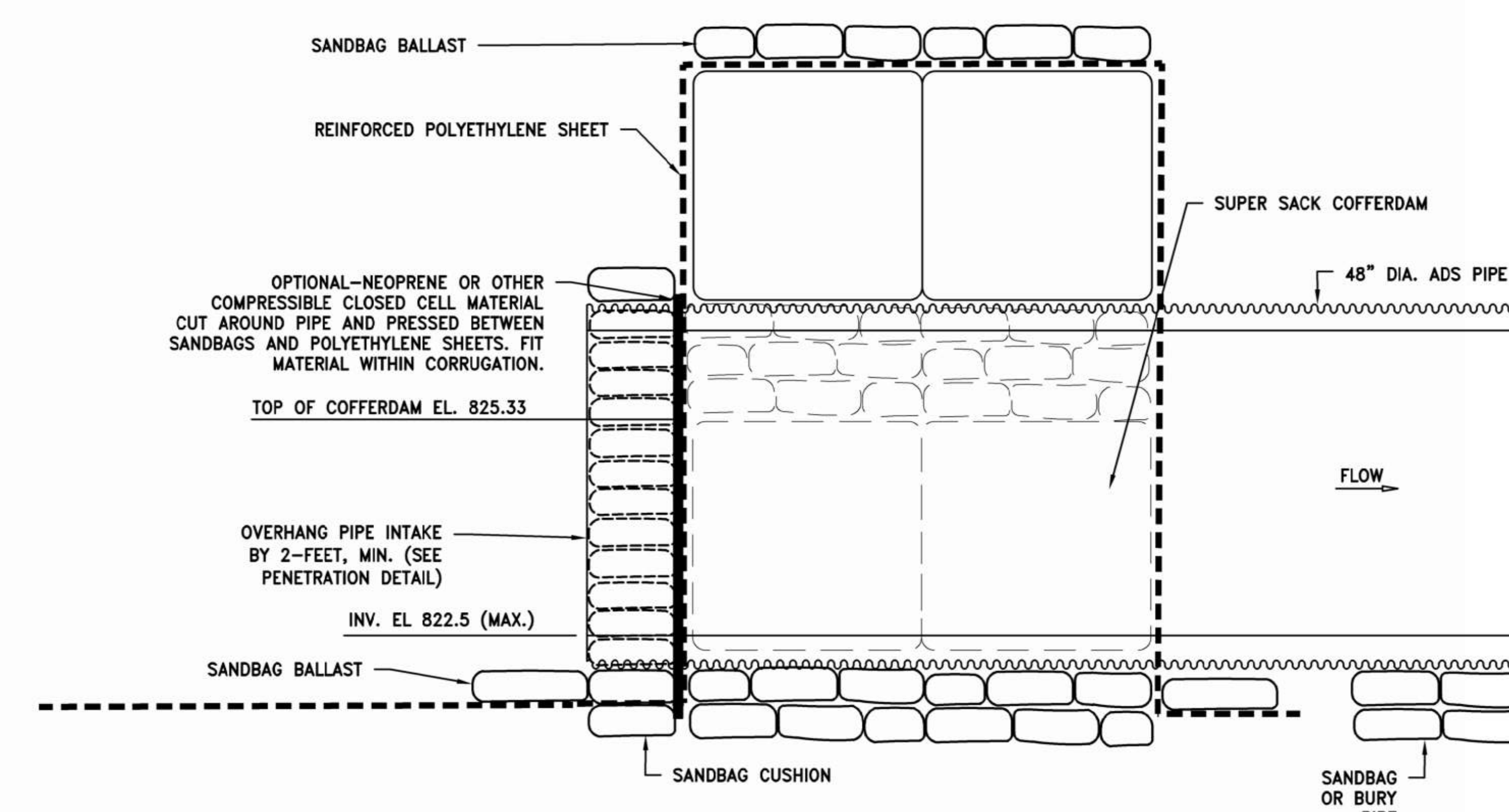
1. TOP OF UPSTREAM COFFERDAM TO BE EL. 825.33.
2. TOP OF DOWNSTREAM COFFERDAM EL. TO BE 824.0.
3. IF NEEDED MAS SHALL STAGGER BAG PLACEMENT SO THAT VERTICAL JOINTS BETWEEN BAGS DO NOT ALIGN.
4. BAG CONFIGURATION C-1 SHALL ONLY BE USED TO ISOLATE THE SPECIFIC WORK AREAS WITHIN THE UPSTREAM AND DOWNSTREAM COFFERDAM LIMITS.
5. IN THE EVENT OF AN OVERTOPPING EVENT A SINGLE BAG AS SHOWN IN A-1 OR A-2 CONFIGURATIONS MAY BE INSUFFICIENT TO RESIST CHANNEL FLOWS. TO INCREASE THE CHANCES OF THE COFFERDAM REMAINING IN PLACE A SECOND ROW OF BAGS CAN BE ADDED BEHIND THE COFFERDAM. A SECOND ROW SHOULD BE OVERLAPPED WITH POLYETHYLENE SHEETING, AS SHOWN IN THE BY-PASS PIPE INLET SECTION DETAIL.



POLYETHYLENE OVERLAP DETAIL



BY-PASS PIPE COFFERDAM PENETRATION DETAIL



BY-PASS PIPE INLET SECTION

NOTES:

1. POLYETHYLENE SHEET TO EXTEND 20-FEET BEYOND THE COFFERDAM AND TO DRAPE OVER THE COFFERDAM TO THE DOWNSTREAM TOE

FOR CONSTRUCTION

PARE
PARE CORPORATION

SCALE ADJUSTMENT GUIDE
0" 1"
BAR IS ONE INCH ON ORIGINAL DRAWING.

LOCKS POND ROAD BRIDGE REPLACEMENT
CONTROL OF WATER AT LOCKS POND ROAD
SHUTESBURY, MASSACHUSETTS
PREPARED FOR: MAS BUILDING & BRIDGE
OWNERS:TOWN OF SHUTESBURY - DEPARTMENT OF PUBLIC WORKS

REVISIONS:		
1	8-10-2023	REVISED PIPE SIZE AND TOP ELEVATION

PROJECT NO.:	21139.00
DATE:	AUGUST 2023
SCALE:	NOT TO SCALE
DESIGNED BY:	DJM
CHECKED BY:	DRC
DRAWN BY:	LMC
APPROVED BY:	DRC

COFFERDAM DETAILS

SHEET NO.: 3.0

CONTROL OF WATER
DESIGN CALCULATIONS

Calculation Cover Sheet

PARE CORPORATION

Project #: 21139.00
Project: MAS Shutesbury Control of Water
Subject/Task: Sandbag Cofferdam and Pipe Calculations
Status: Review
Date: 08/03/2023

Design basic:

1. Determine global stability and scour protection required for the anticipated sandbag cofferdam
2. Determine anticipated thrust force and thrust block design.

Provided:

1. Plan set of anticipated control of water (From MAS).
2. Pipe 48 inch inner diameter ADS N-12 ST IB.

General Assumptions:

1. Water Density = 62.4 lb/ft^3
2. Unit weight of sandbag material is 115 lb/ft^3
3. Interface friction angle between bags and channel floor is 38-degrees
4. 2-year design storm event will occur at elevation 826.3 with a flow rate of 244 cfs.
5. Water levels will raise gradually as to not impart an impact load on the cofferdam.
6. Burial material for pipe shall be of Class I or Class II in accordance with the requirements in technical document 2.01 provided by the ADS design handbook.
7. Channel floor materials are Class 8 medium dense to dense materials or better in accordance with Table 1806.2a of Chapter 18 of the Massachusetts Supplements to the IBC, capable of an allowable bearing capacity of 6000 psf.
8. Ice Loading not considered.
9. Earthquake Loading not considered.

References:

1. USGS StreamStats, https://streamstats.usgs.gov/ss/
2. Handbook of PE Pipe, Plastics Pipe Institute, Second Edition, 2008.
3. ADS Drainage Handbook
4. Technical Note 2.01, ADS, May 2022.

Results:

ADS N-12 Pipe shall be able to withstand pipe crushing conditions under H-25 loading as specified by the technical documents provided by the manufacturer. It is anticipated a double sandbag wall one sand bag high shall meet global stability requirements with scour protection during the 2 year flood event. It is anticipated a two sand bag high wall shall also meet global and internal stability requirements for the 2 year storm. The two sandbag high wall is anticipated to require greater scour protection.

	Name	Position	Signature
Calculation by:	Daniel J. Mullaney	Engineer I	[signature]
Checked by:	David Caouette	Managing Engineer	[signature]

SUPERSACK PARAMETERS (assumed):

$\gamma_f := 115\ pcf$	unit weight of fill
$B_l := 36\ in$	length of bag
$B_w := 36\ in$	width of bag
$B_h := 32\ in$	height of bag
$B_v := B_l \cdot B_w \cdot B_h = 24\ ft^3$	Volume of bag
$B_{wt} := B_v \cdot \gamma_f = \left(2.76 \cdot 10^3\right)\ lbf$	Weight of bag

SANDBAG PARAMETERS (assumed):

$\gamma_f := 115\ pcf$	unit weight of fill
$sb_l := 36\ in$	length of bag
$sb_w := 36\ in$	width of bag
$sb_h := 3\ in$	height of bag
$sb_v := sb_l \cdot sb_w \cdot sb_h = 2.25\ ft^3$	Volume of bag
$sb_{wt} := sb_v \cdot \gamma_f = 258.75\ lbf$	Weight of bag

typical filled sandbag length and width is 12"x18" however for ease of calculation a 36"x36" size will be assumed uniformly under the supersack.

WATER PARAMETERS (assumed):

$\gamma_w := 62.4\ pcf$ unit weight of water

GENERAL PARAMETERS (assumed):

$\phi_{bi} := 32\ deg$	Interaction angle between bags (internal stability)
$\phi_{be} := 38\ deg$	Interaction angle between bags and canal (external stability)
$FB := 0\ in$	Freeboard
$TOC := 825.33\ ft$	Top of Cofferdam Elevation

BAG CONFIGURATION "A-1" (GLOBAL):

Geometry

$h_{a1} := B_h = 2.667\ ft$ height of cofferdam

$w_{a1} := B_l = 3\ ft$ base width of cofferdam

$h_{wa1} := h_{a1} - FB = 2.667\ ft$ height of water

Resisting Forces

$F_{va1} := B_{wt} = \left(2.76 \cdot 10^3\right)\ lbf$ Weight of cofferdam

$F_{fa1} := F_{va1} \cdot \tan\left(\phi_{be}\right) = \left(2.156 \cdot 10^3\right)\ lbf$ Sliding Friction of cofferdam

$y_{ba1} := \frac{w_{a1}}{2} = 1.5\ ft$ Moment arm

$M_{ra1} := B_{wt} \cdot y_{ba1} = \left(4.14 \cdot 10^3\right)\ lbf \cdot ft$ Resisting Moment of cofferdam

Driving Forces

$F_{da1} := 0.5 \cdot \gamma_w \cdot \left(h_{wa1}\right)^2 \cdot B_w = 665.6\ lbf$ Horizontal force of water

$y_{wa1} := \frac{h_{wa1}}{3} = 0.889\ ft$ Moment arm

$M_{oa1} := F_{da1} \cdot y_{wa1} = 591.644\ lbf \cdot ft$ Overturning Moment of water

Sliding Resistance

$FS_{sa1} := \frac{F_{fa1}}{F_{da1}} = 3.24$ $FS_{slda1} := \text{if}\left(FS_{sa1} \geq 1.5, \text{“OK”}, \text{“NG”}\right) = \text{“OK”}$

CHECK ECCENTRICITY

$e_{a1} := \frac{w_{a1}}{2} - \frac{\left(M_{ra1} - M_{oa1}\right)}{F_{va1}} = 0.214\ ft$

check $X_{ra1} := \frac{M_{ra1} - M_{oa1}}{F_{va1}} = 1.286\ ft$

$\frac{w_{a1}}{3} = 1\ ft$

$\frac{w_{a1}}{6} = 0.5\ ft$ If e<w/6, then FS OK aganst overturning.

Overturning Resistance

$eccentricity := \text{if}\left(\left|e_{a1}\right| \leq \frac{w_{a1}}{6}, \text{“OK”}, \text{“NG”}\right) = \text{“OK”}$

$q_{ta1} := \frac{F_{va1}}{w_{a1}} \cdot \left(1 + 6 \cdot \frac{e_{a1}}{w_{a1}}\right) = \left(1.314 \cdot 10^3\right)\ plf$ pressure at toe

$FS_{ma1} := \frac{M_{ra1}}{M_{oa1}} = 7$

$q_{ha1} := \frac{F_{va1}}{w_{a1}} \cdot \left(1 - 6 \cdot \frac{e_{a1}}{w_{a1}}\right) = 525.57\ plf$ pressure at heel

BAG CONFIGURATION "A-2" (GLOBAL):

Geometry

$h_{a2} := B_h + 2 \cdot sb_h = 3.167\ ft$ height of cofferdam

$w_{a2} := B_l = 3\ ft$ base width of cofferdam

$h_{wa2} := h_{a2} - FB = 3.167\ ft$ height of water

Resisting Forces

$F_{va2} := B_{wt} + 2 \cdot sb_{wt} = \left(3.278 \cdot 10^3\right)\ lbf$ Weight of cofferdam

$F_{fa2} := F_{va2} \cdot \tan\left(\phi_{be}\right) = \left(2.561 \cdot 10^3\right)\ lbf$ Sliding Friction of cofferdam

$y_{ba2} := \frac{w_{a2}}{2} = 1.5\ ft$ Moment arm

$M_{ra2} := B_{wt} \cdot y_{ba2} = \left(4.14 \cdot 10^3\right)\ lbf \cdot ft$ Resisting Moment of cofferdam

Driving Forces

$F_{da2} := 0.5 \cdot \gamma_w \cdot \left(h_{wa2}\right)^2 \cdot B_w = 938.6\ lbf$ Horizontal force of water

$y_{wa2} := \frac{h_{wa2}}{3} = 1.056\ ft$ Moment arm

$M_{oa2} := F_{da2} \cdot y_{wa2} = 990.744\ lbf \cdot ft$ Overturning Moment of water

Sliding Resistance

$FS_{sa2} := \frac{F_{fa2}}{F_{da2}} = 2.73$ $FS_{slda2} := \text{if}\left(FS_{sa2} \ge 1.5, \text{“OK”}, \text{“NG”}\right) = \text{“OK”}$

CHECK ECCENTRICITY

$e_{a2} := \frac{w_{a2}}{2} - \frac{\left(M_{ra2} - M_{oa2}\right)}{F_{va2}} = 0.539\ ft$

$\frac{w_{a2}}{6} = 0.5\ ft$ If e<w/6, then FS OK aganst overturning.

$eccentricity := \text{if}\left(\left|e_{a2}\right| \le \frac{w_{a2}}{6}, \text{“OK”}, \text{“NG”}\right) = \text{“NG”}$

check $X_{ra2} := \frac{M_{ra2} - M_{oa2}}{F_{va2}} = 0.961\ ft$

$\frac{w_{a2}}{3} = 1\ ft$

Overturning Resistance

$q_{ta2} := \frac{F_{va2}}{w_{a2}} \cdot \left(1 + 6 \cdot \frac{e_{a2}}{w_{a2}}\right) = \left(2.27 \cdot 10^3\right)\ plf$ pressure at toe

$FS_{ma2} := \frac{M_{ra2}}{M_{oa2}} = 4.18$

$q_{ha2} := \frac{F_{va2}}{w_{a2}} \cdot \left(1 - 6 \cdot \frac{e_{a2}}{w_{a2}}\right) = -85.496\ plf$ pressure at heel

BAG CONFIGURATION "B-1" (GLOBAL):

Geometry

$h_{b1} := 2 \cdot B_h = 5.333\ ft$ — height of cofferdam

$w_{b1} := 2 \cdot B_l = 6\ ft$ — base width of cofferdam

$h_{wb1} := h_{b1} - FB = 5.333\ ft$ — height of water

Resisting Forces

$F_{vb1} := 3 \cdot B_{wt} = \left(8.28 \cdot 10^3\right)\ lbf$ — Weight of cofferdam

$F_{fb1} := F_{vb1} \cdot \tan\left(\phi_{be}\right) = \left(6.469 \cdot 10^3\right)\ lbf$ — Sliding Friction of cofferdam

$M_{rb1} := B_{wt} \cdot \left(\frac{B_w}{2} + \left(B_w + \frac{B_w}{2}\right) + \left(\frac{w_{b1}}{2}\right)\right) = \left(2.484 \cdot 10^4\right)\ lbf \cdot ft$ — Resisting Moment of cofferdam

Driving Forces

$F_{db1} := 0.5 \cdot \gamma_w \cdot \left(h_{wb1}\right)^2 \cdot B_l = \left(2.662 \cdot 10^3\right)\ lbf$ — Horizontal force of water

$y_{wb1} := \frac{h_{wb1}}{3} = 1.778\ ft$ — Moment arm

$M_{ob1} := F_{db1} \cdot y_{wb1} = \left(4.733 \cdot 10^3\right)\ lbf \cdot ft$ — Overturning Moment of water

Sliding Resistance

$FS_{sb1} := \frac{F_{fb1}}{F_{db1}} = 2.43$

$FS_{sldb1} := \text{if}\left(FS_{sb1} \ge 1.5, \text{“OK”}, \text{“NG”}\right) = \text{“OK”}$

CHECK ECCENTRICITY

$e_{b1} := \frac{w_{b1}}{2} - \frac{\left(M_{rb1} - M_{ob1}\right)}{F_{vb1}} = 0.572\ ft$

check $X_{rb1} := \frac{M_{rb1} - M_{ob1}}{F_{vb1}} = 2.428\ ft$

$\frac{w_{b1}}{3} = 2\ ft$

$\frac{w_{b1}}{6} = 1\ ft$

If e<w/6, then FS OK aganst overturning.

$eccentricity := \text{if}\left(\left|e_{b1}\right| \le \frac{w_{b1}}{6}, \text{“OK”}, \text{“NG”}\right) = \text{“OK”}$

Overturning Resistance

$FS_{mb1} := \frac{M_{rb1}}{M_{ob1}} = 5.25$

$q_{tb1} := \frac{F_{vb1}}{w_{b1}} \cdot \left(1 + 6 \cdot \frac{e_{b1}}{w_{b1}}\right) = \left(2.169 \cdot 10^3\right)\ plf$ — pressure at toe

$q_{hb1} := \frac{F_{vb1}}{w_{b1}} \cdot \left(1 - 6 \cdot \frac{e_{b1}}{w_{b1}}\right) = 591.141\ plf$ — pressure at heel

BAG CONFIGURATION "B-2" (GLOBAL):

Geometry

$h_{b2} := 2 \cdot B_h + 2 \cdot sb_h = 5.833\ ft$ height of cofferdam

$w_{b2} := 2 \cdot B_l = 6\ ft$ base width of cofferdam

$h_{wb2} := h_{b2} - FB = 5.833\ ft$ height of water

Resisting Forces

$F_{vb2} := 3 \cdot B_{wt} + 2 \cdot sb_{wt} = \left(8.798 \cdot 10^3\right)\ lbf$ Weight of cofferdam

$F_{fb2} := F_{vb2} \cdot \tan\left(\phi_{be}\right) = \left(6.873 \cdot 10^3\right)\ lbf$ Sliding Friction of cofferdam

$$M_{rb2} := B_{wt} \cdot \left(\frac{B_w}{2} + \left(B_w + \frac{B_w}{2}\right) + \left(\frac{w_{b2}}{2}\right)\right) + 2 \cdot sb_{wt} \cdot \left(\frac{w_{b2}}{2}\right) = \left(2.639 \cdot 10^4\right)\ lbf \cdot ft$$ Resisting Moment of cofferdam

Driving Forces

$F_{db2} := 0.5 \cdot \gamma_w \cdot \left(h_{wb2}\right)^2 \cdot B_l = \left(3.185 \cdot 10^3\right)\ lbf$ Horizontal force of water

$y_{wb2} := \frac{h_{wb2}}{3} = 1.944\ ft$ Moment arm

$M_{ob2} := F_{db2} \cdot y_{wb2} = \left(6.193 \cdot 10^3\right)\ lbf \cdot ft$ Overturning Moment of water

Sliding Resistance

$FS_{sb2} := \frac{F_{fb2}}{F_{db2}} = 2.16$ $FS_{sldb2} := \text{if}\left(FS_{sb2} \ge 1.5, \text{"OK"}, \text{"NG"}\right) = \text{"OK"}$

CHECK ECCENTRICITY

$e_{b2} := \frac{w_{b2}}{2} - \frac{\left(M_{rb2} - M_{ob2}\right)}{F_{vb2}} = 0.704\ ft$

check $X_{rb2} := \frac{M_{rb2} - M_{ob2}}{F_{vb2}} = 2.296\ ft$

$\frac{w_{b2}}{3} = 2\ ft$

$\frac{w_{b2}}{6} = 1\ ft$ If e<w/6, then FS OK aganst overturning.

Overturning Resistance

$eccentricity := \text{if}\left(\left|e_{b2}\right| \le \frac{w_{b2}}{6}, \text{"OK"}, \text{"NG"}\right) = \text{"OK"}$

$q_{tb2} := \frac{F_{vb2}}{w_{b2}} \cdot \left(1 + 6 \cdot \frac{e_{b2}}{w_{b2}}\right) = \left(2.498 \cdot 10^3\right)\ plf$ pressure at toe

$FS_{mb2} := \frac{M_{rb2}}{M_{ob2}} = 4.26$

$q_{hb2} := \frac{F_{vb2}}{w_{b2}} \cdot \left(1 - 6 \cdot \frac{e_{b2}}{w_{b2}}\right) = 434.074\ plf$ pressure at heel

BAG CONFIGURATION "A-1" (Internal): This applies for the internal stability of the top bag for Configurations A-2, B-1, B-2.

Geometry

$h_{a1} := B_h = 2.667\ ft$ height of cofferdam

$w_{a1} := B_l = 3\ ft$ base width of cofferdam

$h_{wa1} := h_{a1} - FB = 2.667\ ft$ height of water

Resisting Forces

$F_{va1} := B_{wt} = \left(2.76 \cdot 10^3\right)\ lbf$ Weight of cofferdam

$F_{fa1i} := F_{va1} \cdot \tan\left(\phi_{bi}\right) = \left(1.725 \cdot 10^3\right)\ lbf$ Sliding Friction of cofferdam

Driving Forces

$F_{da1i} := 0.5 \cdot \gamma_w \cdot \left(h_{wa1}\right)^2 \cdot B_w = 665.6\ lbf$ Horizontal force of water

Internal Sliding Resistance

$FS_{sa1i} := \frac{F_{fa1i}}{F_{da1i}} = 2.59$ $FS_{slda1i} := \text{if}\left(FS_{sa1i} \ge 1.5, \text{“OK”}, \text{“NG”}\right) = \text{“OK”}$

BAG CONFIGURATION "B-1" (Internal): This applies for the internal stability of the top bag for Configurations B-2, C-1 and C-2.

Geometry

$h_{b1} := 2 \cdot B_h = 5.333\ ft$ height of cofferdam

$w_{b1} := 2 \cdot B_l = 6\ ft$ base width of cofferdam

$h_{wb1} := h_{b1} - FB = 5.333\ ft$ height of water

Resisting Forces

$F_{vb1} := 3 \cdot B_{wt} = \left(8.28 \cdot 10^3\right)\ lbf$ Weight of cofferdam

$F_{fb1i} := F_{vb1} \cdot \tan\left(\phi_{bi}\right) = \left(5.174 \cdot 10^3\right)\ lbf$ Sliding Friction of cofferdam

Driving Forces

$F_{db1i} := 0.5 \cdot \gamma_w \cdot \left(h_{wb1}\right)^2 \cdot B_l = \left(2.662 \cdot 10^3\right)\ lbf$ Horizontal force of water

Sliding Resistance

$FS_{sb1i} := \frac{F_{fb1i}}{F_{db1i}} = 1.94$ $FS_{sldb1i} := \text{if}\left(FS_{sb1i} \ge 1.5, \text{“OK”}, \text{“NG”}\right) = \text{“OK”}$

SUMMARY OF COFFERDAM RESULTS:

Configuration	F.S. Sliding	F.S. Overturning	Eccentricity	Max. Bearing Pressure
A-1	$FS_{sa1}=3.24$	$FS_{ma1}=6.997$		$q_{ta1}=\left(1.314 \cdot 10^3\right)$ *plf*
A-2	$FS_{sa2}=2.728$	$FS_{ma2}=4.179$		$q_{ta2}=\left(2.27 \cdot 10^3\right)$ *plf*
B-1	$FS_{sb1}=2.43$	$FS_{mb1}=5.248$	Within middle third for all configurations	$q_{tb1}=\left(2.169 \cdot 10^3\right)$ *plf*
B-2	$FS_{sb2}=2.158$	$FS_{mb2}=4.262$		$q_{tb2}=\left(2.498 \cdot 10^3\right)$ *plf*
A-1 internal	$FS_{sa1i}=2.591$	Same as external		Same as external
B-1 internal	$FS_{sb1i}=1.943$	Same as external		Same as external

Configuration	Min. / Max. Bearing Pressure		Lowest Allowable Bottom El.
A-1	$q_{ha1}=525.57$ *plf*	$q_{ta1}=\left(1.314 \cdot 10^3\right)$ *plf*	$BOT_{a1}:=TOC-h_{a1}=822.663$ *ft*
A-2	$q_{ha2}=-85.496$ *plf*	$q_{ta2}=\left(2.27 \cdot 10^3\right)$ *plf*	$BOT_{a2}:=TOC-h_{a2}=822.163$ *ft*
B-1	$q_{hb1}=591.141$ *plf*	$q_{tb1}=\left(2.169 \cdot 10^3\right)$ *plf*	$BOT_{b1}:=TOC-h_{b1}=819.997$ *ft*
B-2	$q_{hb2}=434.074$ *plf*	$q_{tb2}=\left(2.498 \cdot 10^3\right)$ *plf*	$BOT_{b2}:=TOC-h_{b2}=819.497$ *ft*

Summary for Pond 91P: 1x48 inch TOC @825.0, 40 cfs Longer pipe

[58] Hint: Peaked 806.05' above defined flood level

Inflow	=	40.00 cfs @	0.00 hrs,	Volume=	238.182 af,	Incl. 40.00 cfs Base Flow
Outflow	=	40.00 cfs @	0.00 hrs,	Volume=	238.182 af,	Atten= 0%, Lag= 0.0 min
Primary	=	40.00 cfs @	0.00 hrs,	Volume=	238.182 af	
Secondary	=	0.00 cfs @	0.00 hrs,	Volume=	0.000 af	
Tertiary	=	0.00 cfs @	0.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 825.32' @ 0.00 hrs
Flood Elev= 19.27'

Device	Routing	Invert	Outlet Devices
#1	Primary	822.50'	**36.0" Round 36-inch pipe X 0.00** L= 263.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 822.50' / 821.50' S= 0.0038 '/' Cc= 1.000 n= 0.012, Flow Area= 7.07 sf
#2	Primary	822.50'	**48.0" Round 48-inch pipe** L= 405.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 822.50' / 821.50' S= 0.0025 '/' Cc= 1.000 n= 0.012 Corrugated PP, smooth interior, Flow Area= 12.57 sf
#3	Secondary	822.50'	**18.0" Round 18-inch pipe X 0.00** L= 263.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 822.50' / 821.50' S= 0.0038 '/' Cc= 1.000 n= 0.012, Flow Area= 1.77 sf
#4	Tertiary	825.33'	**45.0' long (Profile 17) Broad-Crested Rectangular Weir** Head (feet) 0.49 0.98 1.48 1.97 2.46 2.95 Coef. (English) 2.84 3.13 3.26 3.30 3.31 3.31

Primary OutFlow Max=40.00 cfs @ 0.00 hrs HW=825.32' TW=822.50' (Fixed TW Elev= 822.50')
1=36-inch pipe (Controls 0.00 cfs)
2=48-inch pipe (Barrel Controls 40.00 cfs @ 5.93 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=825.32' TW=822.50' (Fixed TW Elev= 822.50')
3=18-inch pipe (Controls 0.00 cfs)

Tertiary OutFlow Max=0.00 cfs @ 0.00 hrs HW=825.32' (Free Discharge)
4=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Stage-Discharge for Pond 91P: 1x48 inch TOC @825.0, 40 cfs Longer pipe

Elevation (feet)	Discharge (cfs)	Primary (cfs)	Secondary (cfs)	Tertiary (cfs)
822.50	0.00	0.00	**0.00**	0.00
822.60	0.01	0.01	0.00	0.00
822.70	0.09	0.09	0.00	0.00
822.80	0.25	0.25	0.00	0.00
822.90	0.53	0.53	0.00	0.00
823.00	0.94	0.94	0.00	0.00
823.10	1.48	1.48	0.00	0.00
823.20	2.17	2.17	0.00	0.00
823.30	3.02	3.02	0.00	0.00
823.40	4.02	4.02	0.00	0.00
823.50	5.19	5.19	0.00	0.00
823.60	6.51	6.51	0.00	0.00
823.70	7.99	7.99	0.00	0.00
823.80	9.62	9.62	0.00	0.00
823.90	11.21	11.21	0.00	0.00
824.00	12.80	12.80	0.00	0.00
824.10	14.46	14.46	0.00	0.00
824.20	16.21	16.21	0.00	0.00
824.30	18.03	18.03	0.00	0.00
824.40	19.92	19.92	0.00	0.00
824.50	21.88	21.88	0.00	0.00
824.60	23.91	23.91	0.00	0.00
824.70	25.99	25.99	0.00	0.00
824.80	28.12	28.12	0.00	0.00
824.90	30.31	30.31	0.00	0.00
825.00	32.54	32.54	0.00	0.00
825.10	34.81	34.81	0.00	0.00
825.20	37.12	37.12	0.00	0.00
825.30	39.46	39.46	0.00	0.00
825.40	44.20	41.83	0.00	2.37
825.50	53.19	44.23	0.00	8.96
825.60	64.57	46.64	0.00	17.93
825.70	77.83	49.06	0.00	28.76
825.80	92.67	51.49	0.00	41.18
825.90	109.84	53.93	0.00	55.91
826.00	129.07	56.36	0.00	72.72
826.10	150.17	58.78	0.00	91.39
826.20	173.10	61.18	0.00	111.92
826.30	197.86	63.56	0.00	134.31
826.40	222.97	65.91	0.00	157.06
826.50	**249.28**	**68.22**	0.00	**181.07**

Summary for Pond 91P: 1x48 inch TOC @825.0, 2 yr Storm Longer pipe

[58] Hint: Peaked 807.24' above defined flood level

Inflow	=	244.00 cfs @	0.00 hrs,	Volume=	1,452.909 af,	Incl. 244.00 cfs Base Flow
Outflow	=	244.00 cfs @	0.00 hrs,	Volume=	1,452.909 af,	Atten= 0%, Lag= 0.0 min
Primary	=	59.56 cfs @	0.00 hrs,	Volume=	354.653 af	
Secondary	=	0.00 cfs @	0.00 hrs,	Volume=	0.000 af	
Tertiary	=	184.44 cfs @	0.00 hrs,	Volume=	1,098.256 af	

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 826.51' @ 0.00 hrs
Flood Elev= 19.27'

Device	Routing	Invert	Outlet Devices
#1	Primary	822.50'	**36.0" Round 36-inch pipe X 0.00** L= 263.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 822.50' / 821.50' S= 0.0038 '/' Cc= 1.000 n= 0.012, Flow Area= 7.07 sf
#2	Primary	822.50'	**48.0" Round 48-inch pipe** L= 405.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 822.50' / 821.50' S= 0.0025 '/' Cc= 1.000 n= 0.012 Corrugated PP, smooth interior, Flow Area= 12.57 sf
#3	Secondary	822.50'	**18.0" Round 18-inch pipe X 0.00** L= 263.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 822.50' / 821.50' S= 0.0038 '/' Cc= 1.000 n= 0.012, Flow Area= 1.77 sf
#4	Tertiary	825.33'	**45.0' long (Profile 17) Broad-Crested Rectangular Weir** Head (feet) 0.49 0.98 1.48 1.97 2.46 2.95 Coef. (English) 2.84 3.13 3.26 3.30 3.31 3.31

Primary OutFlow Max=59.56 cfs @ 0.00 hrs HW=826.51' TW=825.00' (Fixed TW Elev= 825.00')
├─**1=36-inch pipe** (Controls 0.00 cfs)
└─**2=48-inch pipe** (Outlet Controls 59.56 cfs @ 5.87 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=826.51' TW=825.00' (Fixed TW Elev= 825.00')
└─**3=18-inch pipe** (Controls 0.00 cfs)

Tertiary OutFlow Max=184.42 cfs @ 0.00 hrs HW=826.51' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Weir Controls 184.42 cfs @ 3.46 fps)

Stage-Discharge for Pond 91P: 1x48 inch TOC @825.0, 2 yr Storm Longer pipe

Elevation (feet)	Discharge (cfs)	Primary (cfs)	Secondary (cfs)	Tertiary (cfs)
822.50	0.00	0.00	**0.00**	0.00
822.60	0.00	0.00	0.00	0.00
822.70	0.00	0.00	0.00	0.00
822.80	0.00	0.00	0.00	0.00
822.90	0.00	0.00	0.00	0.00
823.00	0.00	0.00	0.00	0.00
823.10	0.00	0.00	0.00	0.00
823.20	0.00	0.00	0.00	0.00
823.30	0.00	0.00	0.00	0.00
823.40	0.00	0.00	0.00	0.00
823.50	0.00	0.00	0.00	0.00
823.60	0.00	0.00	0.00	0.00
823.70	0.00	0.00	0.00	0.00
823.80	0.00	0.00	0.00	0.00
823.90	0.00	0.00	0.00	0.00
824.00	0.00	0.00	0.00	0.00
824.10	0.00	0.00	0.00	0.00
824.20	0.00	0.00	0.00	0.00
824.30	0.00	0.00	0.00	0.00
824.40	0.00	0.00	0.00	0.00
824.50	0.00	0.00	0.00	0.00
824.60	0.00	0.00	0.00	0.00
824.70	0.00	0.00	0.00	0.00
824.80	0.00	0.00	0.00	0.00
824.90	0.00	0.00	0.00	0.00
825.00	0.00	0.00	0.00	0.00
825.10	8.57	8.57	0.00	0.00
825.20	12.83	12.83	0.00	0.00
825.30	16.58	16.58	0.00	0.00
825.40	22.51	20.15	0.00	2.37
825.50	32.60	23.64	0.00	8.96
825.60	45.05	27.12	0.00	17.93
825.70	59.36	30.60	0.00	28.76
825.80	75.27	34.09	0.00	41.18
825.90	93.53	37.61	0.00	55.91
826.00	113.87	41.16	0.00	72.72
826.10	136.11	44.72	0.00	91.39
826.20	160.22	48.30	0.00	111.92
826.30	186.20	51.90	0.00	134.31
826.40	212.55	55.49	0.00	157.06
826.50	**240.14**	**59.08**	0.00	**181.07**

Summary for Pond 88P: 1x48 inch TOC @825.33, 2-yr storm

[58] Hint: Peaked 807.23' above defined flood level

Inflow =	244.00 cfs @	0.00 hrs, Volume=	1,452.909 af,	Incl. 244.00 cfs Base Flow
Outflow =	244.00 cfs @	0.00 hrs, Volume=	1,452.909 af,	Atten= 0%, Lag= 0.0 min
Primary =	63.33 cfs @	0.00 hrs, Volume=	377.105 af	
Tertiary =	180.67 cfs @	0.00 hrs, Volume=	1,075.804 af	

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 826.50' @ 0.00 hrs
Flood Elev= 19.27'

Device	Routing	Invert	Outlet Devices
#1	Primary	822.50'	**48.0" Round 48-inch pipe** L= 291.6' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 822.50' / 821.50' S= 0.0034 '/' Cc= 1.000 n= 0.012, Flow Area= 12.57 sf
#2	Tertiary	825.33'	**45.0' long (Profile 17) Broad-Crested Rectangular Weir** Head (feet) 0.49 0.98 1.48 1.97 2.46 2.95 Coef. (English) 2.84 3.13 3.26 3.30 3.31 3.31

Primary OutFlow Max=63.33 cfs @ 0.00 hrs HW=826.50' TW=825.00' (Fixed TW Elev= 825.00')
↑—**1=48-inch pipe** (Outlet Controls 63.33 cfs @ 6.27 fps)

Tertiary OutFlow Max=180.67 cfs @ 0.00 hrs HW=826.50' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 180.67 cfs @ 3.44 fps)

Stage-Discharge for Pond 88P: 1x48 inch TOC @825.33, 2-yr storm

Elevation (feet)	Discharge (cfs)	Primary (cfs)	Tertiary (cfs)
822.50	0.00	0.00	0.00
822.55	0.00	0.00	0.00
822.60	0.00	0.00	0.00
822.65	0.00	0.00	0.00
822.70	0.00	0.00	0.00
822.75	0.00	0.00	0.00
822.80	0.00	0.00	0.00
822.85	0.00	0.00	0.00
822.90	0.00	0.00	0.00
822.95	0.00	0.00	0.00
823.00	0.00	0.00	0.00
823.05	0.00	0.00	0.00
823.10	0.00	0.00	0.00
823.15	0.00	0.00	0.00
823.20	0.00	0.00	0.00
823.25	0.00	0.00	0.00
823.30	0.00	0.00	0.00
823.35	0.00	0.00	0.00
823.40	0.00	0.00	0.00
823.45	0.00	0.00	0.00
823.50	0.00	0.00	0.00
823.55	0.00	0.00	0.00
823.60	0.00	0.00	0.00
823.65	0.00	0.00	0.00
823.70	0.00	0.00	0.00
823.75	0.00	0.00	0.00
823.80	0.00	0.00	0.00
823.85	0.00	0.00	0.00
823.90	0.00	0.00	0.00
823.95	0.00	0.00	0.00
824.00	0.00	0.00	0.00
824.05	0.00	0.00	0.00
824.10	0.00	0.00	0.00
824.15	0.00	0.00	0.00
824.20	0.00	0.00	0.00
824.25	0.00	0.00	0.00
824.30	0.00	0.00	0.00
824.35	0.00	0.00	0.00
824.40	0.00	0.00	0.00
824.45	0.00	0.00	0.00
824.50	0.00	0.00	0.00
824.55	0.00	0.00	0.00
824.60	0.00	0.00	0.00
824.65	0.00	0.00	0.00
824.70	0.00	0.00	0.00
824.75	0.00	0.00	0.00
824.80	0.00	0.00	0.00
824.85	0.00	0.00	0.00
824.90	0.00	0.00	0.00
824.95	0.00	0.00	0.00
825.00	0.00	0.00	0.00
825.05	6.39	6.39	0.00
825.10	9.30	9.30	0.00
825.15	11.71	11.71	0.00
825.20	13.90	13.90	0.00
825.25	15.96	15.96	0.00
825.30	17.94	17.94	0.00
825.35	20.24	19.88	0.36
825.40	24.14	21.78	2.37
825.45	28.97	23.66	5.31
825.50	34.49	25.53	8.96
825.55	40.58	27.39	13.19
825.60	47.18	29.25	17.93
825.65	54.25	31.12	23.13
825.70	61.74	32.98	28.76
825.75	69.63	34.85	34.79
825.80	77.90	36.72	41.18
825.85	86.82	38.60	48.22
825.90	96.39	40.48	55.91
825.95	106.45	42.37	64.08
826.00	116.98	44.26	72.72
826.05	127.98	46.16	81.82
826.10	139.46	48.07	91.39
826.15	151.40	49.98	101.42
826.20	163.81	51.89	111.92
826.25	176.69	53.81	122.88
826.30	190.03	55.73	134.31
826.35	203.22	57.64	145.58
826.40	216.62	59.56	157.06
826.45	230.37	61.48	168.89
826.50	**244.46**	**63.39**	**181.07**

Summary for Pond 88P: 1x48 inch TOC @825.33, 43 cfs

[58] Hint: Peaked 806.04' above defined flood level

Inflow	=	43.00 cfs @	0.00 hrs, Volume=	256.045 af,	Incl. 43.00 cfs Base Flow
Outflow	=	43.00 cfs @	0.00 hrs, Volume=	256.045 af,	Atten= 0%, Lag= 0.0 min
Primary	=	43.00 cfs @	0.00 hrs, Volume=	256.045 af	
Tertiary	=	0.00 cfs @	0.00 hrs, Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 825.31' @ 0.00 hrs
Flood Elev= 19.27'

Device	Routing	Invert	Outlet Devices
#1	Primary	822.50'	**48.0" Round 48-inch pipe** L= 291.6' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 822.50' / 821.50' S= 0.0034 '/' Cc= 1.000 n= 0.012, Flow Area= 12.57 sf
#2	Tertiary	825.33'	**45.0' long (Profile 17) Broad-Crested Rectangular Weir** Head (feet) 0.49 0.98 1.48 1.97 2.46 2.95 Coef. (English) 2.84 3.13 3.26 3.30 3.31 3.31

Primary OutFlow Max=43.00 cfs @ 0.00 hrs HW=825.31' TW=821.88' (Fixed TW Elev= 821.88')
↑—**1=48-inch pipe** (Barrel Controls 43.00 cfs @ 6.40 fps)

Tertiary OutFlow Max=0.00 cfs @ 0.00 hrs HW=825.31' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Stage-Discharge for Pond 88P: 1x48 inch TOC @825.33, 43 cfs

Elevation (feet)	Discharge (cfs)	Primary (cfs)	Tertiary (cfs)
822.50	0.00	0.00	0.00
822.55	0.01	0.01	0.00
822.60	0.04	0.04	0.00
822.65	0.11	0.11	0.00
822.70	0.21	0.21	0.00
822.75	0.34	0.34	0.00
822.80	0.52	0.52	0.00
822.85	0.73	0.73	0.00
822.90	0.98	0.98	0.00
822.95	1.28	1.28	0.00
823.00	1.61	1.61	0.00
823.05	1.97	1.97	0.00
823.10	2.35	2.35	0.00
823.15	2.77	2.77	0.00
823.20	3.22	3.22	0.00
823.25	3.70	3.70	0.00
823.30	4.21	4.21	0.00
823.35	4.75	4.75	0.00
823.40	5.32	5.32	0.00
823.45	5.91	5.91	0.00
823.50	6.54	6.54	0.00
823.55	7.19	7.19	0.00
823.60	7.87	7.87	0.00
823.65	8.58	8.58	0.00
823.70	9.31	9.31	0.00
823.75	10.06	10.06	0.00
823.80	10.84	10.84	0.00
823.85	11.65	11.65	0.00
823.90	12.48	12.48	0.00
823.95	13.32	13.32	0.00
824.00	14.20	14.20	0.00
824.05	15.09	15.09	0.00
824.10	16.00	16.00	0.00
824.15	16.93	16.93	0.00
824.20	17.89	17.89	0.00
824.25	18.86	18.86	0.00
824.30	19.85	19.85	0.00
824.35	20.86	20.86	0.00
824.40	21.88	21.88	0.00
824.45	22.93	22.93	0.00
824.50	23.98	23.98	0.00
824.55	25.06	25.06	0.00
824.60	26.15	26.15	0.00
824.65	27.25	27.25	0.00
824.70	28.37	28.37	0.00
824.75	29.51	29.51	0.00
824.80	30.65	30.65	0.00
824.85	31.81	31.81	0.00
824.90	32.98	32.98	0.00
824.95	34.16	34.16	0.00
825.00	35.36	35.36	0.00
825.05	36.56	36.56	0.00
825.10	37.77	37.77	0.00
825.15	38.99	38.99	0.00
825.20	40.22	40.22	0.00
825.25	41.46	41.46	0.00
825.30	42.71	42.71	0.00
825.35	44.33	43.96	0.36
825.40	47.59	45.22	2.37
825.45	51.80	46.49	5.31
825.50	56.72	47.76	8.96
825.55	62.22	49.04	13.19
825.60	68.25	50.32	17.93
825.65	74.73	51.60	23.13
825.70	81.65	52.88	28.76
825.75	88.96	54.17	34.79
825.80	96.64	55.46	41.18
825.85	104.97	56.75	48.22
825.90	113.95	58.04	55.91
825.95	123.41	59.33	64.08
826.00	133.33	60.61	72.72
826.05	143.72	61.90	81.82
826.10	154.57	63.18	91.39
826.15	165.88	64.45	101.42
826.20	177.64	65.72	111.92
826.25	189.87	66.99	122.88
826.30	202.55	68.25	134.31
826.35	215.08	69.50	145.58
826.40	227.80	70.74	157.06
826.45	240.87	71.98	168.89
826.50	**254.27**	**73.20**	**181.07**

Project:	Control of Water at Locks Pond Road Shutesbury, MA	Proj. No.:	21139.00
Subject:	Downstream Channel Flow Calc		
Computations By:	DJM	Date:	7/28/2023
Checked By:		Date:	

HydroCAD Model Inputs:	
Section 1:	
Offset:	Elevation:
0	822
8.3	821
17.18	821
19.5	822
Section 2:	
Offset:	Elevation:
0	822
2.3	821
18.58	820
21.21	821
21.76	822
Avg Slope:	
Offset:	Elevation:
0	821
393.22	815
0.0153	ft/ft
Min Slope:	
Offset:	Elevation:
0	820
97.08	819
0.0103	ft/ft
Manning's Number:	
Natural Stream	
Stream, clean & straight	
0.030	unitless

HydroCAD Model Outputs:			
Average Slope			
Section 1		Section 2	
Flow Rate (cfs)	Average Depth of Flow (ft)	Flow Rate (cfs)	Average Depth of Flow (ft)
5	0.23	5	0.48
10	0.35	10	0.62
15	0.43	15	0.72
20	0.51	20	0.80
25	0.58	25	0.87
30	0.64	30	0.93
35	0.69	35	0.99
40	0.75	40	1.03
45	0.79	45	1.07
50	0.84	50	1.11
55	0.88	55	1.15
60	0.93	60	1.18
Minimum Slope			
Section 1		Section 2	
Flow Rate (cfs)	Average Depth of Flow (ft)	Flow Rate (cfs)	Average Depth of Flow (ft)
5	0.26	5	0.51
10	0.39	10	0.66
15	0.49	15	0.77
20	0.57	20	0.86
25	0.64	25	0.94
30	0.71	30	1.00
35	0.77	35	1.05
40	0.83	40	1.10
45	0.88	45	1.15
50	0.93	50	1.18
55	0.98	55	1.23
60	1.03	60	1.27
Red values indicate overtopping of the stream channel.			

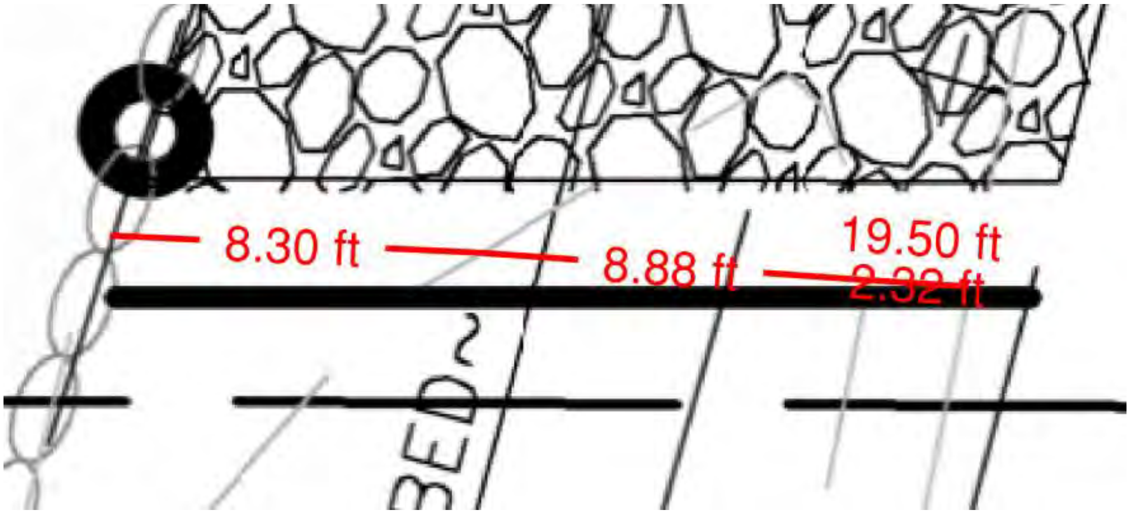


Figure 1: Section 1

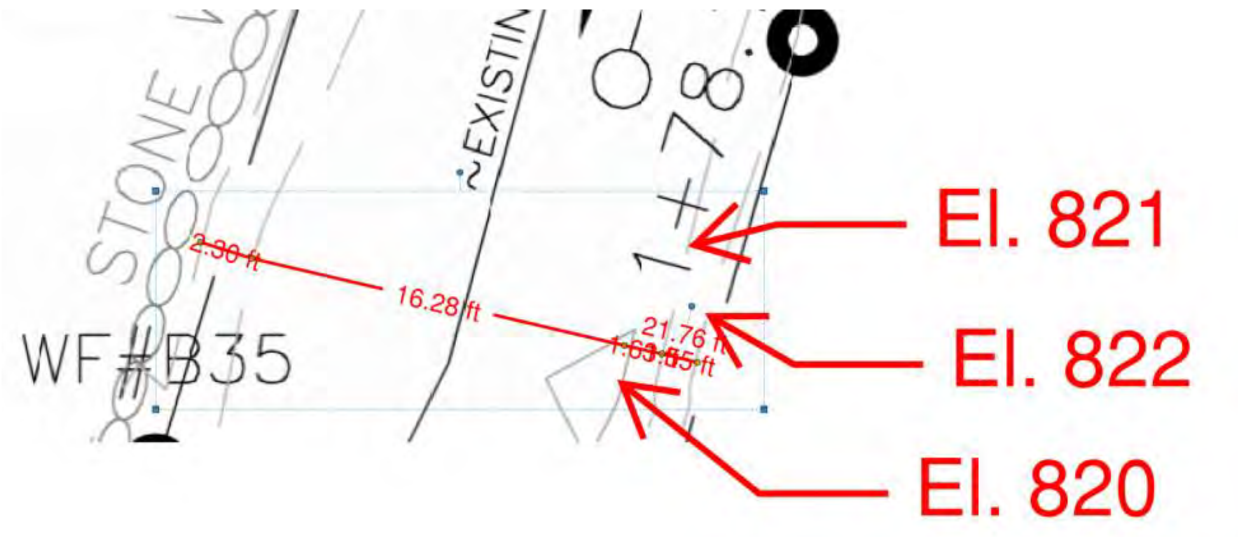


Figure 2: Section 2

Figure 3: Average Slope of Sawmill River

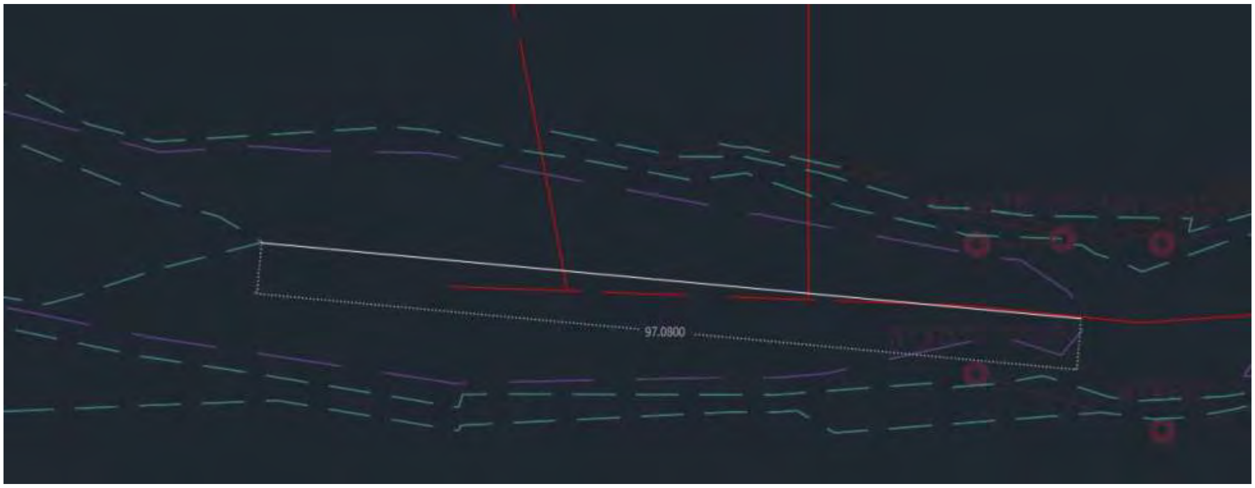


Figure 4: Minimum Slope of Sawmill River

Figure 5: Sawmill River Picture 1

Figure 6: Sawmill River Picture 2

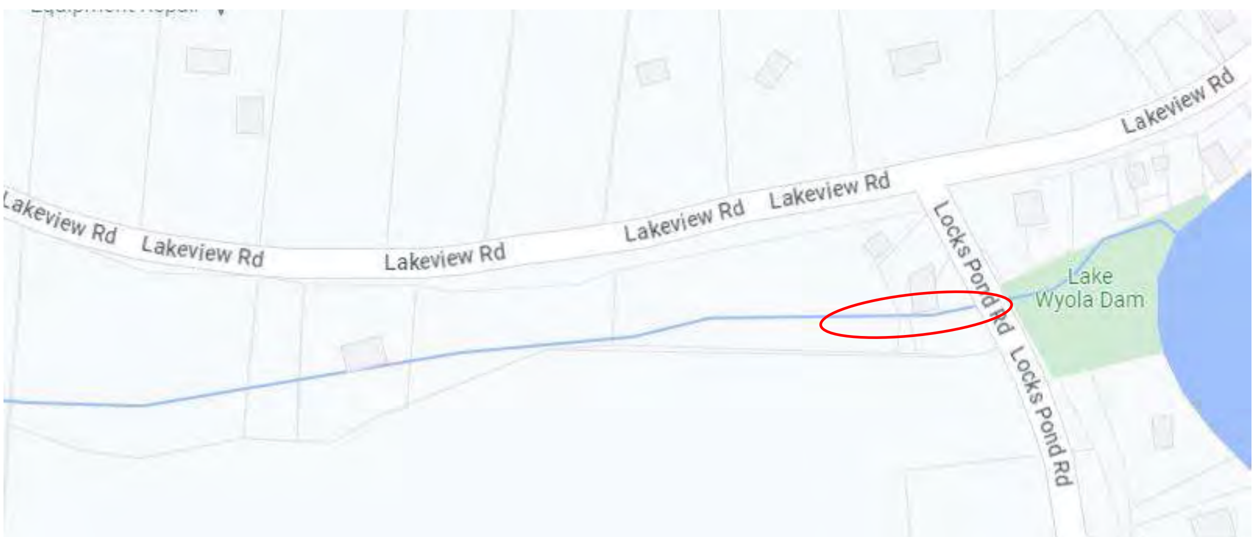
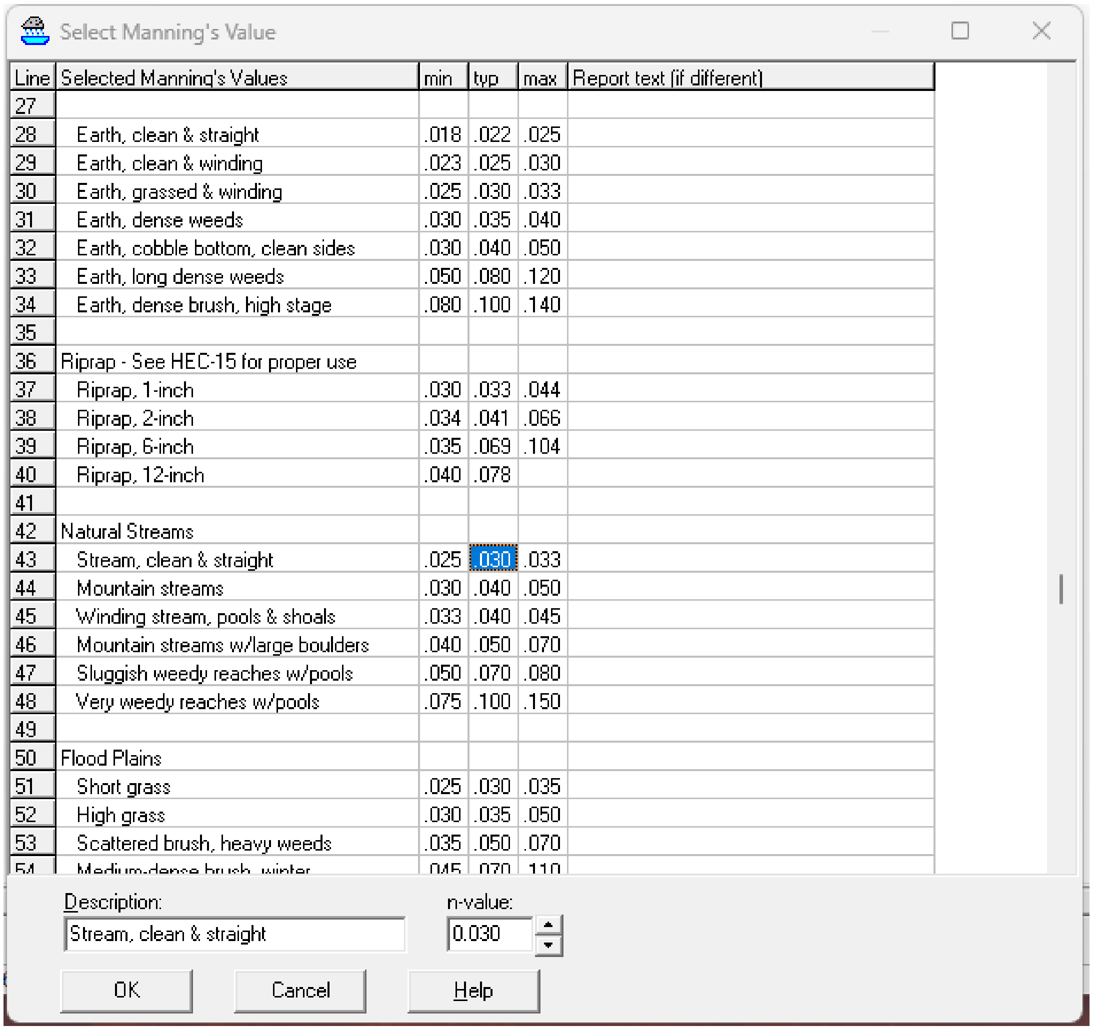


Figure 7: Map of Sawmill River



Select Manning's Value

Line	Selected Manning's Values	min	typ	max	Report text (if different)
27					
28	Earth, clean & straight	.018	.022	.025	
29	Earth, clean & winding	.023	.025	.030	
30	Earth, grassed & winding	.025	.030	.033	
31	Earth, dense weeds	.030	.035	.040	
32	Earth, cobble bottom, clean sides	.030	.040	.050	
33	Earth, long dense weeds	.050	.080	.120	
34	Earth, dense brush, high stage	.080	.100	.140	
35					
36	Riprap - See HEC-15 for proper use				
37	Riprap, 1-inch	.030	.033	.044	
38	Riprap, 2-inch	.034	.041	.066	
39	Riprap, 6-inch	.035	.069	.104	
40	Riprap, 12-inch	.040	.078		
41					
42	Natural Streams				
43	Stream, clean & straight	.025	.030	.033	
44	Mountain streams	.030	.040	.050	
45	Winding stream, pools & shoals	.033	.040	.045	
46	Mountain streams w/large boulders	.040	.050	.070	
47	Sluggish weedy reaches w/pools	.050	.070	.080	
48	Very weedy reaches w/pools	.075	.100	.150	
49					
50	Flood Plains				
51	Short grass	.025	.030	.035	
52	High grass	.030	.035	.050	
53	Scattered brush, heavy weeds	.035	.050	.070	
54	Medium-dense brush, winter	.045	.070	.110	

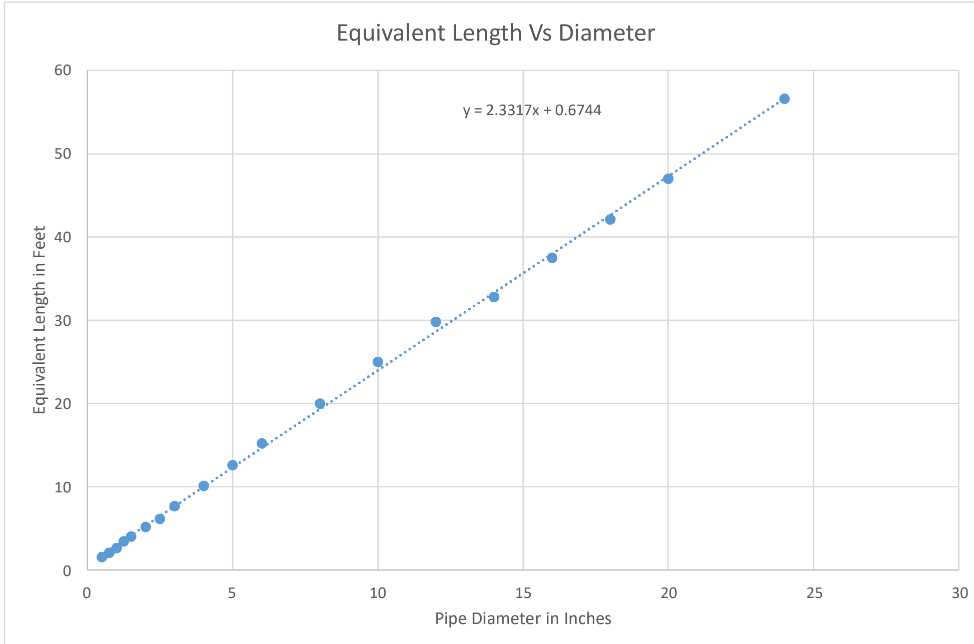
Description: Stream, clean & straight

n-value: 0.030

OK | Cancel | Help

Figure 8: Manning's Coefficient

Pipe Size (in)	Lequivalent (ft)
0.5	1.55
0.75	2.06
1	2.62
1.25	3.45
1.5	4.02
2	5.17
2.5	6.16
3	7.67
4	10.1
5	12.6
6	15.2
8	20
10	25
12	29.8
14	32.8
16	37.5
18	42.1
20	47
24	56.6
30	70.63
36	84.62
40	93.94
48	112.60
Values in blue are interpolated	



ENGINEERING INFORMATION - PIPE RESISTANCE AND MUELLER PRODUCT FLOW DATA

16.27

REV. 4-99

Equivalent resistence of bends, fittings, and valves, length of straight pipe in feet *

		Screwed fittings				90° welding elbows & smooth bends							Miter elbows (No. of miters)				Welding tees		Valves (screwed, flanged, or welded)			
		45° ell	90° ell	180° close return bends	Tee	R/d = 1	R/d =1-1/2	R/d = 2	R/d = 4	R/d = 6	R/d = 8	1-45°	1-60°	1-90°	2-90°	3-90°	Forged	Miter	Gate	Globe	Angle	Swing Check
k factor =		0.42	0.90	2.00	1.80	0.48	0.36	0.27	0.21	0.27	0.36	0.45	0.90	1.80	0.60	0.45	1.35	1.80	0.21	10	5.0	2.5
L/d' ration n =		14	30	67	60	16	12	9	7	9	12	15	30	60	20	15	45	60	7	333	167	83
Nom. Pipe Size (inches)	Inside diam. d (inches) Sched. 40	L = equivalent length in feet of schedule 40 (standard weight) straight pipe																				
1/2	0.622	0.73	1.55	3.47	3.10	0.83	0.62	0.47	0.36	0.47	0.62	0.78	1.55	3.10	1.04	0.78	2.33	3.10	0.36	17.3	8.65	4.32
3/4	0.824	0.96	2.06	4.60	4.12	1.10	0.82	0.62	0.48	0.62	0.82	1.03	2.06	4.12	1.37	1.03	3.09	4.12	0.48	22.9	11.4	5.72
1	1.049	1.22	2.62	5.82	5.24	1.40	1.05	0.79	0.61	0.79	1.05	1.31	2.62	5.24	1.75	1.31	3.93	5.24	0.61	29.1	14.6	7.27
1-1/4	1.380	1.61	3.45	7.66	6.90	1.84	1.38	1.03	0.81	1.03	1.38	1.72	3.45	6.90	2.30	1.72	5.17	6.90	0.81	38.3	19.1	9.58
1-1/2	1.610	1.88	4.02	8.95	8.04	2.14	1.61	1.21	0.94	1.21	1.61	2.01	4.02	8.04	2.68	2.01	6.04	8.04	0.94	44.7	22.4	11.2
2	2.067	2.41	5.17	11.5	10.3	2.76	2.07	1.55	1.21	1.55	2.07	2.58	5.17	10.3	3.45	2.58	7.75	10.3	1.21	57.4	28.7	14.4
2-1/2	2.469	2.88	6.16	13.7	12.3	3.29	2.47	1.85	1.44	1.85	2.47	3.08	6.16	12.3	4.11	3.08	9.25	12.3	1.44	68.5	34.3	17.1
3	3.068	3.58	7.67	17.1	15.3	4.09	3.07	2.30	1.79	2.30	3.07	3.84	7.67	15.3	5.11	3.84	11.5	15.3	1.79	85.2	42.6	21.3
4	4.026	4.70	10.1	22.4	20.2	5.37	4.03	3.02	2.35	3.02	4.03	5.04	10.1	20.2	6.71	5.04	15.1	20.2	2.35	112.0	56.0	28.0
5	5.047	5.88	12.6	28.0	25.2	6.72	5.05	3.78	2.94	3.78	5.05	6.30	12.6	25.2	8.40	6.30	18.9	25.2	2.94	140.0	70.0	35.0
6	6.065	7.07	15.2	33.8	30.4	8.09	6.07	4.55	3.54	4.55	6.07	7.58	15.2	30.4	10.1	7.58	22.8	30.4	3.54	168.0	84.1	42.1
8	7.981	9.31	20.0	44.6	40.0	10.6	7.98	5.98	4.65	5.98	7.98	9.97	20.0	40.0	13.3	9.97	29.9	40.0	4.65	222.0	111.0	55.5
10	10.02	11.7	25.0	55.7	50.0	13.3	10.0	7.51	5.85	7.51	10.0	12.5	25.0	50.0	16.7	12.5	37.6	50.0	5.85	278.0	139.0	69.5
12	11.94	13.9	29.8	66.3	59.6	15.9	11.9	8.95	6.96	8.95	11.9	14.9	29.8	59.6	19.9	14.9	44.8	59.6	6.96	332.0	166.0	83.0
14	13.13	15.3	32.8	73.0	65.6	17.5	13.1	9.85	7.65	9.85	13.1	16.4	32.8	65.6	21.9	16.4	49.2	65.6	7.65	364.0	182.0	91.0
16	15.00	17.5	37.5	83.5	75.0	20.0	15.0	11.2	8.75	11.2	15.0	18.8	37.5	75.0	25.0	18.8	56.2	75.0	8.75	417.0	208.0	104.0
18	16.88	19.7	42.1	93.8	84.2	22.5	16.9	12.7	9.85	12.7	16.9	21.1	42.1	84.2	28.1	21.1	63.2	84.2	9.85	469.0	234.0	117.0
20	18.81	22.0	47.0	105.0	94.0	25.1	18.8	14.1	11.0	14.1	18.8	23.5	47.0	94.0	31.4	23.5	70.6	94.0	11.0	522.0	261.0	131.0
24	22.63	26.4	56.6	126.0	113.0	30.2	22.6	17.0	13.2	17.0	22.6	28.3	56.6	113.0	37.8	28.3	85.0	113.0	13.2	629.0	314.0	157.0

StreamStats Report

Region ID: MA
Workspace ID: MA20230801190949135000
Clicked Point (Latitude, Longitude): 42.50213, -72.43619
Time: 2023-08-01 15:10:09 -0400

Collapse All

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
ACRSDFT	Area underlain by stratified drift	2.02	square miles
BSLDEM10M	Mean basin slope computed from 10 m DEM	8.13	percent
BSLDEM250	Mean basin slope computed from 1:250K DEM	4.049	percent
CAT1ROADS	Length of interstates lmtd access highways and ramps for lmtd access highways, includes cloverleaf interchanges (USGS Ntl Transp Dataset)	0	miles
CAT2ROADS	Length of sec hwy or maj connecting roads; main arteries & hwys not lmtd access, usually in the US Hwy or State Hwy systems (USGS Ntl Transp Dataset)	0	miles
CAT3ROADS	Length of local connecting roads; roads that collect traffic from local roads & connect towns, subdivisions & neighborhoods (USGS Nat Transp Dataset)	0	miles
CAT4ROADS	Length of local roads; generally paved street, road, or byway that usually have single lane of traffic in each direction (USGS Ntnl Transp Dataset)	19.8	miles
CENTROIDX	Basin centroid horizontal (x) location in state plane coordinates	124183.7	meters
CENTROIDY	Basin centroid vertical (y) location in state plane units	918663.6	meters
CROSCOUNT1	Number of intersections between streams and roads, where the roads are interstate, limited access highway, or ramp (CAT1ROADS)	0	dimensionless
CROSCOUNT2	Number of intersections between streams and roads, where the roads are secondary highway or major connecting road (CAT2ROADS)	0	dimensionless
CROSCOUNT3	Number of intersections between streams and roads, where roads are local conecting roads (CAT3ROADS)	0	dimensionless
CROSCOUNT4	Number of intersections between streams and roads, where roads are local roads (CAT4ROADS)	11	dimensionless
CRSDFT	Percentage of area of coarse-grained stratified drift	29.62	percent
CSL10_85	Change in elevation divided by length between points 10 and 85 percent of distance along main channel to basin divide - main channel method not known	50.4	feet per mi

Parameter Code	Parameter Description	Value	Unit
DRFTPERSTR	Area of stratified drift per unit of stream length	0.17	square mile per mile
DRNAREA	Area that drains to a point on a stream	6.84	square miles
ELEV	Mean Basin Elevation	992	feet
FOREST	Percentage of area covered by forest	80.08	percent
LAKEAREA	Percentage of Lakes and Ponds	4.52	percent
LC06STOR	Percentage of water bodies and wetlands determined from the NLCD 2006	8.01	percent
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	6.16	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	0.52	percent
LFPLENGTH	Length of longest flow path	4.3	miles
MAREGION	Region of Massachusetts 0 for Eastern 1 for Western	1	dimensionless
MAXTEMPC	Mean annual maximum air temperature over basin area, in degrees Centigrade	13.4	degrees C
OUTLETX	Basin outlet horizontal (x) location in state plane coordinates	123055	feet
OUTLETY	Basin outlet vertical (y) location in state plane coordinates	917265	feet
PCTSNDGRV	Percentage of land surface underlain by sand and gravel deposits	29.62	percent
PRECPRIS00	Basin average mean annual precipitation for 1971 to 2000 from PRISM	50	inches
STRMTOT	total length of all mapped streams (1:24,000-scale) in the basin	12.1	miles
WETLAND	Percentage of Wetlands	4.15	percent

Peak-Flow Statistics

Peak-Flow Statistics Parameters [Peak Statewide 2016 5156]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.84	square miles	0.16	512
ELEV	Mean Basin Elevation	992	feet	80.6	1948
LC06STOR	Percent Storage from NLCD2006	8.01	percent	0	32.3

Peak-Flow Statistics Flow Report [Peak Statewide 2016 5156]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	ASEp
50-percent AEP flood	244	ft^3/s	122	486	42.3
20-percent AEP flood	410	ft^3/s	203	829	43.4
10-percent AEP flood	547	ft^3/s	264	1130	44.7
4-percent AEP flood	750	ft^3/s	349	1610	47.1
2-percent AEP flood	922	ft^3/s	415	2050	49.4
1-percent AEP flood	1110	ft^3/s	484	2550	51.8
0.5-percent AEP flood	1310	ft^3/s	554	3100	54.1
0.2-percent AEP flood	1610	ft^3/s	648	4000	57.6

Peak-Flow Statistics Citations

Zarriello, P.J.,2017, Magnitude of flood flows at selected annual exceedance probabilities for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2016–5156, 99 p. (https://dx.doi.org/10.3133/sir20165156)

Low-Flow Statistics

Low-Flow Statistics Parameters [Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.84	square miles	1.61	149
BSLDEM250	Mean Basin Slope from 250K DEM	4.049	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.17	square mile per mile	0	1.29
MAREGION	Massachusetts Region	1	dimensionless	0	1

Low-Flow Statistics Flow Report [Statewide Low Flow WRIR00 4135]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SE	ASEp
7 Day 2 Year Low Flow	1.14	ft^3/s	0.395	3.17	49.5	49.5
7 Day 10 Year Low Flow	0.604	ft^3/s	0.163	2.08	70.8	70.8

Low-Flow Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

Flow-Duration Statistics

Flow-Duration Statistics Parameters [Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.84	square miles	1.61	149
DRFTPERSTR	Stratified Drift per Stream Length	0.17	square mile per mile	0	1.29
MAREGION	Massachusetts Region	1	dimensionless	0	1
BSLDEM250	Mean Basin Slope from 250K DEM	4.049	percent	0.32	24.6

Flow-Duration Statistics Flow Report [Statewide Low Flow WRIR00 4135]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SE	ASEp
50 Percent Duration	6.79	ft^3/s	3.61	12.7	17.6	17.6
60 Percent Duration	4.89	ft^3/s	2.55	9.32	19.8	19.8
70 Percent Duration	3.93	ft^3/s	1.69	9.03	23.5	23.5
75 Percent Duration	3.32	ft^3/s	1.45	7.52	25.8	25.8
80 Percent Duration	2.86	ft^3/s	1.26	6.41	28.4	28.4
85 Percent Duration	2.26	ft^3/s	0.95	5.28	31.9	31.9
90 Percent Duration	1.82	ft^3/s	0.741	4.37	36.6	36.6
95 Percent Duration	1.17	ft^3/s	0.425	3.11	45.6	45.6
98 Percent Duration	0.831	ft^3/s	0.257	2.55	60.3	60.3
99 Percent Duration	0.631	ft^3/s	0.184	2.04	65.1	65.1

Flow-Duration Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

August Flow-Duration Statistics

August Flow-Duration Statistics Parameters [Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.84	square miles	1.61	149
BSLDEM250	Mean Basin Slope from 250K DEM	4.049	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.17	square mile per mile	0	1.29
MAREGION	Massachusetts Region	1	dimensionless	0	1

August Flow-Duration Statistics Flow Report [Statewide Low Flow WRIR00 4135]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SE	ASEp
August 50 Percent Duration	2.5	ft^3/s	1.01	6.09	33.2	33.2

August Flow-Duration Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

Bankfull Statistics

Bankfull Statistics Parameters [Bankfull Statewide SIR2013 5155]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.84	square miles	0.6	329
BSLDEM10M	Mean Basin Slope from 10m DEM	8.13	percent	2.2	23.9

Bankfull Statistics Parameters [Appalachian Highlands D Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.84	square miles	0.07722	940.1535

Bankfull Statistics Parameters [New England P Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.84	square miles	3.799224	138.999861

Bankfull Statistics Parameters [USA Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.84	square miles	0.07722	59927.7393

Bankfull Statistics Flow Report [Bankfull Statewide SIR2013 5155]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	ASEp
Bankfull Width	32.8	ft	21.3
Bankfull Depth	1.68	ft	19.8
Bankfull Area	54.8	ft^2	29
Bankfull Streamflow	175	ft^3/s	55

Bankfull Statistics Flow Report [Appalachian Highlands D Bieger 2015]

Statistic	Value	Unit
Bieger_D_channel_width	33.7	ft
Bieger_D_channel_depth	1.95	ft
Bieger_D_channel_cross_sectional_area	66.8	ft^2

Bankfull Statistics Flow Report [New England P Bieger 2015]

Statistic	Value	Unit
Bieger_P_channel_width	43.3	ft
Bieger_P_channel_depth	2.1	ft
Bieger_P_channel_cross_sectional_area	92.3	ft^2

Bankfull Statistics Flow Report [USA Bieger 2015]

Statistic	Value	Unit
Bieger_USA_channel_width	24.4	ft
Bieger_USA_channel_depth	1.82	ft
Bieger_USA_channel_cross_sectional_area	48.3	ft^2

Bankfull Statistics Flow Report [Area-Averaged]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	ASEp
Bankfull Width	32.8	ft	21.3
Bankfull Depth	1.68	ft	19.8
Bankfull Area	54.8	ft^2	29
Bankfull Streamflow	175	ft^3/s	55
Bieger_D_channel_width	33.7	ft	
Bieger_D_channel_depth	1.95	ft	
Bieger_D_channel_cross_sectional_area	66.8	ft^2	
Bieger_P_channel_width	43.3	ft	
Bieger_P_channel_depth	2.1	ft	
Bieger_P_channel_cross_sectional_area	92.3	ft^2	
Bieger_USA_channel_width	24.4	ft	
Bieger_USA_channel_depth	1.82	ft	
Bieger_USA_channel_cross_sectional_area	48.3	ft^2	

Bankfull Statistics Citations

Bent, G.C., and Waite, A.M.,2013, Equations for estimating bankfull channel geometry and discharge for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2013–5155, 62 p., (http://pubs.usgs.gov/sir/2013/5155/)

Bieger, Katrin; Rathjens, Hendrik; Allen, Peter M.; and Arnold, Jeffrey G.,2015, Development and Evaluation of Bankfull Hydraulic Geometry Relationships for the Physiographic Regions of the United States, Publications from USDA-ARS / UNL Faculty, 17p. (https://digitalcommons.unl.edu/usdaarsfacpub/1515?utm_source=digitalcommons.unl.edu%2Fusdaarsfacpub%2F1515&utm_medium=PDF&utm_campaign=PDFCoverPages)

> Probability Statistics

Probability Statistics Parameters [Perennial Flow Probability]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.84	square miles	0.01	1.99

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
PCTSNDGRV	Percent Underlain By Sand And Gravel	29.62	percent	0	100
FOREST	Percent Forest	80.08	percent	0	100
MAREGION	Massachusetts Region	1	dimensionless	0	1

Probability Statistics Disclaimers [Perennial Flow Probability]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Probability Statistics Flow Report [Perennial Flow Probability]

Statistic	Value	Unit
Probability Stream Flowing Perennially	0.981	dim

Probability Statistics Citations

Bent, G.C., and Steeves, P.A.,2006, A revised logistic regression equation and an automated procedure for mapping the probability of a stream flowing perennially in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2006–5031, 107 p. (http://pubs.usgs.gov/sir/2006/5031/pdfs/SIR_2006-5031rev.pdf)

Maximum Probable Flood Statistics

Maximum Probable Flood Statistics Parameters [Crippen Bue Region 1]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.84	square miles	0.1	10000

Maximum Probable Flood Statistics Flow Report [Crippen Bue Region 1]

Statistic	Value	Unit
Maximum Flood Crippen Bue Regional	14400	ft^3/s

Maximum Probable Flood Statistics Citations

Crippen, J.R. and Bue, Conrad D.1977, Maximum Floodflows in the Conterminous United States, Geological Survey Water-Supply Paper 1887, 52p. (https://pubs.usgs.gov/wsp/1887/report.pdf)

Application Version: 4.16.1
StreamStats Services Version: 1.2.22
NSS Services Version: 2.2.1

DETERMINE THRUST IN 48 INCH PIPE AT BENDS & REQUIRED BALLAST

$\phi_{map} := 45\ deg$ — maximum angle of pipe bend on turn (2x22.5-degree)

$\gamma_w := 62.4\ \frac{lb}{ft^3}$ — unit weight of water

$El_w := 826.5\ ft$ — maximum elevation of water upstream during 2-yr

$El_p := 822.5\ ft$ — elevation of pipe invert

$d_{pipe} := 48\ in$ — inside diameter of pipe

$A_{pipe} := \pi \cdot \left(\frac{d_{pipe}}{2}\right)^2 = 12.566\ ft^2$ — flow area in pipe (full)

$OD := 54\ in$ — outside diameter of pipe

$D_{cover} := 2.5\ ft$ — depth of cover

$Q_p := 63\ \frac{ft^3}{s}$ — Flow rate of single pipe during 2 year storm event

$V_p := \frac{Q_p}{A_{pipe}} = 5.013\ \frac{ft}{s}$ — Velocity within pipe

$P_p := \gamma_w \cdot (El_w - El_p) = 249.6\ \frac{lb}{ft^2}$ $\quad P_p = 1.733\ \frac{lb}{in^2}$ — Pressure in pipe from water

Force from Flow

$R_{xp} := \gamma_w \cdot \pi \cdot \left(\frac{d_{pipe}}{2}\right)^2 \cdot V_p^{\ 2} \cdot (1 - \cos(\phi_{map})) = 179.415\ lbf$ — x-direction velocity force within pipe

$R_{yp} := \gamma_w \cdot \pi \cdot \left(\frac{d_{pipe}}{2}\right)^2 \cdot V_p^{\ 2} \cdot (\sin(\phi_{map})) = 433.147\ lbf$ — y-direction velocity force within pipe

Force from Pressure

$R_{xpr} := P_p \cdot \pi \cdot \left(\frac{d_{pipe}}{2}\right)^2 \cdot (1 - \cos(\phi_{map})) \cdot 32.2\ \frac{ft}{s^2} = 919.42\ lbf$ — x-direction pressure force within pipe

$R_{ypr} := P_p \cdot \pi \cdot \left(\frac{d_{pipe}}{2}\right)^2 \cdot (\sin(\phi_{map})) \cdot 32.2\ \frac{ft}{s^2} = (2.22 \cdot 10^3)\ lbf$ — y-direction pressure force within pipe

Sum of All Forces

$N_p := 1$ number of pipes

$\Sigma_x := R_{xp} \cdot N_p + R_{xpr} \cdot N_p = \left(1.099 \cdot 10^3\right)\ lbf$ Sum of forces in the x-direction

$\Sigma_y := R_{yp} \cdot N_p + R_{ypr} \cdot N_p = \left(2.653 \cdot 10^3\right)\ lbf$ Sum of forces in the y-direction

$R_f := \sqrt[2]{\Sigma_x^{\ 2} + \Sigma_y^{\ 2}} = \left(2.871 \cdot 10^3\right)\ lbf$ Resultant thrust force from velocity and pressure

Required Ballast - Bulk Bag

$W_p := 31.3\ lb$ weight of pipe/ft table 5-8 ADS design handbook

$W_w := \gamma_w \cdot A_{pipe} \cdot 1\ ft = 784.142\ lb$ weight of water per ft of pipe

$H_c := 2.5\ ft$ $Width_c := 3\ ft$ $L_c := 3\ ft$ Dimensions of equivalent bulk bag

$\gamma_{soil} := 115\ pcf$ unit weight of soil

$W_c := H_c \cdot L_c \cdot Width_c \cdot \gamma_{soil} = \left(2.588 \cdot 10^3\right)\ lbf$ weight of bulk bag

$\delta_{bag} := 26\ deg$ interface friction angle between bag and ground

$FS := 1.2$ Required factor of safety against sliding

$W_{breq} := \dfrac{R_f \cdot FS}{\tan\left(\delta_{bag}\right)} = \left(7.065 \cdot 10^3\right)\ lbf$ Required bag weight to resist sliding

$N_{bags} := \dfrac{\left(W_{breq}\right)}{W_c} = 2.73$ Number of Bags to Resist Sliding

Soil Resistance and thrust Block (assumed):

$W_p := 31.3\ lb$ weight of pipe/ft table 5-8 ADS design handbook

$W_w := \gamma_w \cdot A_{pipe} \cdot 1\ ft = 784.142\ lb$ weight of water per ft of pipe

$H_{con} := 2.5\ ft$ $Width_{con} := 2.5\ ft$ $L_{con} := 5\ ft$ — Dimensions of equivalent concrete block

$\gamma_{con} := 140\ pcf$ — unit weight of bloc

$W_{con} := H_{con} \cdot L_{con} \cdot Width_{con} \cdot \gamma_{con} = \left(4.375 \cdot 10^{3}\right)\ lbf$ — weight of concrete block

$\delta_{bag} := 22\ deg$ — interface friction angle between block and ground

$FS := 1.2$ — Required factor of safety against sliding

$$W_{breq} := \frac{R_f \cdot FS}{\tan\left(\delta_{bag}\right)} = \left(8.528 \cdot 10^{3}\right)\ lbf$$

Required bag weight to resist sliding

$$N_{bags} := \frac{\left(W_{breq}\right)}{W_{con}} = 1.949$$

Number of Blocks to Resist Sliding

Calculation Cover Sheet

Project #: 21136.00 **Calculation #:** 002
Project: Lock Pond Road Control of Water **Date:** 8/9/2023
Subject/Task: Discharge Rip Rap
Status: -
Revision Summary:

Revision #	Description	Date
1	Original Calculation	8/5/2021
2	Revised Calculation	8/9/2023

Description: Determine the required geometry of a riprap for dissipating energy from one 48-inch diameter bypass pipe.

References:

1. "Design Guide MD #6: Riprap Design Methods – A Collection of Design Examples and Related Information". Natural Resources Conservation Service, Maryland. January 2004.
2. Hwang, Ned and Houghtalen, Robert. "Fundamentals of Hydraulic Engineering Systems" 4th Edition. 1996.
3. HydroCAD results.

Assumptions:

1. Intake invert for pipe is at elevation 822.5.
2. Discharge invert for pipe is at elevation 821.5.
3. Length of the pipe is 170+/- feet.
4. Top of cofferdam elevation is 825.33 feet (allows head pressure build up).
5. From HydroCAD results analyzing the assumed pipe configuration maximum discharge flow is estimated to be 43 cfs from the 48-inch pipe.
6. Assume no tailwater/free discharge if upstream water is below 825.33 feet.
7. Riprap will be installed at the discharge to limit scour in the existing riverbed.

Methodology:

Flow Calculations: Flow rate from the assumed conditions were determined from a HydroCAD analysis with the above stated assumptions. An overall discharge capacity from the one 48-inch pipe of 43 cfs was determined. Through a 48-inch diameter (54-inch OD) pipe this equates to a pipe discharge velocity of 3.42 ft/sec

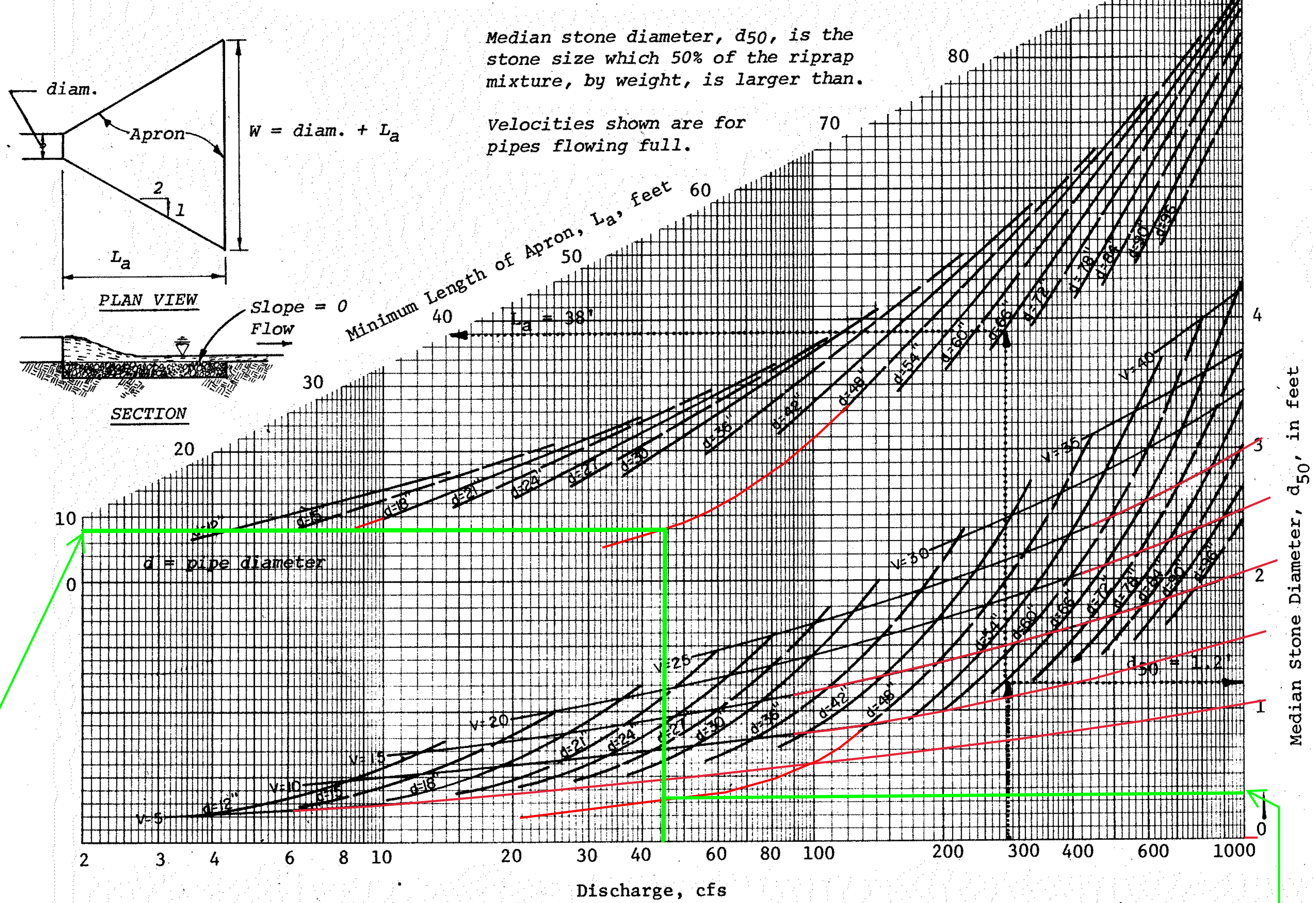
Conclusions: Under elevated tailwater conditions a 6 foot long by 7 foot-wide apron of 1-inch D_{50} material is required for the 48-inch pipe. Under minimum tailwater conditions a 8 foot long by 12 foot wide apron of 5-inch D_{50} material is required for the 48 inch pipe used.

Recommendations:

Pare's recommendation is to install the required M2.02.2 dumped riprap as called for on the plans at the pipe discharge. Pare notes that the size of the proposed riprap is larger than the required stone to protect from scour. Additionally, Pare notes that reducing the overall apron length/width at the pipe discharge to 8-foot long by 12 foot wide for the 48-inch diameter pipe is acceptable as shown on Sheet 2.0.

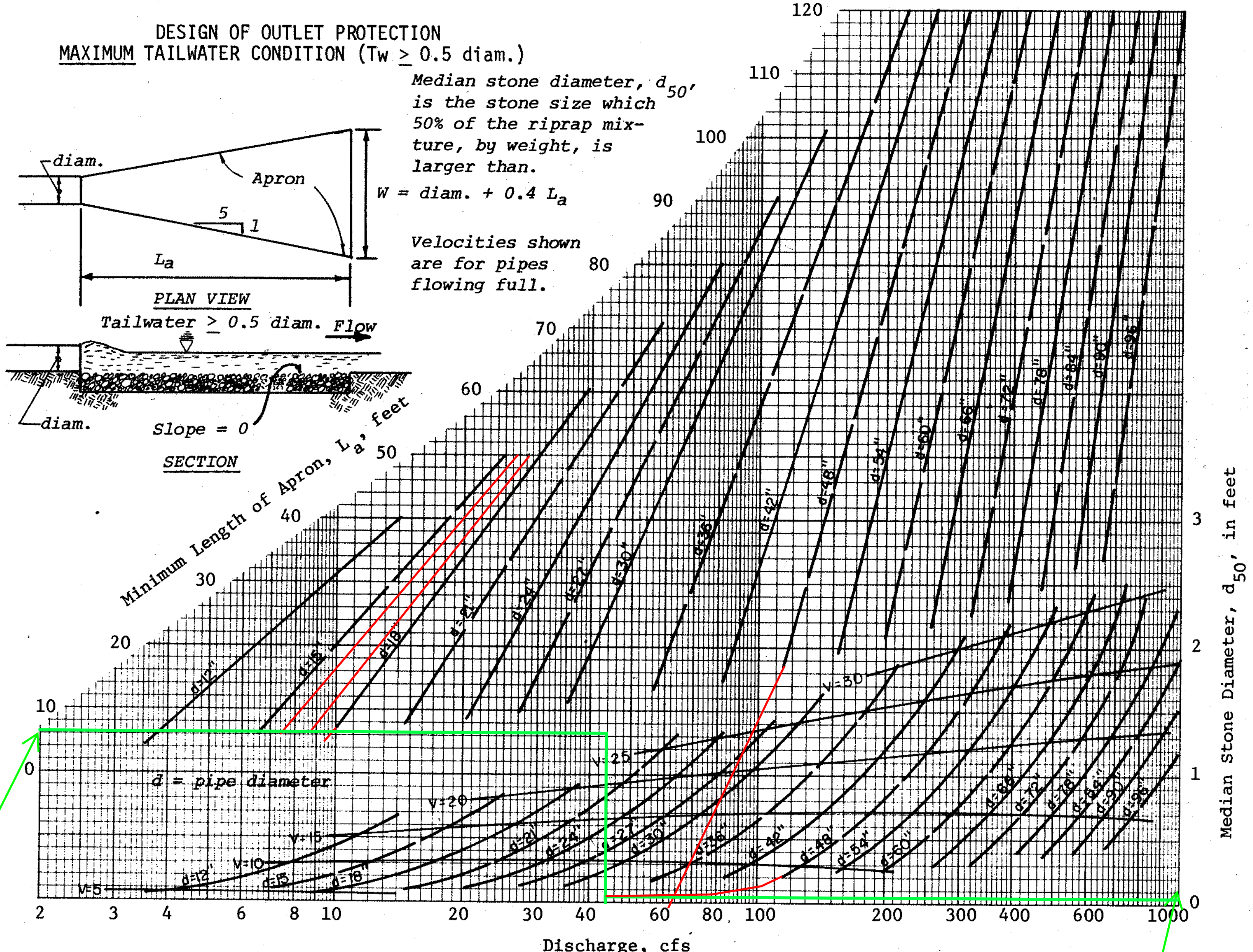
Pare notes that if existing channel bedding meets these requirements additional riprap is not needed.

DESIGN OF OUTLET PROTECTION
MINIMUM TAILWATER CONDITION (Tw <0.5 diam.)



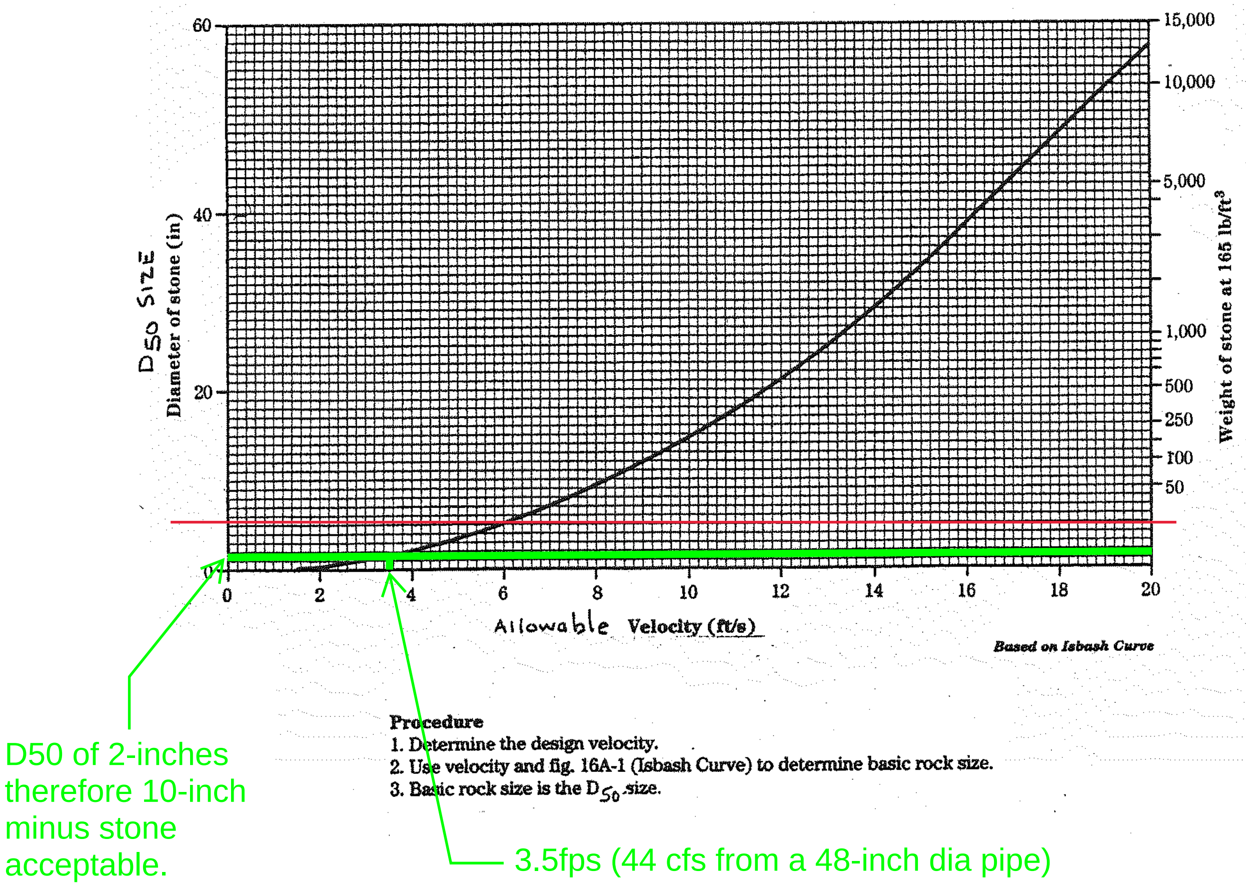
Requires a 8 foot long x 12 foot wide apron.

d50 of 5-inches



Requires a 6 foot long x 7 foot wide apron.

d50 of 1-inches

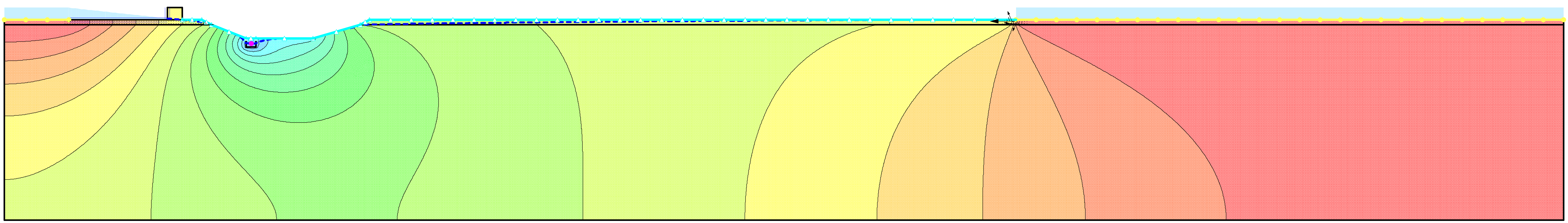


Procedure

1. Determine the design velocity.
2. Use velocity and fig. 16A-1 (Isbash Curve) to determine basic rock size.
3. Basic rock size is the D_{50} size.

COFFERDAM SEEPAGE AND SLOPE STABILITY - HIGH FLOW CONDITION
Top of Cofferdam = 825 feet
Upstream water = 825 feet
Downstream water = 822 feet
Excavation slopes = 2H:1V

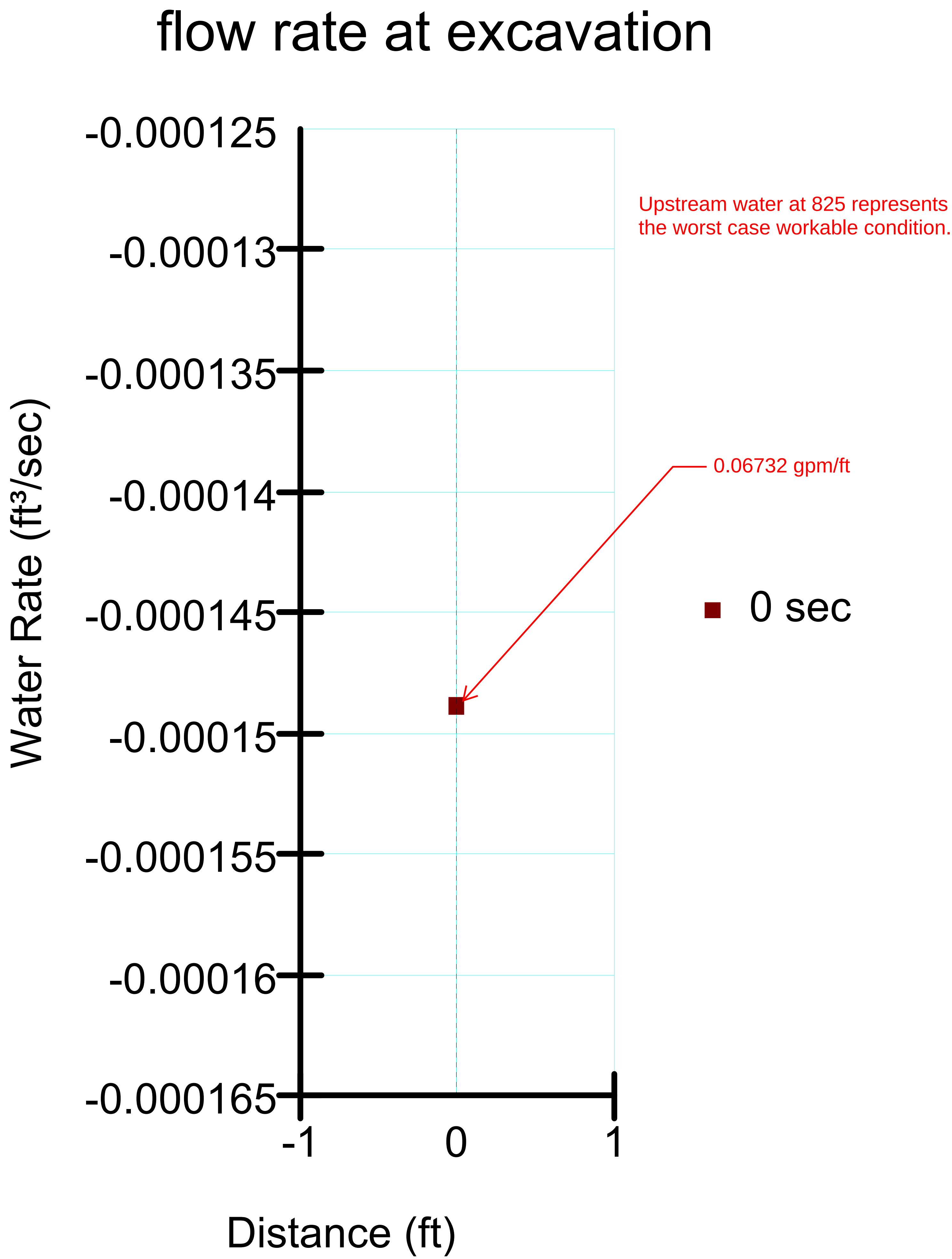
Upstream water at 825 represents the worst case workable condition.



Color	Name	Category	Kind	Parameters
Yellow	825 top of cofferdam flow	Hydraulic	Water Total Head	825 ft
Cyan	Drainage	Hydraulic	Water Rate	0 ft³/sec
Magenta	SUMP	Hydraulic	Water Pressure Head	0 ft

Color	Name	Material Model	Vol. WC. Function	K-Function	Ky'/Kx' Ratio	Rotation (°)
Light green	M.dense Sand	Saturated / Unsaturated	M.Dense Sand	m.dense sand	0.5	0
Orange	River Bed	Saturated / Unsaturated	River bed	River Bed	1	0
Olive	sand bags	Saturated / Unsaturated	M.Dense Sand	m.dense sand	1	0

2:1 Bags - seep const flow	
Seep&SLope - 825&827.gsz	
08/05/2021	1:241



flow rate at excavation
Upstream water at 825 represents the worst case workable condition.
0.06732 gpm/ft
0 sec
Water Rate (ft³/sec)
-0.000125
-0.00013
-0.000135
-0.00014
-0.000145
-0.00015
-0.000155
-0.00016
-0.000165
-1
0
1
Distance (ft)

COFFERDAM SEEPAGE AND SLOPE STABILITY - HIGH FLOW CONDITION

Top of Cofferdam = 825 feet

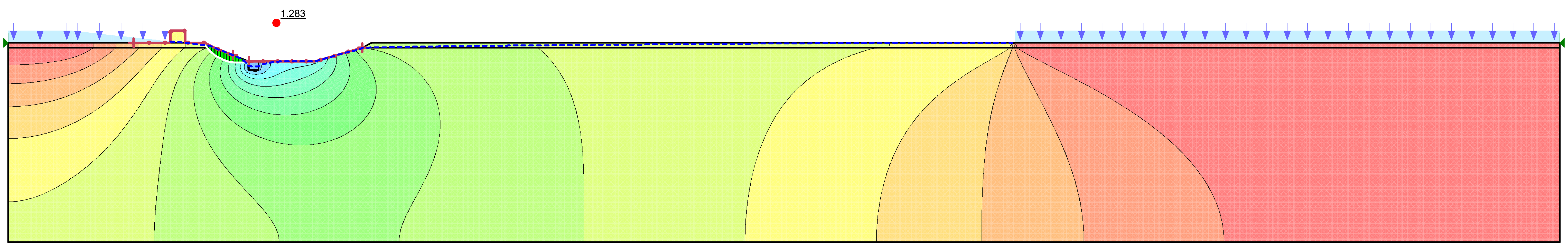
Upstream water = 825 feet

Downstream water = 822 feet

Excavation slopes = 2H:1V

Critical slope failure FS shown

Upstream water at 825 represents the worst case workable condition.



Color	Name	Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Vol. WC. Function	Residual Water Content (% of Sat WC) (%)
	M.dense Sand	Mohr-Coulomb	115	0	37	M.Dense Sand	20
	River Bed	Mohr-Coulomb	125	0	36	River bed	10
	sand bags	High Strength	115				

Slope Stability const flow	
Seep&SLope - 825&827.gsz	
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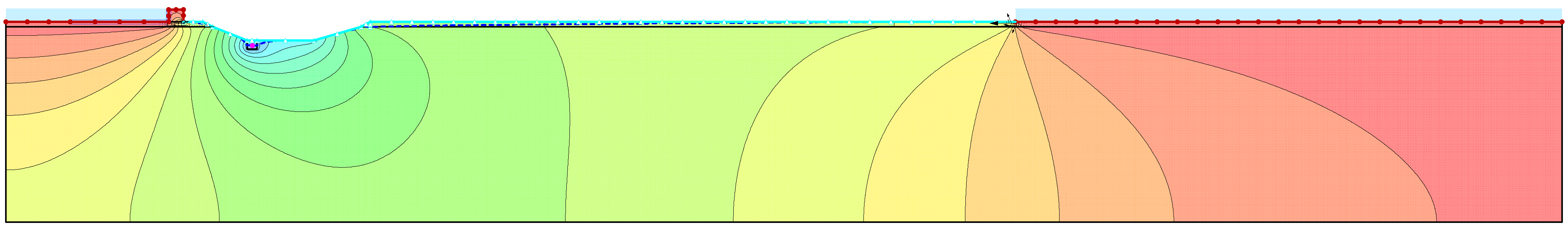
COFFERDAM SEEPAGE AND SLOPE STABILITY - HIGH FLOW CONDITION
Top of Cofferdam = 825 feet
Upstream water = 825.3 feet
Downstream water = 822 feet
Excavation slopes = 2H:1V

Upstream water at 825.3 represents the worst case non-workable condition as cofferdam is overtopping and work area is flooding.



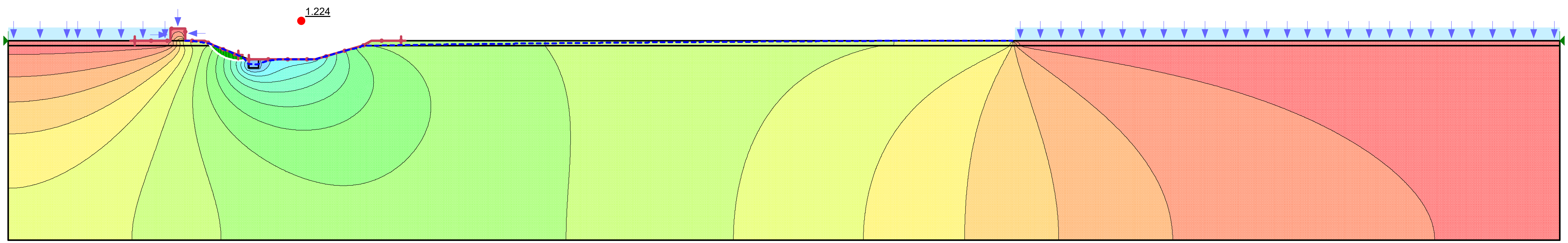
Color	Name	Material Model	Vol. WC. Function	K-Function	Ky'/Kx' Ratio	Rotation (°)
	M.dense Sand	Saturated / Unsaturated	M.Dense Sand	m.dense sand	0.5	0
	River Bed	Saturated / Unsaturated	River bed	River Bed	1	0
	sand bags	Saturated / Unsaturated	M.Dense Sand	m.dense sand	1	0

Color	Name	Category	Kind	Parameters
	825 flood flow START	Hydraulic	Water Total Head	825.2 ft
	Drainage	Hydraulic	Water Rate	0 ft³/sec
	SUMP	Hydraulic	Water Pressure Head	0 ft

2:1 Bags - seep flood flow start	
Seep&SLope - 825&827.gsz	
08/05/2021	1:241

COFFERDAM SEEPAGE AND SLOPE STABILITY - HIGH FLOW CONDITION
Top of Cofferdam = 825 feet
Upstream water = 825.3 feet
Downstream water = 822 feet
Excavation slopes = 2H:1V

Upstream water at 825.3 represents the worst case non-workable condition as cofferdam is overtopping, cofferdam has lost its seal, and work area is flooding.



Color	Name	Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Vol. WC. Function	Residual Water Content (% of Sat WC) (%)
	M.dense Sand	Mohr-Coulomb	115	0	37	M.Dense Sand	20
	River Bed	Mohr-Coulomb	125	0	36	River bed	10
	sand bags	High Strength	115				

Slope Stability flood flow start	
Seep&SLope - 825&827.gsz	
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ADS N-12® ST IB PIPE (ASTM F2648) SPECIFICATION

Scope
This specification describes 4- through 60-inch (100 to 1500 mm) ADS N-12 ST IB pipe (per ASTM F2648) for use in gravity-flow land drainage applications.

Pipe Requirements
ADS N-12 ST IB pipe (per ASTM F2648) shall have a smooth interior and annular exterior corrugations.

- 4- through 60-inch (100 to 1500 mm) pipe shall meet ASTM F2648.
- Manning's "n" value for use in design shall be 0.012.

Joint Performance
Pipe shall be joined using a bell & spigot joint meeting ASTM F2648. The joint shall be soil-tight and gaskets for diameters 12- through 60-inch, shall meet the requirements of ASTM F477. For diameters 4- through 10-inch, the joint shall be soil-tight using an engaging dimple connection. Gaskets shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during assembly.

Fittings
Fittings shall conform to ASTM F2306. Bell and spigot connections shall utilize a welded bell and valley or saddle gasket meeting the soil-tight joint performance requirements of ASTM F2306.

Material Properties
Material for pipe production shall be an engineered compound of virgin and recycled high density polyethylene conforming with the minimum requirements of cell classification 424420C (ESCR Test Condition B) for 4- through 10-inch (100 to 250 mm) diameters, and 435420C (ESCR Test Condition B) for 12- through 60-inch (300 to 1500 mm) diameters, as defined and described in the latest version of ASTM D3350, except that carbon black content should not exceed 4%. The design engineer shall verify compatibility with overall system including structural, hydraulic, material, and installation requirements for a given application.

Installation
Installation shall be in accordance with ASTM D2321 and ADS recommended installation guidelines, with the exception that minimum cover in trafficked areas for 4- through 48-inch (100 to 1200 mm) diameters shall be one foot. (0.3 m) and for 60-inch (1500 mm) diameter the minimum cover shall be 2 ft. (0.6 m) in single run applications. Backfill for minimum cover situations shall consist of Class 1 (compacted) or Class 2 (minimum 90% SPD) material. Maximum fill heights depend on embedment material and compaction level; please refer to Technical Note 2.02. Contact your local ADS representative or visit our website at www.adspipe.com for a copy of the latest installation guidelines.

Pipe Dimensions

	Nominal Diameter, in (mm)												
Pipe I.D. in (mm)	4 (100)	6 (150)	8 (200)	10 (250)	12 (300)	15 (375)	18 (450)	24 (600)	30 (750)	36 (900)	42 (1050)	48 (1200)	60 (1500)
Pipe O.D.* in (mm)	4.8 (122)	6.9 (175)	9.1 (231)	11.4 (290)	14.5 (368)	18 (457)	22 (559)	28 (711)	36 (914)	42 (1067)	48 (1219)	54 (1372)	67 (1702)

*Pipe O.D. values are provided for reference purposes only, values stated for 12 through 60-inch are ±1 inch. Contact a sales representative for exact values
**All diameters available with or without perforations.

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CUSTOMER SERVICE LINE

#14981-0-3 BULK BAG

SPEC#	**6B48SX**
Unfilled Dimension:	**43"x 39"x 38"**
Cubic Capacity:	**27 Cubic Feet**
Fill Spout:	**3oz./sq.yd. Coated UV Treated Woven Polypropylene 14" diameter x 18" with ½" web tie**
Top Panel:	**3oz./sq.yd. Coated UV Treated Woven Polypropylene**
Body Fabric:	**6oz./sq.yd. Uncoated UV Treated Woven Polypropylene**
Bottom:	**Solid**
Lifting Loops:	**(4) 10" Long 5000lb strength lifting loops**
Liner:	**None**
Safe Work Load:	**3000 lbs at 5:1 safety factor**

Sewage and Trash Pump DV200cSA

Overview:

The 12" suction x 8" discharge self-priming centrifugal DV200cSA trash pump provides up to a maximum of 4,600 gallons per minute pumping and up to 260 feet of head. This trailer mounted pump is equipped with a sound attenuated enclosure package. The standard Clean Prime priming system allows continuous operation without pumping liquid carryover to contaminate the outside environment. The pump is also equipped with a Run-Dry feature, which provides the mechanical seal faces with continuous lubrication, even when there is no liquid in the pump casing.

Features:

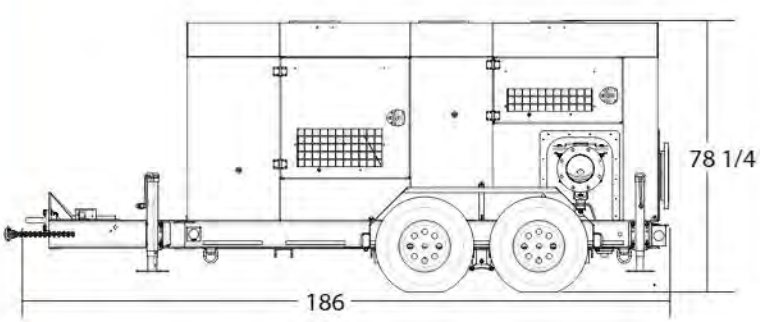
- Continuous self-priming
- Runs dry unattended
- 12 volt, electric start with auto-start capable control panel
- Flex coupled to diesel engine
- 24-hour minimum capacity fuel tank
- Air-Ejector (Venturi) priming system
- Cast iron wet end with closed impellers
- Replaceable wear plates
- SAE Mounted
- Suction lift up to 28ft.
- Sound Attenuation: 70dB(A) @ 30'

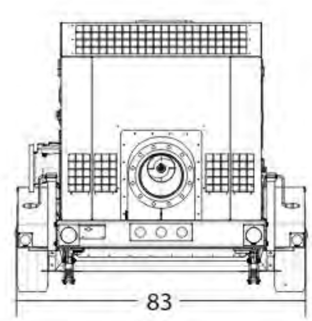
Specs:

Maximum Flow	4,600 GPM
Maximum Head	260 feet
Pump Size	12" x 8"
Maximum Solids Handling	3.375 inches
Dry weight	8,430 lbs.
Footprint: Trailer mounted model	186" x 83"
Fuel Capacity (usable)	180 gallon
Fuel consumption	7 gph @ 1,800 RPM

Accessories:

- Spillguard
- Suction and Discharge Hoses
- Fuel Nurse Tank

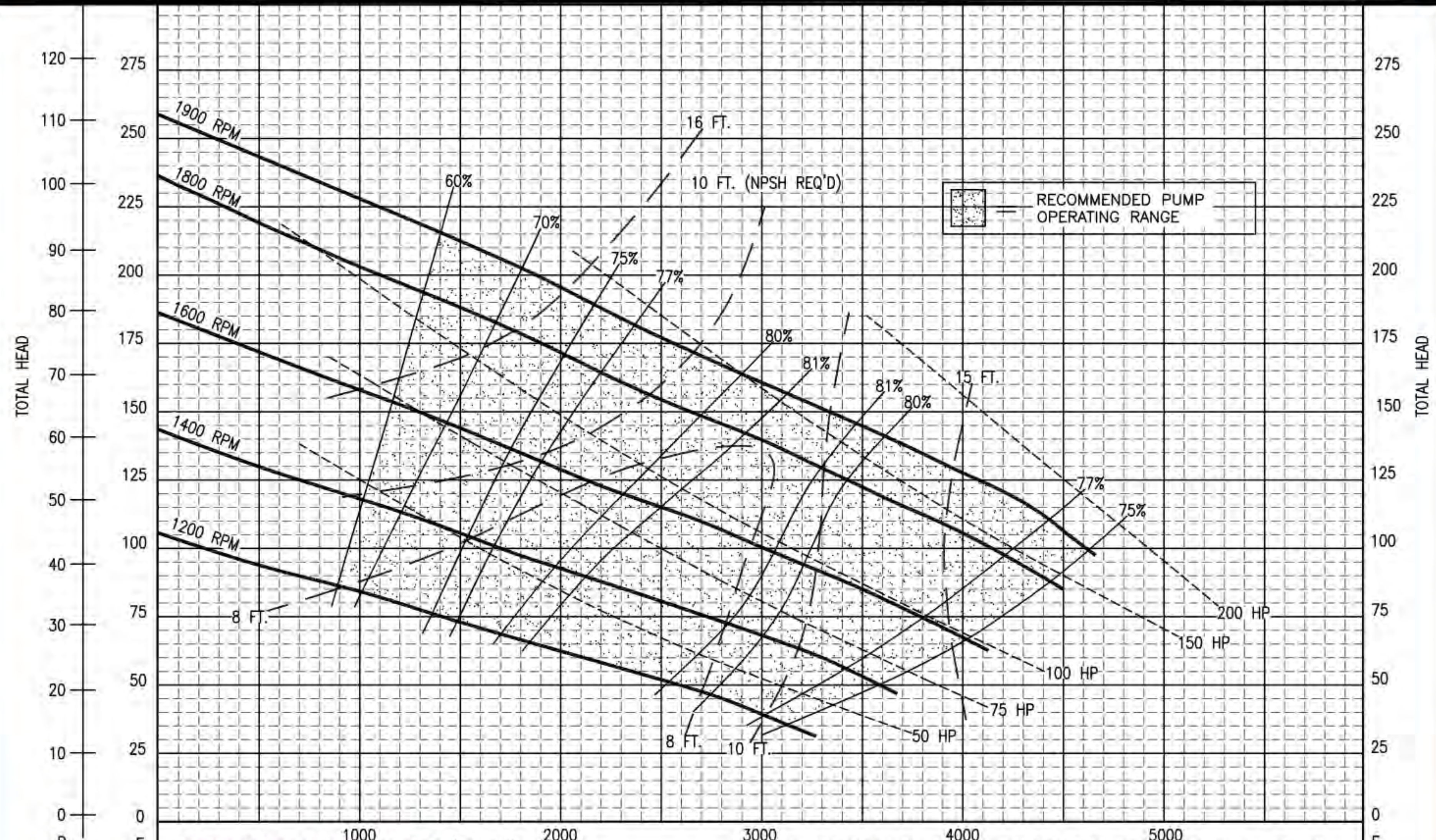




Rain For Rent

CURVE: 01-0133-02-16	PUMP : DV-200c

SUCTION	DISCHARGE	MAX. SPHERE	IMPELLER	IMPELLER	IMPELLER & WEAR RINGS
12"	8"	3.375"	2 VANE	14.00"	CAST IRON



FLOW – CLEAR WATER PERFORMANCE (US GPM)

–PUMP PERFORMANCE CURVES DO NOT INCLUDE CHECK VALVE LOSSES

–POWER CURVES DO NOT INCLUDE PRIMING SYSTEM POWER CONSUMPTION

CONFIDENTIAL

DIRTBAG®

DEWATERING BAG

SEDIMENT AND PERIMETER CONTROL

FILTERS SILT, SAND, AND FINES OUT OF PUMPED WATER

Dirtbag dewatering bags remove silt, sand, and other debris from pumped water on construction sites, ponds, dredging locations and more.

The bag easily connects to a pump discharge hose using the 4” neck and sewn in attachment straps. To increase the effectiveness of Dirtbag’s filtration system, ACF Environmental recommends placing the product on a bed of hay bales or aggregate to maximize water flow through the surface area of the bag. Doing so also helps protect the surrounding area from erosion, sediment displacement and the pollution of receiving waters. Under most circumstances, a 15x15 Dirtbag can pass up to 500 gallons of water per minute.

USE GUIDELINES:

- **Dirtbag must be monitored at all times during use (over-filling may cause rupture)**
- Flow and removal rates vary based on particle size/ sediment composition
- To increase flow rate place Dirtbag on aggregate, straw bales, or other porous surfaces
- Dirtbag is full when it can no longer efficiently pass water at a reasonable rate

ADVANTAGES:

- High flow rate
- 15’ x 15’ Dirtbag is rated up to 500 GPM pump
- Built-in neck receives up to 4” discharge hose
- Removes sediment, trash, and debris
- Economical alternative to other methods
- Custom sizes available upon request

9.19

Full product specifications are available on the Dirtbag product page at www.acfenvironmental.com

SPECIFICATIONS

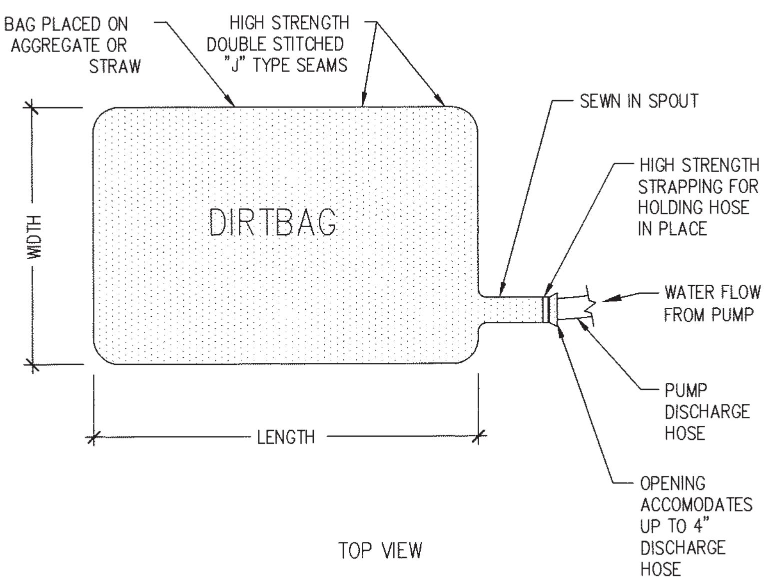
Dirtbag sizes include: 4′ x 6′ | 5′ x 5′ | 8′ x 10′ | 10′ x 10′ | 15′ x 15′ | and custom sizes on request

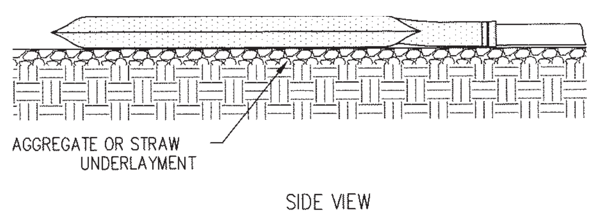
PROPERTY	TEST METHOD	MARV
Weight	ASTM D3776	8 oz/yd
Grab Strength (Tensile)	ASTM D4632	205 lbs
CBR Puncture	ASTM D6241	525 lbs
UV Resistance	ASTM D4355	70%
Apparent Opening Size (AOS)	ASTM D4751	80 US std. sieve
Flow Rate	ASTM D4491	90 gal/min/ft^2
Permittivity	ASTM D4491	1.4 sec^{-1}

Dirtbag® seam test results (ASTM D4884)

NONWOVEN DIRTBAG	WOVEN DIRTBAG
Maximum load 786 lbs	Maximum load 934 lbs
Maximum strength 1178 lb/ft	Maximum strength 1402 lb/ft

NOTE: Each test result was derived from a material failure rather than a stitch failure.





Testing Details:

Dirtbag has been tested under ASTM D-7880 and ASTM-7701. These are standard test methods for determining flow rate of water and suspended solids retention from a closed geosynthetic bag. Testing summary available upon request.

ACF ENVIRONMENTAL
LET'S GET IT DONE
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acfenvironmental.com

Shutesbury Culvert Replacement - 2023 Project Schedule - Updated 8/21/23