Proposed Amendments
to
the Fairfax County Public Facilities Manual

Interpretation of the PFM

Amendment the Public Facilities Manual, §1-0100 (Introduction), the lead in paragraph and §1-0100.6 and §1-0100.7, to read as follows:

1-0100 INTRODUCTION

The Public Facilities Manual (PFM) sets forth the guidelines for the design of all public facilities constructed to serve development. In adopting its Subdivision Ordinance in 1975, the Board incorporated specific reference to the requirements described in the PFM. Similarly, in 1978, the Board adopted a Zoning Ordinance which made specific reference to the requirements in this PFM.

1-0100.~~7~~6 The Director is the designated official to administer the standards and requirements contained in the PFM. ~~He shall~~ The Director will make the final decision on questions regarding the PFM after having reviewed recommendations from designated departments, authorities, boards, and committees. Wherever the term “Director” is used in this PFM without further organizational reference, the reference shall be interpreted as meaning the Director, Land Development Services ~~Department of Public Works and Environmental Services.~~ (See Definitions §13-0300.)

1-0100.~~6~~7 The Director, in administering these standards, shall treat them as guidelines rather than mandates ~~unless the language clearly specifies otherwise~~. Except as expressly provided otherwise in this document, the Director can approve a waiver where strict application of the standard cannot be met for a particular site or where new or creative designs are proposed that meet the intent of the provisions, provided a statement of justification for deviating from the PFM, including supporting data and information, accompanies any submission seeking waiver. The Director may allow for a variation of a given standard where the effect of such variation is in keeping with established engineering practice and procedure. ~~Variations from mandatory policies or requirements will not be permitted.~~

Amendment the Public Facilities Manual, §13-0200 (Interpretations), §13-0200.2, to read as follows:

13-0200.2 The words “shall” and “must” are mandatory minimum requirements; however, “~~shall” and “must” may be~~ the Director may waive these mandatory minimum requirements (See Introduction § 1-0100.7.

Hydraulic Grade Line

Amend §6-0904, Energy and Hydraulic Grade Line, to read as follows:

6-0904 ~~Energy and~~ Hydraulic ~~Gradients~~ Grade Line. ~~The hydraulic gradient for a storm sewer system is a line connecting points to which water will rise in manholes and inlets throughout the system during the design flow. The energy gradient is a line drawn a distance $V^2/2g$ above the hydraulic gradient of the pipes.~~
The hydraulic grade line (HGL) is a measure of flow energy. In open channel flow the HGL coincides with the water surface elevation, and in pressure flow it is a line that connects the elevation to which the water would rise in piezometer tubes along the pipe. The HGL aids the designer in determining the acceptability of the proposed storm sewer system by establishing the elevations to which water will rise in the structures (inlets, manholes, etc.) along the system for the recommended design frequency storm flow. Inlet surcharging and possible access hole lid displacement can occur if the HGL rises above the ground surface. In addition, even though each pipe is designed as non-pressure flow, cumulated energy losses and tailwater conditions at the outlet may cause the system to flow under pressure, especially in low lying areas. Improper and proper pipe design for pressure flow situations is provided in Plate 94-6.

6-0904.1 Unless waived by the Director, the HGL shall be calculated for all proposed storm sewer systems using the method set forth in the latest edition of the VDOT drainage manual. The hydraulic grade line computations begin at the system outfall with a known water surface elevation. However, the Director may also require analysis further downstream of the outfall pipe to demonstrate whether conditions exist provided a statement of justification for deviating from the PFM is on the plan.

6-0904.~~4~~2 Where a proposed drainage system connects to an existing drainage system the HGL ~~hydraulic gradient~~ at the point of junction shall be obtained from the HGL ~~hydraulic gradient~~ computation of the existing system on file with ~~DPWES.~~ LDS or the Director may approve an alternative location to begin the HGL computations given adequate justification on the plan.

6-0904.~~11~~.3 Pressure Flow. Storm sewer systems may be designed for pressure flow; however, all proposed pressure flow systems should be coordinated with DPWES in the preliminary design stage. The HGL ~~hydraulic gradient~~ for the design flows ~~shall~~ should be generally at least 1~~'~~ ft. below the established ground elevation and no more than 5~~'~~ ft. above the crown of the pipe. For curb opening inlets the gutter flow line is considered the established ground elevation.

~~6-0904.1 At storm sewer junctions the total energy loss at the junction, H_L, is the difference in elevation between the energy grade lines of the upstream and downstream pipes. To establish these gradients for a system, it is necessary to start at a point where the hydraulic and energy gradients are known or can readily be determined.~~

~~6-0904.2 Generally, when the energy and hydraulic gradients must be determined, the pipes are assumed to have uniform flow. For uniform gravity flow and for pressure flow, the friction loss in storm sewer pipes may be determined by the Manning Formula as follows:~~

$h_f = SL = [(nV)^2/2.208r^{1.33}]\,L$

Where:
h_f = Friction loss in pipe (ft.)
S = Slope of the energy grade line
n = Roughness coefficient
V = Discharge velocity (fps)
r = Hydraulic radius (ft.)
L = Length of line (ft)

6-0904.3 Few design situations will ever require determination of energy and hydraulic gradients for non-uniform flow conditions. Should non-uniform flow analysis be necessary, designers are referred to standard hydraulic texts for determining gradients for non-uniform flow.

6-0904.4 Where a proposed drainage system is connected to an existing drainage system the hydraulic gradient at the point of junction shall be determined from the hydraulic gradient computation of the existing system on file with DPWES.

6-0904.5 The total energy losses at a junction, H_L, is assumed to be made up of one or more of the following losses:

6-0904.5A Expansion loss, h_i, when stormwater enters the junction.

6-0904.5B Contraction loss, h_o, when stormwater leaves the junction.

6-0904.5C Bend loss, h_Δ, due to the change in horizontal direction of stormwater velocity.

These losses may be estimated as follows:

$$H_L = h_i + h_o + h_\Delta = 0.1\,\frac{V_i^2}{2g} + 0.5\,\frac{V_o^2}{2g} + K_\Delta\,\frac{V_i^2}{2g}$$

Where:
H_L = Total Energy Loss
h_i = Expansion Loss (flow in to junction)
h_o = Contraction Loss (flow out of junction)
h_Δ = Bend Loss
V_i = Velocity in fps, Q/A, of upstream pipe
V_o = Velocity in fps, Q/A, of downstream pipe
Δ = Horizontal angle in degrees between the direction of flow of incoming and outgoing pipes
K_Δ = Bend loss coefficient (see Plates 13-6 and 14-6)

6-0904.6 Considerable judgement must be used when applying the above energy loss equations. Some general rules to be used when applying these equations are as follows:

~~6-0904.6A When two or more pipes discharge into a manhole or inlet type structure, the expansion loss for the junction shall be calculated for the pipe discharge that produces the maximum momentum.~~

~~6-0904.6B When two or more pipes discharge into a manhole or inlet type structure at different angles of flow with the outgoing pipe, the junction bend loss shall be calculated for the pipe discharge that produces the maximum momentum.~~

~~6-0904.6C Prefabricated "T", "Y", and bend sections are assumed to have bend losses only.~~

~~Momentum may be determined as follows: M = Q(w/g)V~~

~~Where:~~
~~M = Momentum~~
~~Q = Pipe discharge (cfs)~~
~~w/g = Density of water 62.4 lbs/ft~~^{3}
~~V = Discharge velocity in fps~~

~~6-0904.7 Since the density of water can be considered constant, the pipe discharge with the largest product, QV, will have the maximum momentum.~~

~~6-0904.8 The energy loss for the initial inlet(s) of a storm sewer system may be assumed to be 0.3 times the velocity head in the outlet pipe.~~

~~6-0904.9 The above energy loss formulas can be readily solved with the use of Plate 14-6 and a transparency made to conform to Plate 13-6.~~

~~6-0904.10 Non-pressure Flow. Storm sewer systems generally shall be designed as non-pressure systems. In general, if a drop in the structure between the inverts of the incoming and outgoing pipes is approximated by a value equal to or greater than the junction energy loss, the system can be assumed to be non-pressure flow.~~

~~6-0904.11 Pressure Flow. Storm sewer systems may be designed for pressure flow; however, all proposed pressure flow systems should be coordinated with DPWES in the preliminary design stage. The hydraulic gradient~~ grade line ~~for the design flows shall be at least 1 foot below the established ground elevation and no more than 5 feet above the crown of the pipe. For curb opening inlets the gutter flow line is considered the established ground elevation.~~

~~6-0904.12 Drop. If possible the energy losses through a junction should be accounted for by a drop across the junction. The equations on Plate 15-6 show the method for computing the drop~~

Amend §6-0905.3A and §6-0905.4, and delete §6-0905.3B, to read as follows:

6-0905.3~~A~~ For storm sewer systems~~, or portions of systems designed for pressure flow,~~ submit a storm sewer profile with ~~energy and~~ hydraulic ~~gradients~~ grade lines drawn on it. ~~shall be submitted for the portion of the system that experiences pressure flow.~~

~~6-0905.3B Energy and hydraulic gradients do not need to be submitted for non-pressure systems.~~

6-0905.4 Energy loss calculations ~~at storm sewer junctions~~ shown on VDOT's form, Hydraulic Grade Line Computations.

Amend §6-1007, Energy and Hydraulic Gradients, and §6-1007.1 and §6-1007.2, to read as follows:

6-1007 Energy and Hydraulic ~~Gradients~~ Grade Lines in Open Channel Systems (Reference Plates 24-6 through 26-6)

6-1007.1 The hydraulic ~~gradient~~ grade line for an open channel system is the water surface. The energy ~~gradient~~ grade line is a line drawn a distance $V^2/2g$ above the hydraulic grade line ~~gradient~~. At channel junctions, the total energy loss at the junction, HL, is the difference in elevation between the energy grade lines of the upstream and downstream channels. To establish these gradients for a system, it is necessary to start at a point where the energy and hydraulic gradients are known or can readily be determined.

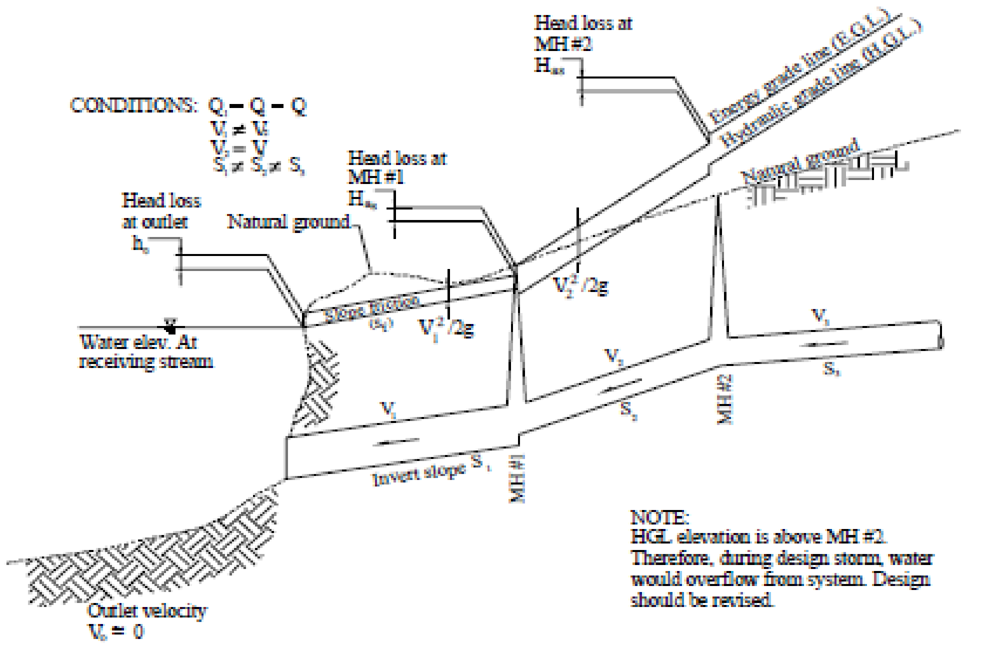
6-1007.2 Generally, when the energy and hydraulic ~~gradients~~ grade lines must be determined, the channels are assumed to have uniform flow. For uniform flow the friction loss along the channel may be determined by the Manning Equation~~Formula~~ as discussed ~~above and in § 6-0902~~ in the latest edition of the VDOT Drainage Manual.

Amend Chapter 6, Table of Contents and List of Plates in accordance with the amendment.
Amend Chapter 6, to add Plate 94-6 (Surcharge Full Flow – Improper and Proper Design), and delete Plates 12-6, 13-6, 14-6 and 15-6, to read as follows:

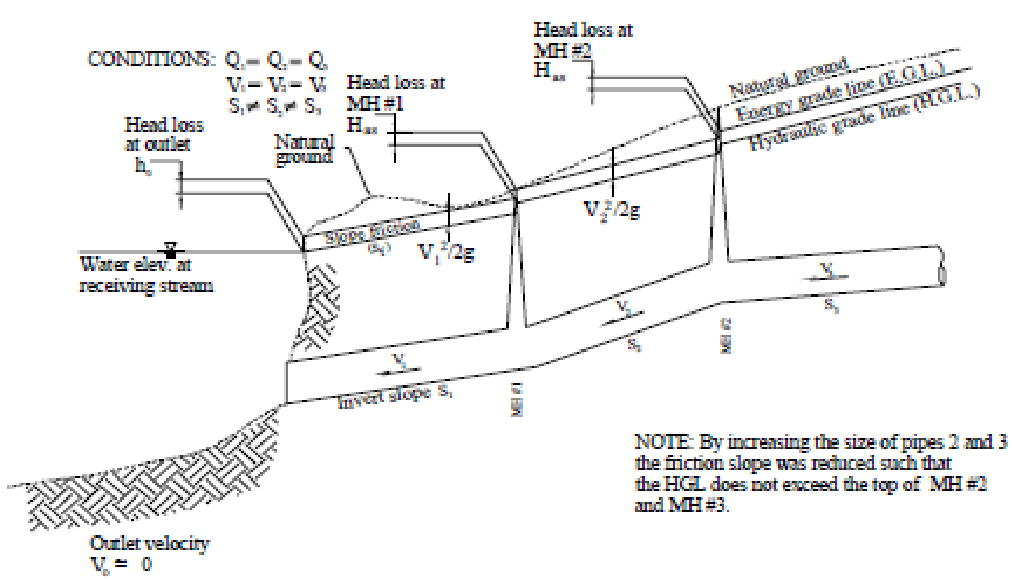
FAIRFAX COUNTY PUBLIC FACILITIES MANUAL

SURCHARGE FULL FLOW

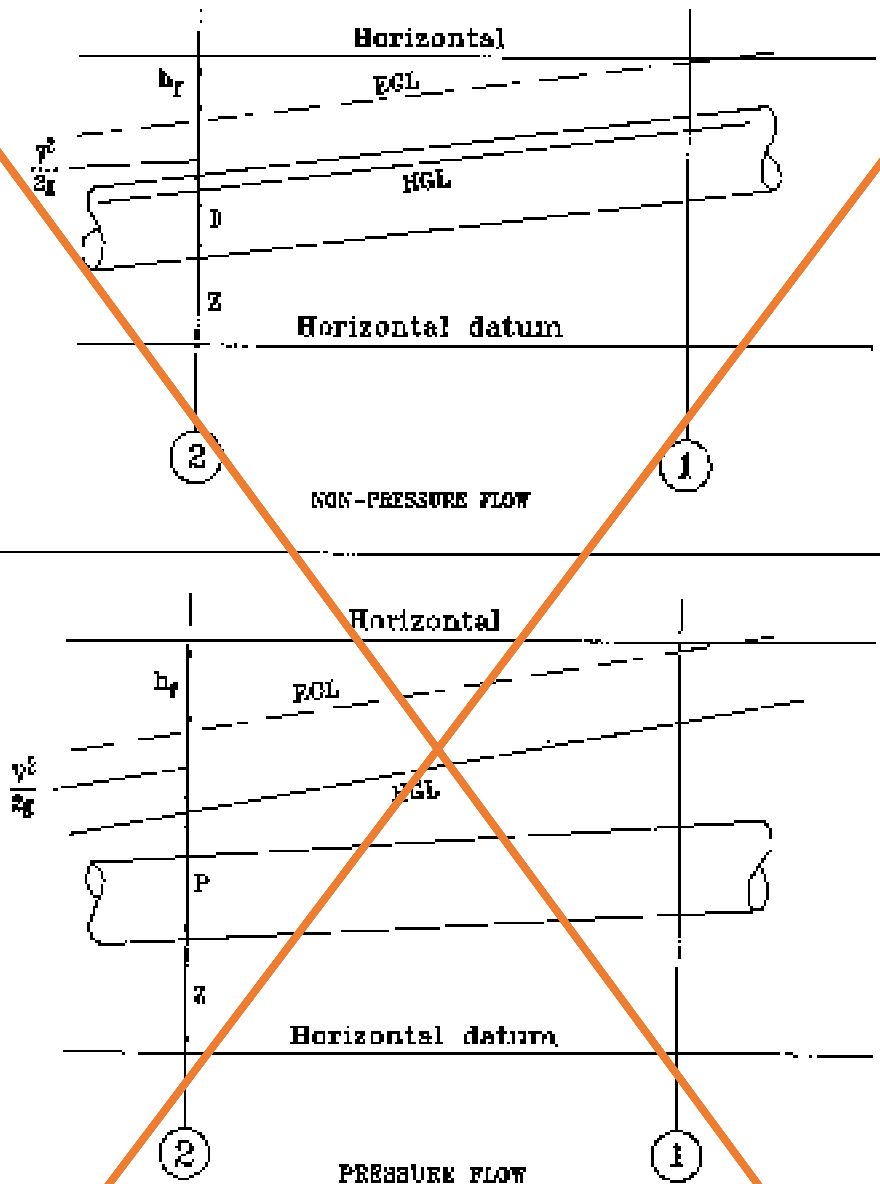
IMPROPER DESIGN



PROPER DESIGN

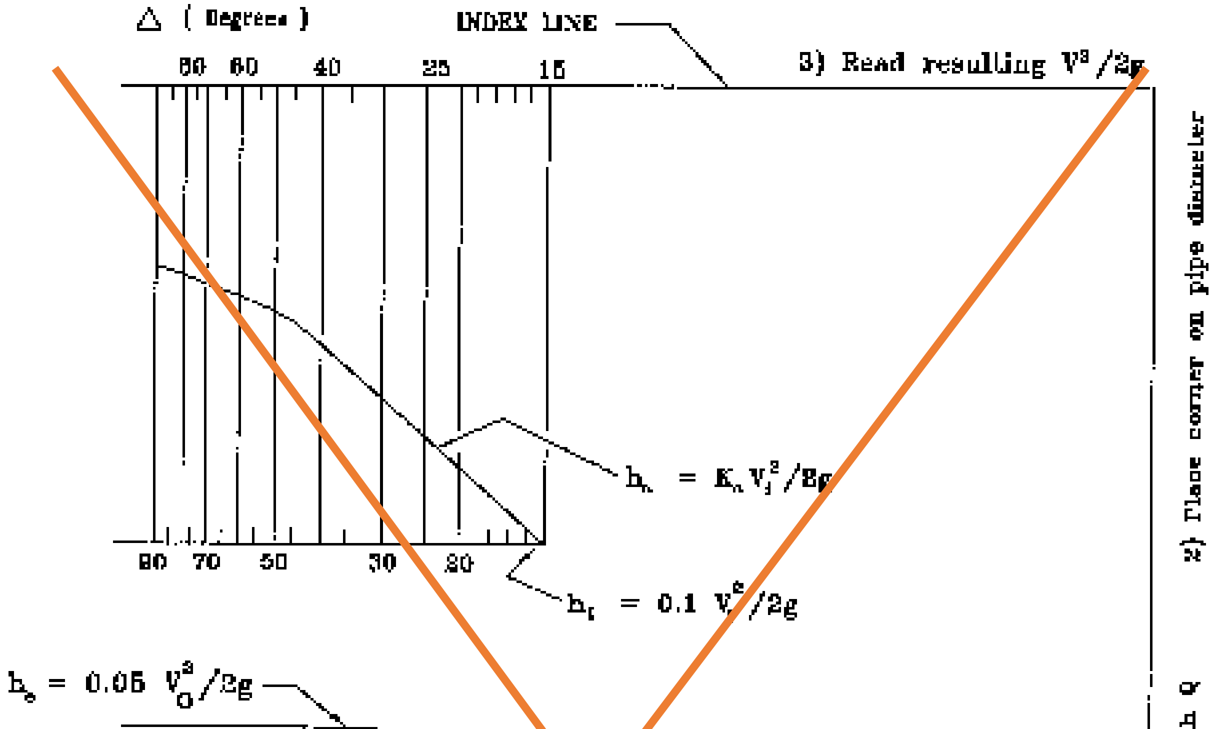


Ref. 6-0904	**SURCHARGE FULL FLOW**	Plate No.	Std. No.
	IMPROPER AND PROPER DESIGN	94-6	



Z = Distance above horizontal datum
D = Depth of flow
P = Pressure head
$\frac{V^2}{2g}$ = Velocity head
h_f = Friction loss between section 1 and 2
EGL = Energy grade line
HGL = Hydraulic grade line

Ref. Sec. 6-0904 Rev. 1-00	CLOSED CONDUIT	PLATE NO. 12-6	STD. NO.



GIVEN: $Q_i = 43$ CFS $D_i = 24"$
$Q_o = 49$ CFS $D_o = 27"$ $\Delta = 55°$

FIND: h_i, h_o, h_Δ, H_L

SOLUTION:

1. Line up vertical line with $Q_i = 43$ CFS and $D_i = 24"$, read $V_i^2/2g = 2.83$ and $h_i = 0.28$ from the top and middle horizontal lines, respectively.

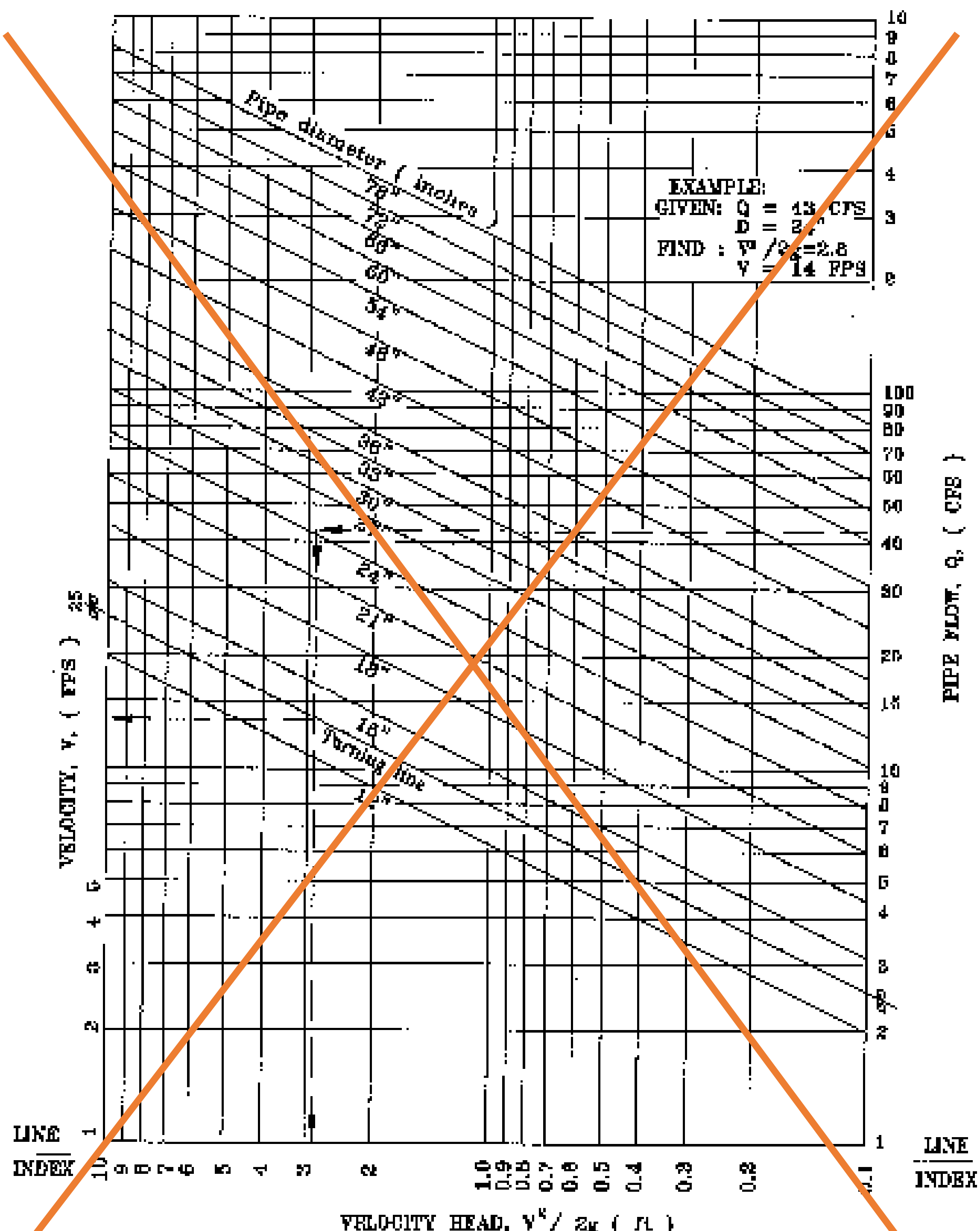
2. Line up vertical line with $Q_o = 49$ CFS and $D_o = 27"$, read $V_o^2/2g = 2.2$ and $h_o = 0.11$ from the top and bottom horizontal lines, respectively.

3. Overlay horizontal Δ degree line at the point $\Delta = 55°$ with the horizontal index line at $V_i^2/2g$, read value of h_Δ at the h_Δ line. $h_\Delta = 0.94$

4. $H_L = h_i + h_o + h_\Delta = 1.33$

Energy loss due to angles less than 15° are considered negligible.

Ref. Sec. 6-0904.6C, 6-0904.9 Rev. 1-00	ENERGY LOSSES AT STORM SEWER JUNCTIONS	PLATE NO. 13-6	STD. NO.



Ref. Sec. 6-0904.6C, 6-0904.9 Rev. 1-00	ENERGY LOSSES AT STORM SEWER JUNCTIONS	PLATE NO.	STD. NO.
		14-6	

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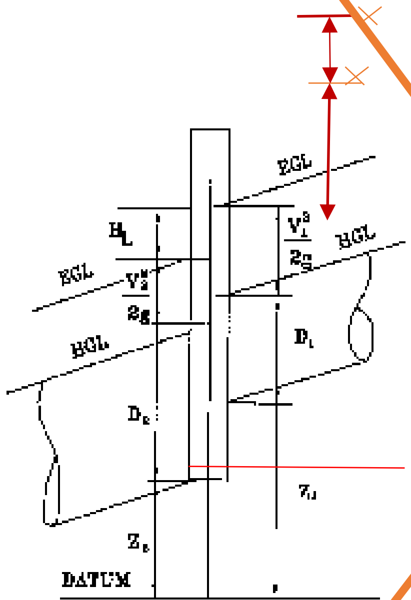
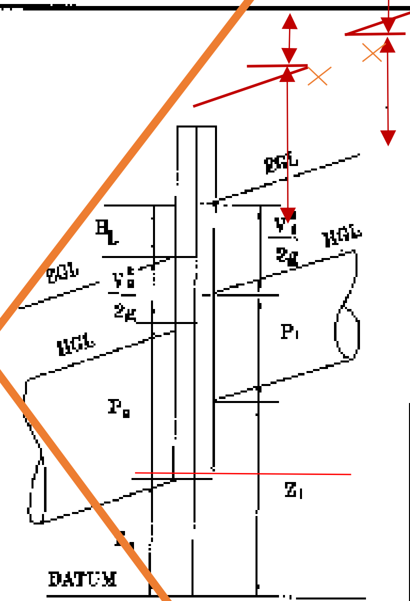


NON- PRESSURE FLOW

$$\text{Drop} = Z_1 - Z_2 = (D_2 - D_1) + \left(\frac{V_2^2}{2g} - \frac{V_1^2}{2g}\right) + H_L$$

$$H_L = h_i + h_o + h_\Delta$$

For non-pressure flow, and approximation of drop, $Z_1 - Z_2$, equal to H_L may be used.



PRESSURE FLOW

$$\text{Drop} = Z_1 - Z_2 = (P_2 - P_1) + \left(\frac{V_2^2}{2g} - \frac{V_1^2}{2g}\right) + H_L$$

$$H_L = h_i + h_o + h_\Delta$$

Z_1 , Z_2 = Incoming and outgoing pipe invert
D_1 , D_2 = Incoming and outgoing depth of flow, assumed to be pipe diameter
P_1 , P_2 = Pressure heads for incoming and outgoing pipes
$\frac{V_1^2}{2g}$, $\frac{V_2^2}{2g}$ = Velocity heads for incoming and outgoing pipes
EGL = Energy grade line
HGL = Hydraulic grade line
H_L = Total energy loss thru junction

Ref. Sec. 6-0904.12 Rev. 1-00	CLOSED CONDUIT JUNCTION	PLATE NO. 15-6	STD. NO.

Debris Control Devices (Trash Racks)

Amend Chapter 6-1604 (Design Guideline for Spillways), paragraph 8B and 8C, where deletions are shown as strikeouts and insertions are underlined, to read as follows:

6-1604.8B Debris control devices for dry stormwater management ponds are ~~may be~~ required for low level intakes ~~at the pond bottom.~~ that are less than 15 inches in diameter or equivalent size opening, and may be required for other opening sizes in accordance with § 1604.8. The preferred debris control structure is shown in Plates 61A-6 and 61B-6. ~~In these situations, debris control structures such as those discussed in the FHWA publication entitled "Debris Control Structures (HEC No. 9)" should be considered where appropriate.~~

6-1604.8C Debris control devices for extended dry stormwater management facilities are required for the low flow orifice controlling the extended drawdown period. The preferred trash rack detail for those facilities is shown in Plates ~~61-6~~ 61A and 61-B.

Amend Chapter 6-1604 (Design Guidelines for Spillways), to add paragraph 12, to read as follows:

6-1604.12 Concrete Apron

6-1604.12A Unless otherwise approved by the Director, a concrete apron shall be provided in front of low level intakes or low flow orifices to provide a stable working platform for maintenance personnel and facilitate easy cleanout of debris in accordance with Plate 61B-6.

Amend Chapter 6, Table of Contents and List of Plates in accordance with the amendment. Amend Chapter 6, to delete existing Plate 61-6 (BMP Extended Drawdown Device (Example Detail), and add Plates 61A-6 (Low Flow/BMP Drawdown Device) and 61B-6 (Low Flow/BMP Drawdown Device (Mounting Details), to read as follows:

Stormwater Maintenance Specifications

Amend Public Facilities Manual Section 6-1306 (Maintenance Design Considerations), to add paragraph 4, to read as follows:

6-1306.4 The standard maintenance specifications for the proposed privately maintained stormwater management/BMP facilities must be incorporated into the construction plan.

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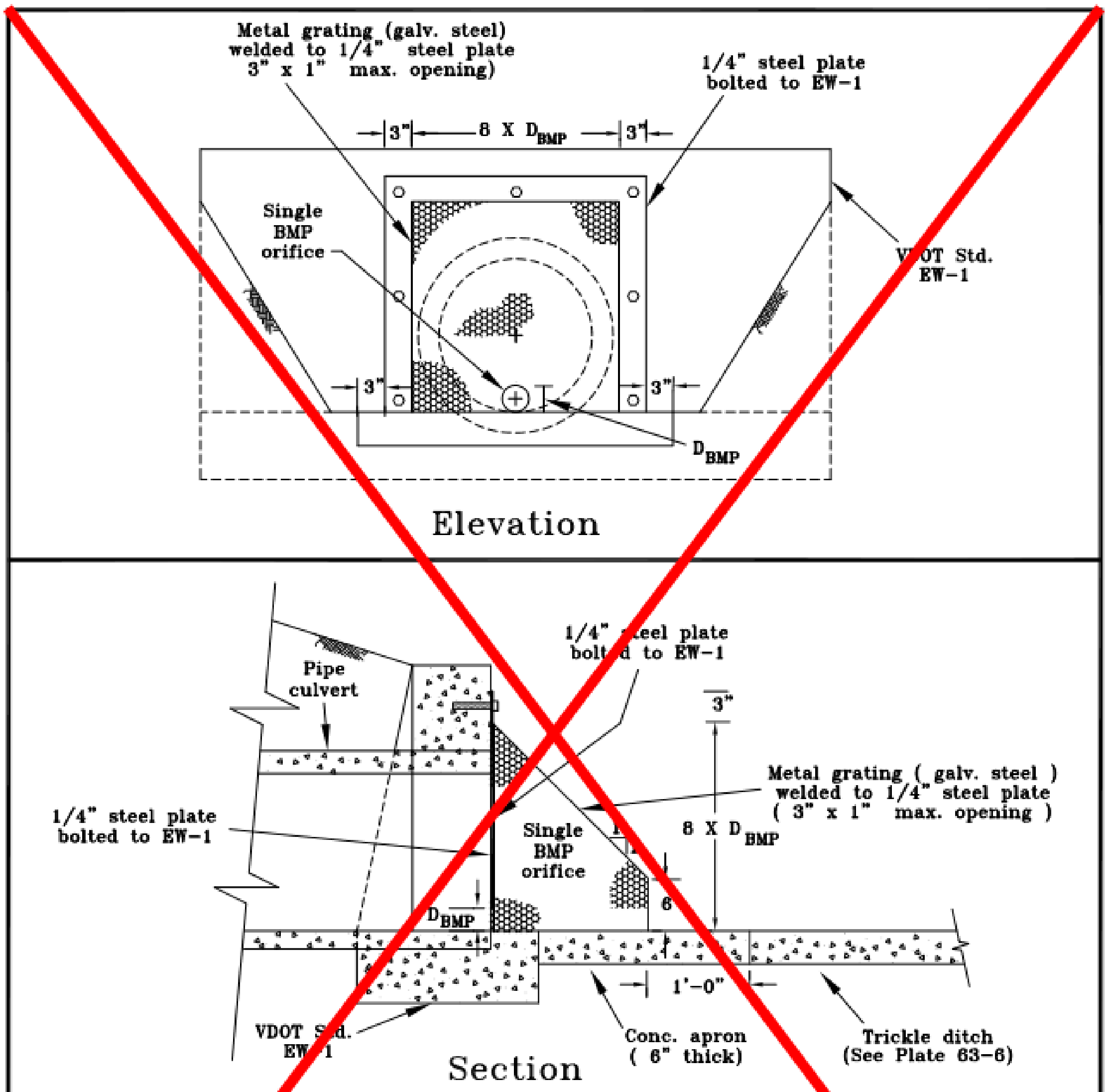
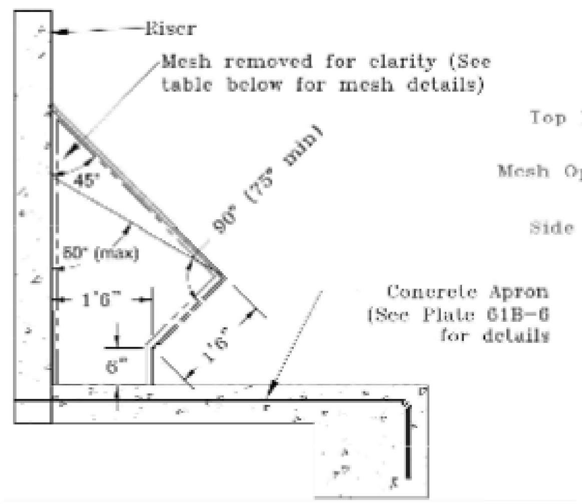


Notes:

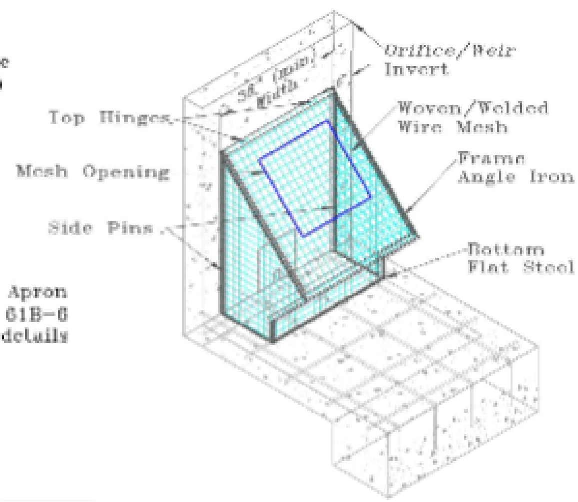
1) Alternative cage configurations are acceptable as long as the flow velocity thru the cage at the max BMP pool elev is less than 0.15 FPS
2) This detail (metal grating and steel plate) may be applied directly against rectangular risers.
3) For larger cages (height > 5') a 3' X 2' hinged gate with locking mechanism shall be installed on the front face of the cage.

Ref. Sec. 6-1604.8C Rev. 1-00	BMP EXTENDED DRAWDOWN DEVICE (EXAMPLE DETAIL)	PLATE NO. 61-6	STD. NO.

FAIRFAX COUNTY PUBLIC FACILITIES MANUAL



Trash Rack – Riser



Isometric View

Mesh Details

Component → / Trash Rack Width ↓	Frame Angle Iron	Bottom Flat Steel	Woven/Welded Wire Mesh	Steel Rod for Grate
up to 36"	1½"X1½"X¼"	1½"X¼"	¼"	
between 36"–60"	2"X2"X¼"	2"X¼"	⅜"	
60" and larger	3"X3"X⅜"	3"X⅜"		⅝"

Min. Mesh Opening Size	
Low Flow–See 6–1604B	BMP–See 6–1604.8C
4"	1"

Trash Rack General Notes:

- 3' minimum trash rack width is required where available.
- Trash rack/mounting components to be Hot–dip galvanized.
- All mounting hardware shall be stainless steel and threads to be coated in anti–sieze. Minimum ½ " x 3 " mounting bolts to be used for trash rack.
- Trash racks to be mounted using top hinge or side pin connection as per details shown in 61B–6. All hinged/pinned trash racks to have locking mechanism. Mechanism to be installed on the upper half to minimize potential to become inaccessible due to submergence under water/sediment.
- Mesh opening size shall be ½ of the diameter/width of orifice being protected, but not smaller than minimum mesh opening size provided in table above.

Additional Notes

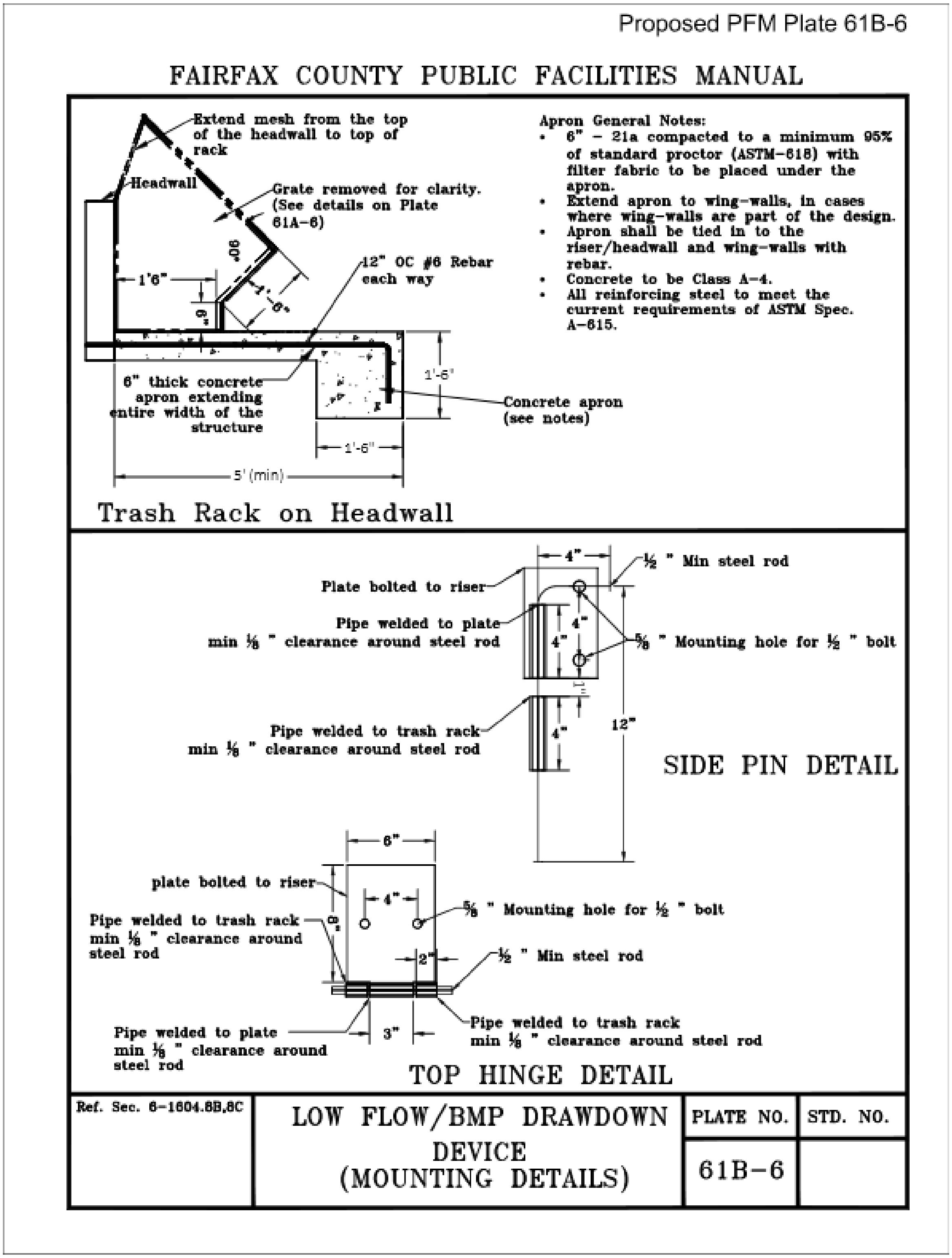
Trash Racks 60" and wider:

- Large trash racks may be painted with dark anti–corrosive paint, in lieu of galvanizing.
- Additional structural reinforcements shall be added to trash rack frame as deemed necessary to support all anticipated loads.
- A 3' x 3' (min) access door with locking mechanism shall be installed on front face.

Trash Racks mounted on Headwalls:

- In case of space restrictions at headwalls, use 2' min width of trash rack.
- Add wire mesh on the back of trash rack to the top of headwall as shown in 61B–6.

Ref. Sec. 6–1604.8B,8C	LOW FLOW/BMP DRAWDOWN DEVICE	PLATE NO.	STD. NO.
		61A–6	


Proposed PFM Plate 61B-6
FAIRFAX COUNTY PUBLIC FACILITIES MANUAL
Extend mesh from the top of the headwall to top of rack
Headwall
Grate removed for clarity. (See details on Plate 61A-6)
90°
12" OC #6 Rebar each way
1'6"
6"
1'-6"
6" thick concrete apron extending entire width of the structure
1'-6"
Concrete apron (see notes)
1'-6"
5' (min)
Trash Rack on Headwall
Apron General Notes:
• 6" – 21a compacted to a minimum 95% of standard proctor (ASTM-618) with filter fabric to be placed under the apron.
• Extend apron to wing-walls, in cases where wing-walls are part of the design.
• Apron shall be tied in to the riser/headwall and wing-walls with rebar.
• Concrete to be Class A-4.
• All reinforcing steel to meet the current requirements of ASTM Spec. A-615.
4"
½ " Min steel rod
Plate bolted to riser
Pipe welded to plate min ⅛ " clearance around steel rod
4"
4"
⅝ " Mounting hole for ½ " bolt
1"
12"
Pipe welded to trash rack min ⅛ " clearance around steel rod
4"
SIDE PIN DETAIL
6"
plate bolted to riser
4"
8"
⅝ " Mounting hole for ½ " bolt
Pipe welded to trash rack min ⅛ " clearance around steel rod
2"
½ " Min steel rod
Pipe welded to plate min ⅛ " clearance around steel rod
3"
Pipe welded to trash rack min ⅛ " clearance around steel rod
TOP HINGE DETAIL
Ref. Sec. 6-1604.6B,6C
LOW FLOW/BMP DRAWDOWN DEVICE (MOUNTING DETAILS)
PLATE NO.
61B-6
STD. NO.