4.3 Typical Structural Details

The drawings in this section were taken with permission from the *Urban Storm Drainage Criteria Manual – Volume 3*, and have not been modified from the way they appear in that manual.

Typical Outlet Structure Notes:

1. The details shown are intended to show design concepts. Preparation of final design plans, addressing details of structural adequacy, excavation, foundation preparation, concrete work, reinforcing steel,backfill, metalwork, and appurtenances, including preparation of technical specifications, are the responsibility of the design engineer.

2. Alternate designs to the typical outlet structures shown may be considered; however, alternate designs must address the hydraulic and trash handling functional elements of the structures shown in the *Manual*.

3. Wingwalls shown are intended to enable the structure to be backfilled to be flush with the side slopes of the basin, which is the recommended geometry. Other geometries may be considered if their designs related to public safety, aesthetics, maintainability, and function are equal to or better than the designs shown in the *Manual*.

4. Permanent Water Surface shown refers to micro–pool for Extended Detention Basin or permanent pool for Constructed Wetland Basin or Retention Pond.

5. An orifice plate is shown as the outflow control; however, an upturned pipe, with orifices may also be used. See Figure 4 for orifice design information.

6. A Vertical Trash Rack option is generally shown; however, an Adverse–Slope Trash Rack may also be used. Continuous–Slope Trash Racks for use with WQCV outlets are not recommended. See figure 6 for trash rack design information.

7. References are made to 2– or 10–year detention above the WQCV; however, detention above the WQCV may be sized for any storm event, according to local criteria.

8. The underdrain, including a shutoff valve, from the perimeter of the pond is required for a Wetland Basin and a Retention Pond. An underdrain, without a shutoff valve, is optional for the micro–pool and may be used to help dry the micro–pool during dry–weather periods.

9. When outlet designs differ from those shown herein:

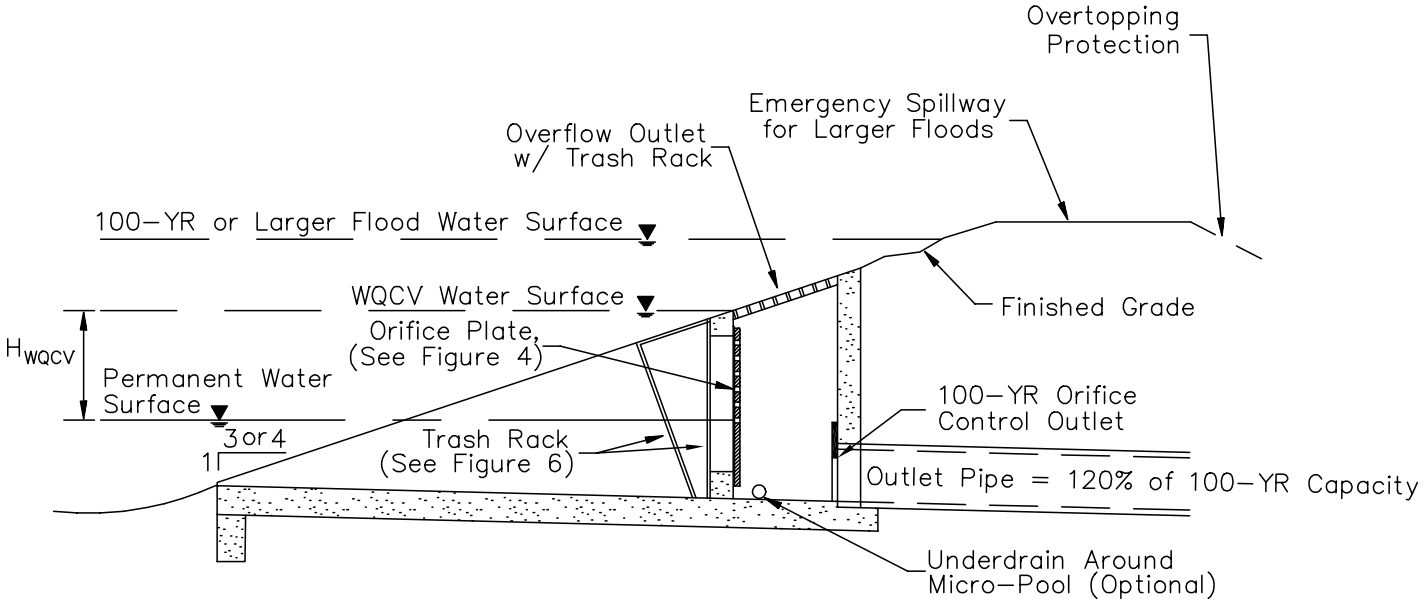
   a) Provide needed orifices that are distributed over the vertical height of the WQCV, with the lowest orifice located at 2'–6" or more above the bottom of the micro–pool.

   b) Provide full hydraulic calculations demonstrating that the outlet will provide no less than the minimum required drain time of the Water Quality Capture Volume for the BMP type being designed.

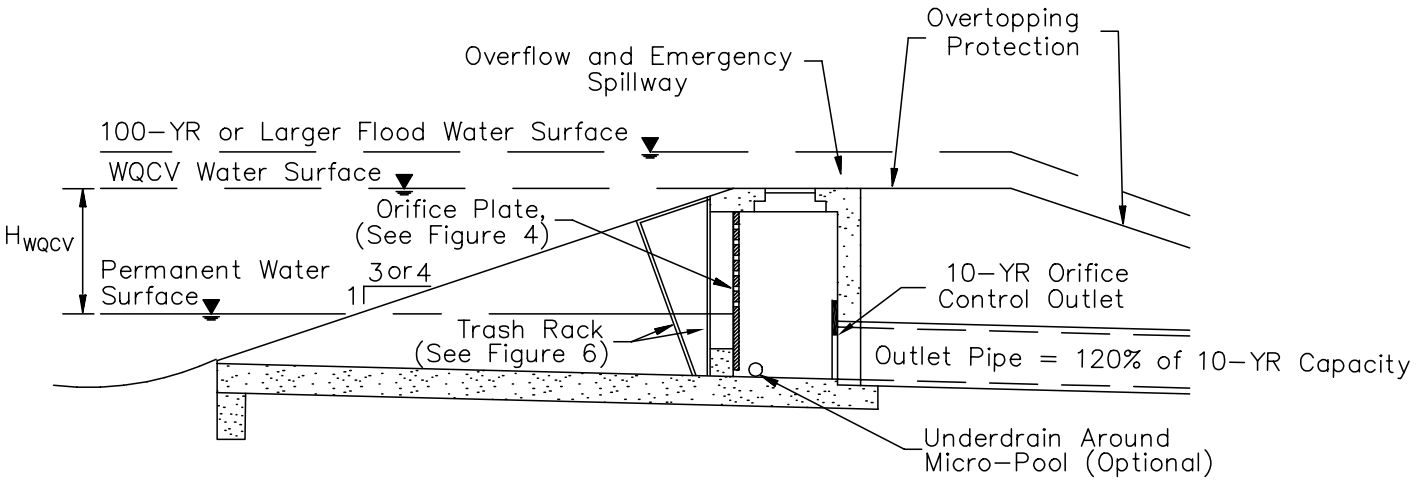
   c) All outlet openings (i.e., orifices) shall be protected by a trash rack sized to provide a minimum net opening area called for by Figure 7, and all trash rack opening dimensions shall be smaller than the smallest dimension of the outlet orifices.

   d) Trash racks shall be manufactured from stainless steel or aluminum alloy structurally designed to not fail under a full hydrostatic load on the upstream sid e.

Note: Size 2– through 100–year overflow trash racks with the aid of figure 7.



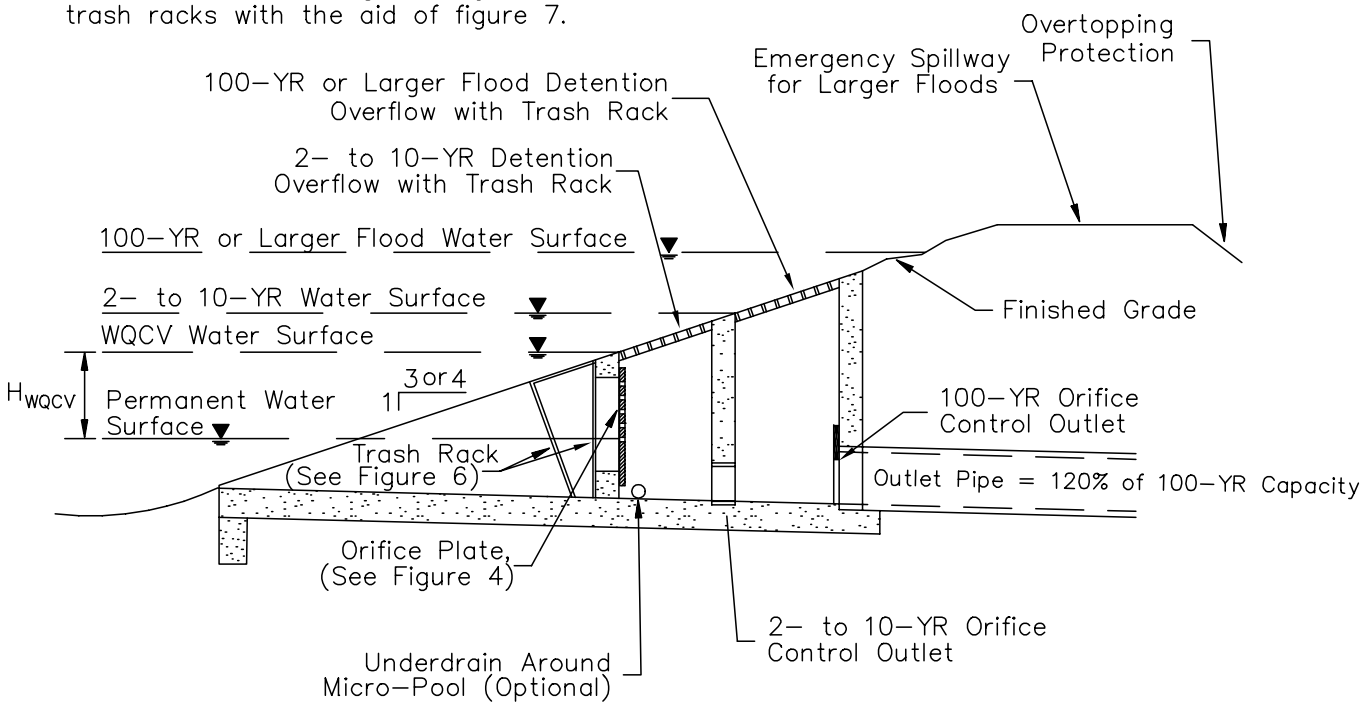
Drop Box Outlet Option



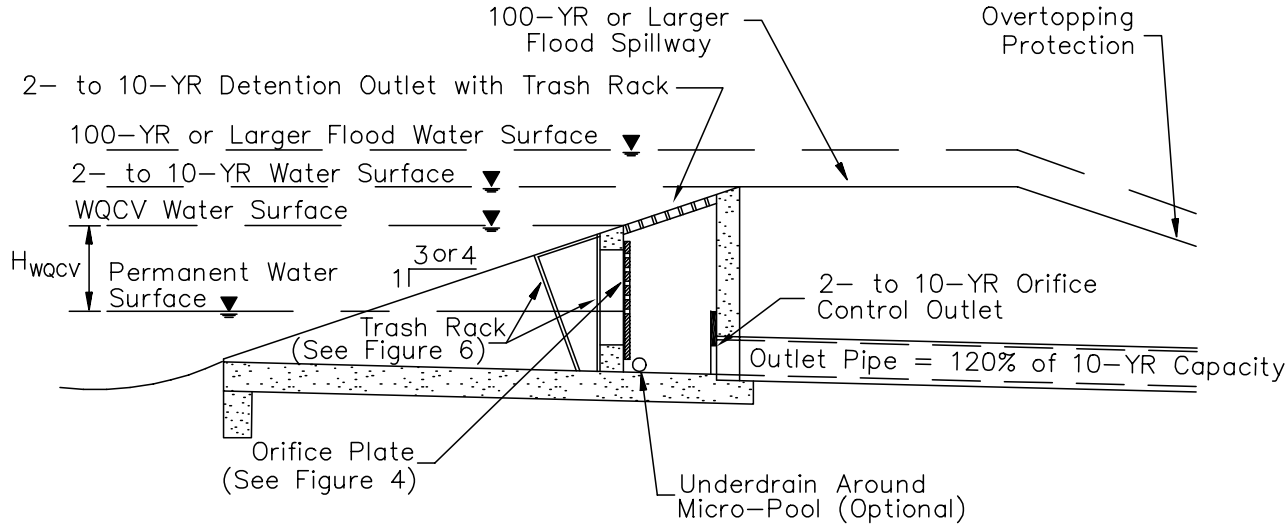
Overtopping Spillway Option

Urban Drainage and Flood Control District Drainage Criteria Manual (V.3) File: Details.dwg	Figure 1 Typical WQCV Outlet Structure Profiles Including 100–Year Detention

Note: Size 2– through 100–year overflow trash racks with the aid of figure 7.



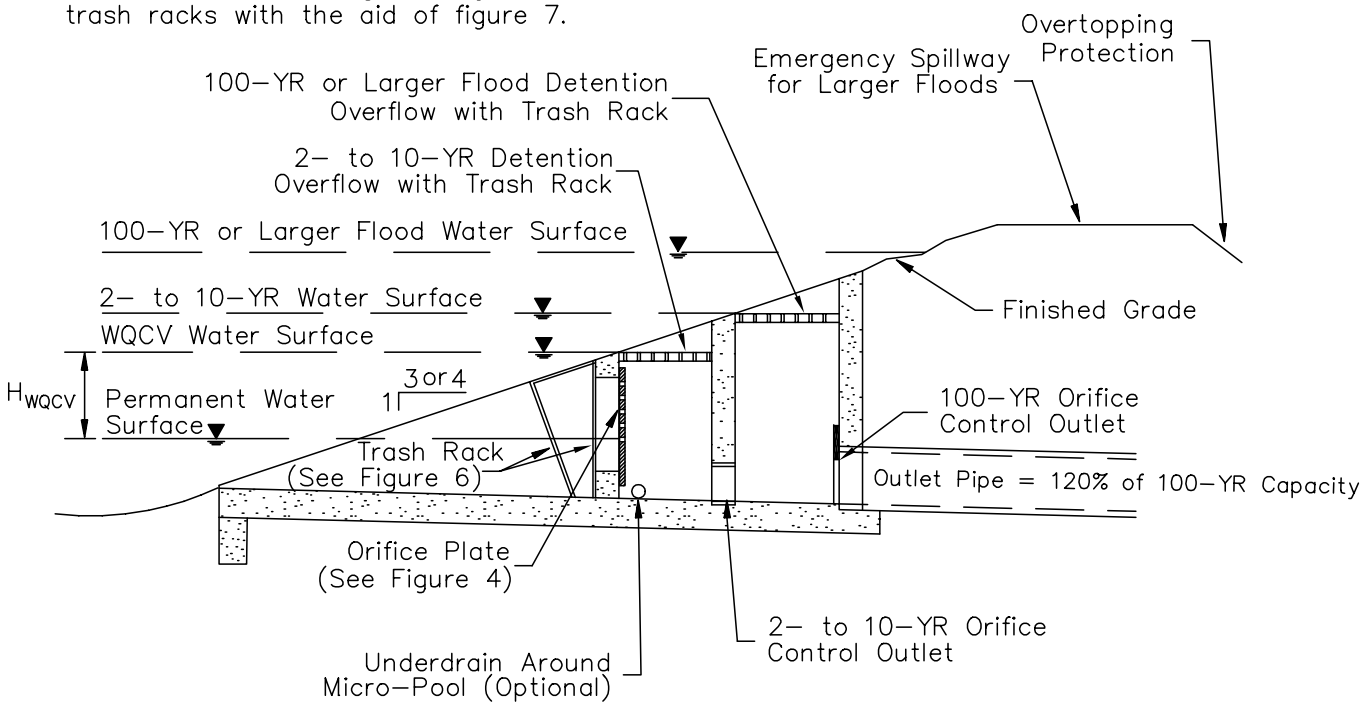
Drop Box Outlet Option



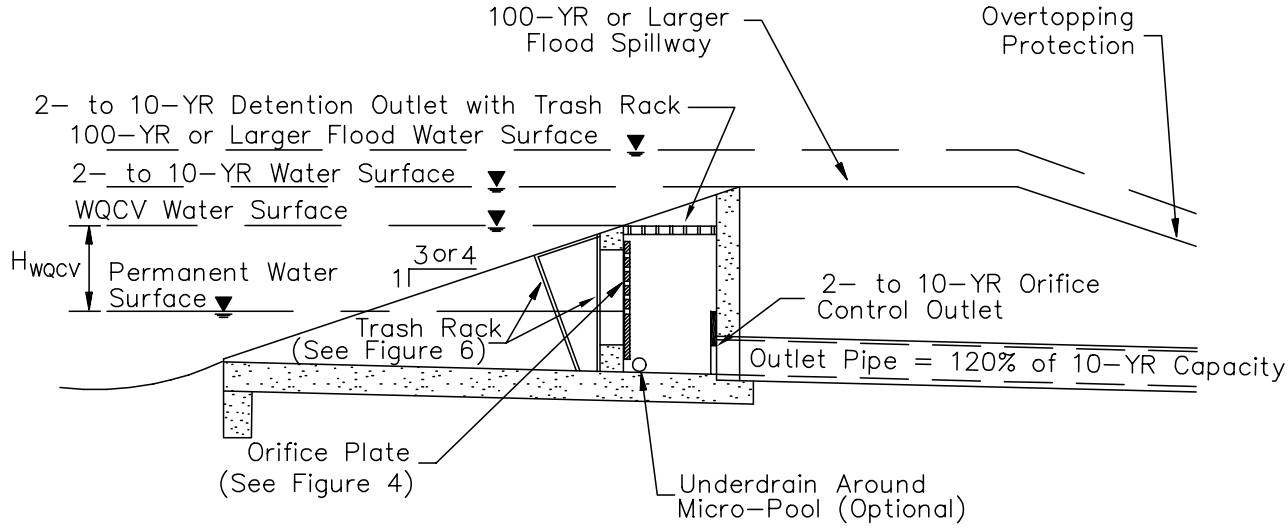
Overtopping Spillway Option

Urban Drainage and Flood Control District Drainage Criteria Manual (V.3) File: Details.dwg	Figure 2 Typical WQCV Outlet Structure Profiles Including 2– to 10–Year and 100–Year Detention

Note: Size 2– through 100–year overflow trash racks with the aid of figure 7.

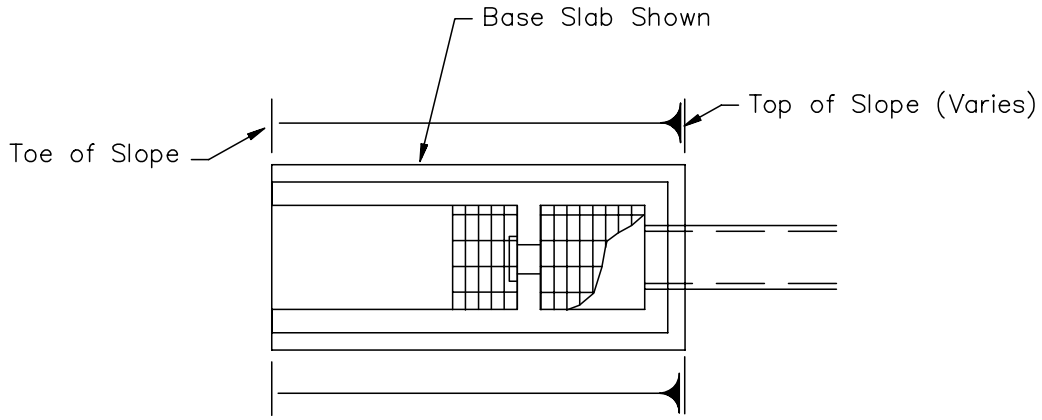


Drop Box Outlet Option

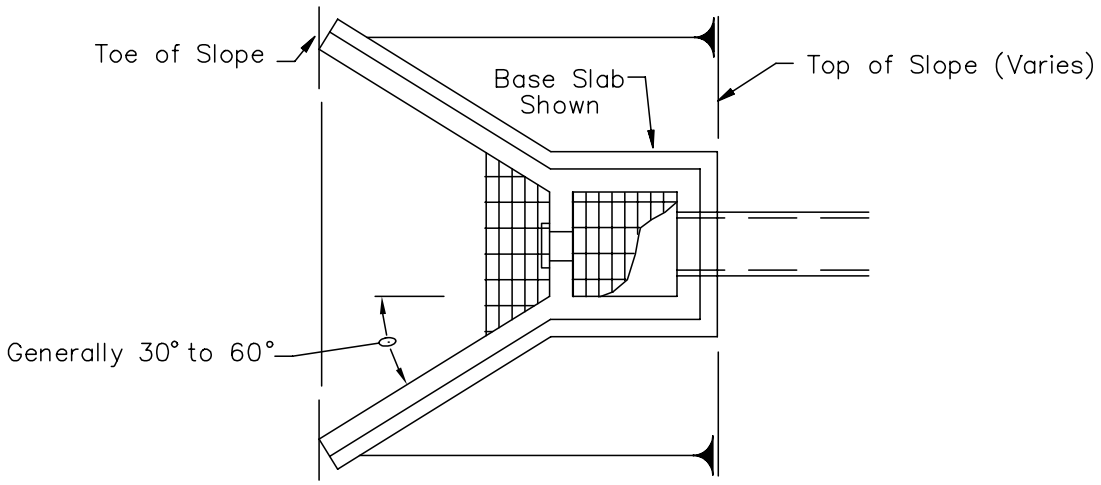


Overtopping Spillway Option

Urban Drainage and Flood Control District Drainage Criteria Manual (V.3) File: Details.dwg	Figure 2–a Alternate Typical WQCV Outlet Structure Profiles Including 2– to 10–Year and 100–Year Detention



Plan View—Straight Wingwall Option

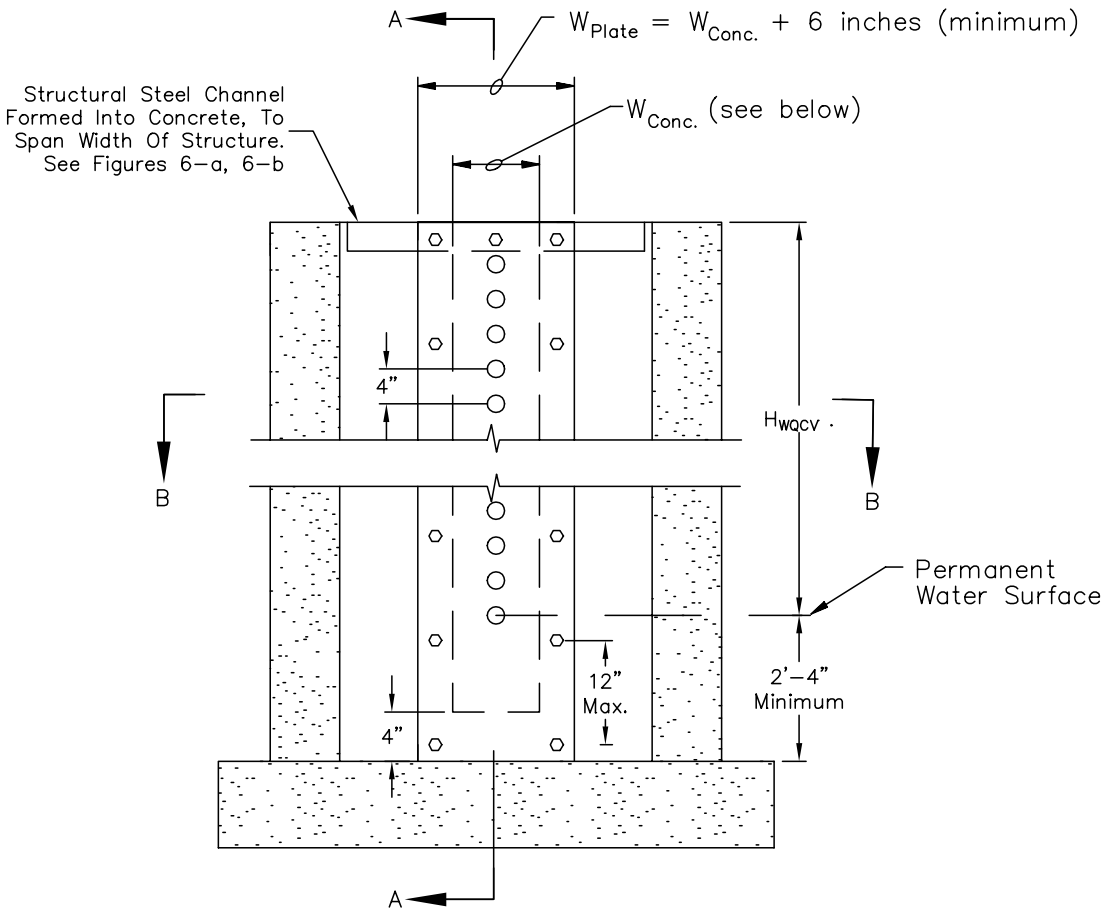


For either a Vertical or Adverse—Slope Trash Rack a handrail may be required.

Plan View—Flared Wingwall Option

Urban Drainage and Flood Control District Drainage Criteria Manual (V.3) File: Details.dwg	Figure 3 Typical WQCV Outlet Structure Wingwall Configurations

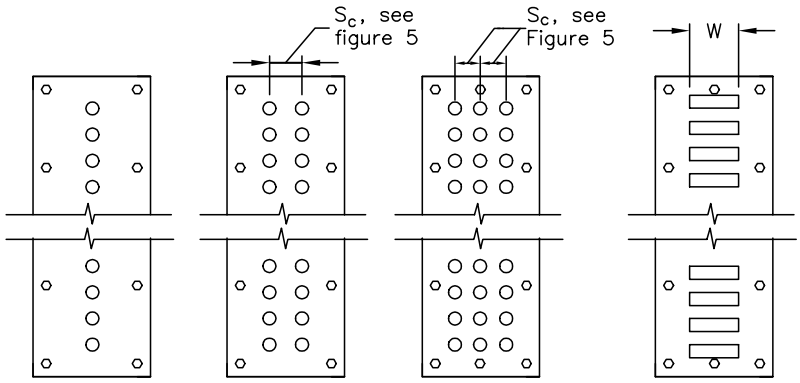
Orifice Perforation Details



Circular Openings: $W_{Conc.}$ Obtained From Table 6a–1

Rectangular Openings: $W_{Conc.}$ = (Width of Rectangular Perforation W) + 12"

Rectangular Openings: $W_{Opening}$ (see Figure 6–b) Obtained From Table 6b–1



Example Perforation Patterns

Note: The goal in designing the outlet is to minimize the number of columns of perforations that will drain the WQCV in the desired time. Do not, however, increase the diameter of circular perforations or the height of the rectangular perforations beyond 2 inches. Use the allowed perforation shapes and configurations shown above along with Figure 5 to determine the pattern that provides an area per row closest to that required without exceeding it.

Urban Drainage and Flood Control District Drainage Criteria Manual (V.3) File: Details.dwg	Figure 4 Orifice Details for Draining WQCV

Orifice Plate Perforation Sizing

Circular Perforation Sizing

Chart may be applied to orifice plate or vertical pipe outlet.

Hole Dia (in) *	Hole Dia (in)	Min. S_c (in)	Area per Row (sq in)		
			n=1	n=2	n=3
1/4	0.250	1	0.05	0.10	0.15
5/16	0.313	2	0.08	0.15	0.23
3/8	0.375	2	0.11	0.22	0.33
7/16	0.438	2	0.15	0.30	0.45
1/2	0.500	2	0.20	0.39	0.59
9/16	0.563	3	0.25	0.50	0.75
5/8	0.625	3	0.31	0.61	0.92
11/16	0.688	3	0.37	0.74	1.11
3/4	0.750	3	0.44	0.88	1.33
13/16	0.813	3	0.52	1.04	1.56
7/8	0.875	3	0.60	1.20	1.80
15/16	0.938	3	0.69	1.38	2.07
1	1.000	4	0.79	1.57	2.36
1 1/16	1.063	4	0.89	1.77	2.66
1 1/8	1.125	4	0.99	1.99	2.98
1 3/16	1.188	4	1.11	2.22	3.32
1 1/4	1.250	4	1.23	2.45	3.68
1 5/16	1.313	4	1.35	2.71	4.06
1 3/8	1.375	4	1.48	2.97	4.45
1 7/16	1.438	4	1.62	3.25	4.87
1 1/2	1.500	4	1.77	3.53	5.30
1 9/16	1.563	4	1.92	3.83	5.75
1 5/8	1.625	4	2.07	4.15	6.22
1 11/16	1.688	4	2.24	4.47	6.71
1 3/4	1.750	4	2.41	4.81	7.22
1 13/16	1.813	4	2.58	5.16	7.74
1 7/8	1.875	4	2.76	5.52	8.28
1 15/16	1.938	4	2.95	5.90	8.84
2	2.000	4	3.14	6.28	9.42
n = Number of columns of perforations					
Minimum steel plate thickness			1/4 "	5/16 "	3/8 "

* Designer may interpolate to the nearest 32nd inch to better match the required area, if desired.

Rectangular Perforation Sizing

Only one column of rectangular perforations allowed.

Rectangular Height = 2 inches

$$\text{Rectangular Width (inches)} = \frac{\text{Required Area per Row (sq in)}}{2"}$$

Rectangular Hole Width	Min. Steel Thickness
5"	1/4 "
6"	1/4 "
7"	5/32 "
8"	5/16 "
9"	11/32 "
10"	3/8 "
>10"	1/2 "

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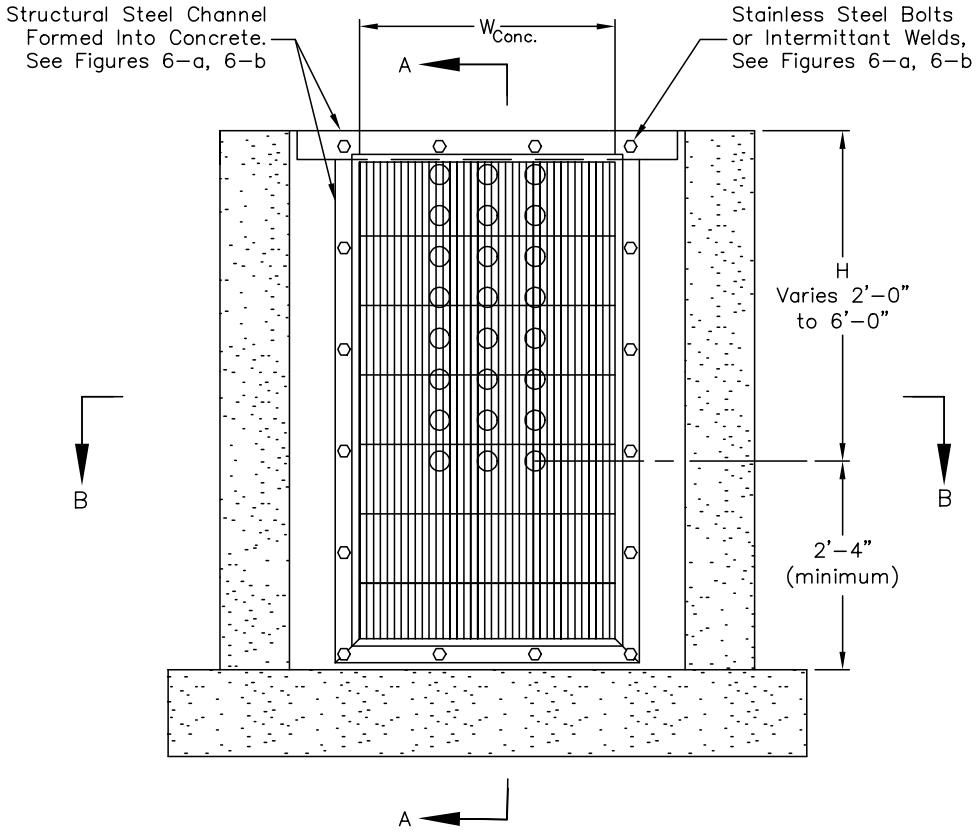
Figure 5

WQCV Outlet Orifice Perforation Sizing

Note: Vertical WQCV Trash Racks are shown in Figures 6, 6–a, and 6–b for suggested standardized outlet design. Adverse–Slope Trash Rack design may be used for non–standardized designs, but must meet minimum design criteria.



Elevation

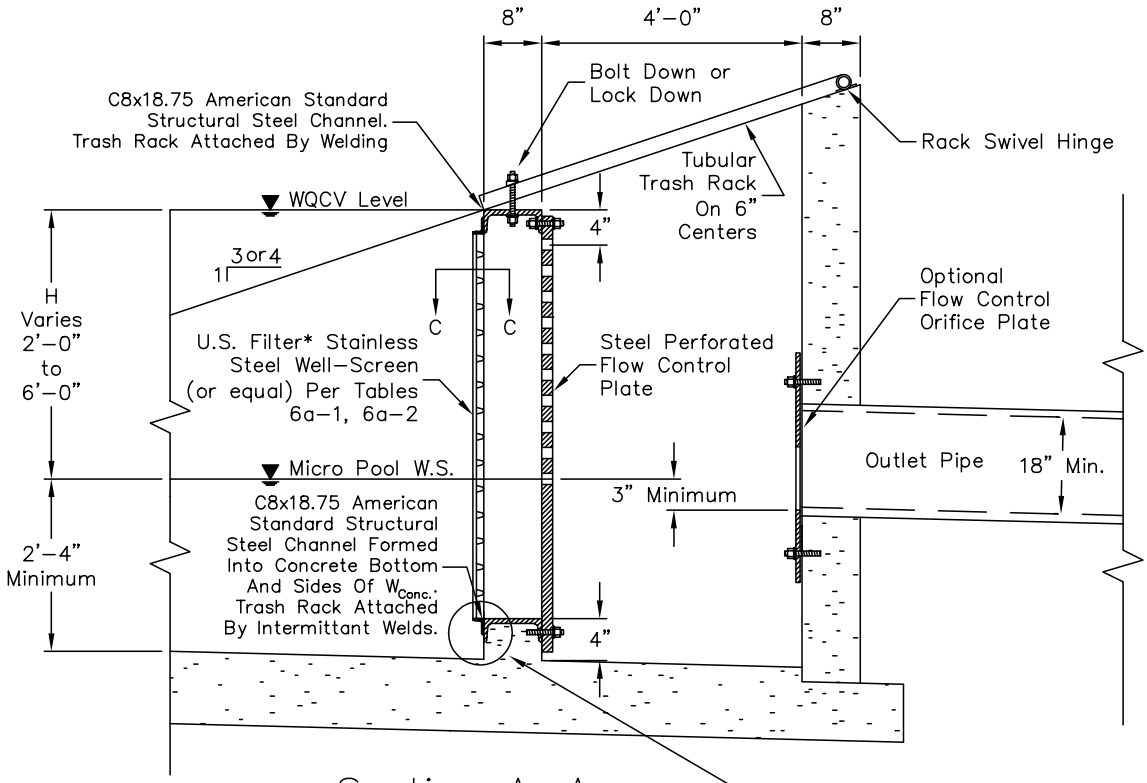
WQCV Trash Racks:

1. Well–screen trash racks shall be stainless steel and shall be attached by intermittant welds along the edge of the mounting frame.
2. Bar grate trash racks shall be aluminum and shall be bolted using stainless steel hardware.
3. Trash Rack widths are for specified trash rack material. Finer well–screen or mesh size than specified is acceptable, however, trash rack dimensions need to be adjusted for materials having a different open area/gross area ratio (R value)
4. Structural design of trash rack shall be based on full hydrostatic head with zero head downstream of the rack.

Overflow Trash Racks:

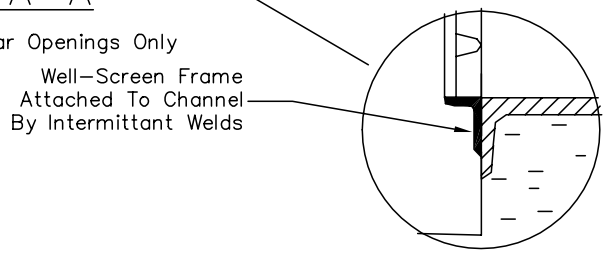
1. All trash racks shall be mounted using stainless steel hardware and provided with hinged and lockable or boltable access panels.
2. Trash racks shall be stainless steel, aluminum, or steel. Steel trash racks shall be hot dip galvanized and may be hot powder painted after galvanizing.
3. Trash Racks shall be designed such that the diagonal dimension of each opening is smaller than the diameter of the outlet pipe.
4. Structural design of trash rack shall be based on full hydrostatic head with zero head downstream of the rack.

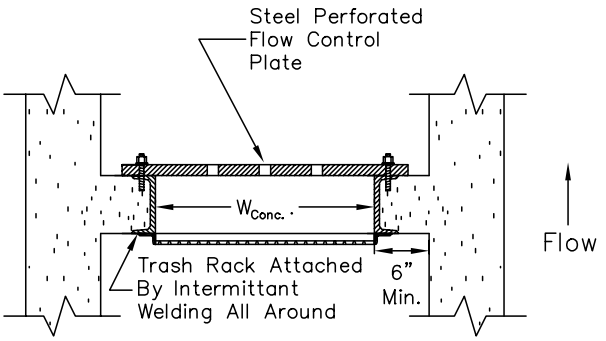
Urban Drainage and Flood Control District Drainage Criteria Manual (V.3) File: Details.dwg	Figure 6 Suggested WQCV Outlet Standardized Trash Rack Design



Section A–A

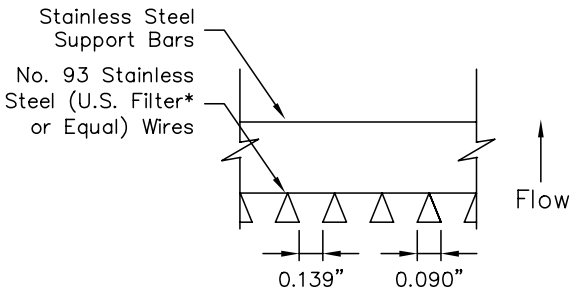
From Figure 6, Circular Openings Only





Section B–B – Plan View

From Figure 6, Circular Openings Only



Section C–C

From Figure 6, Circular Openings Only

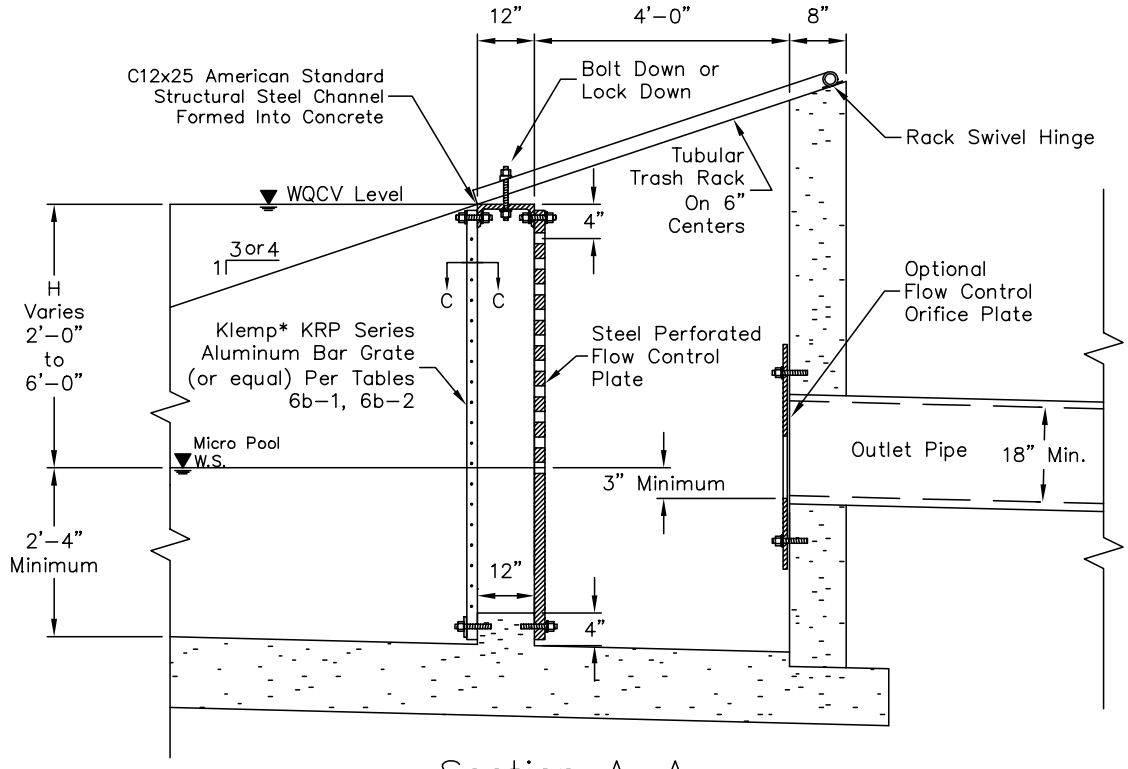
R Value = (net open area)/(gross rack area)
= 0.60

Limits for this Standardized Design:

1. All outlet plate openings are circular.
2. Maximum diameter of opening = 2 inches.

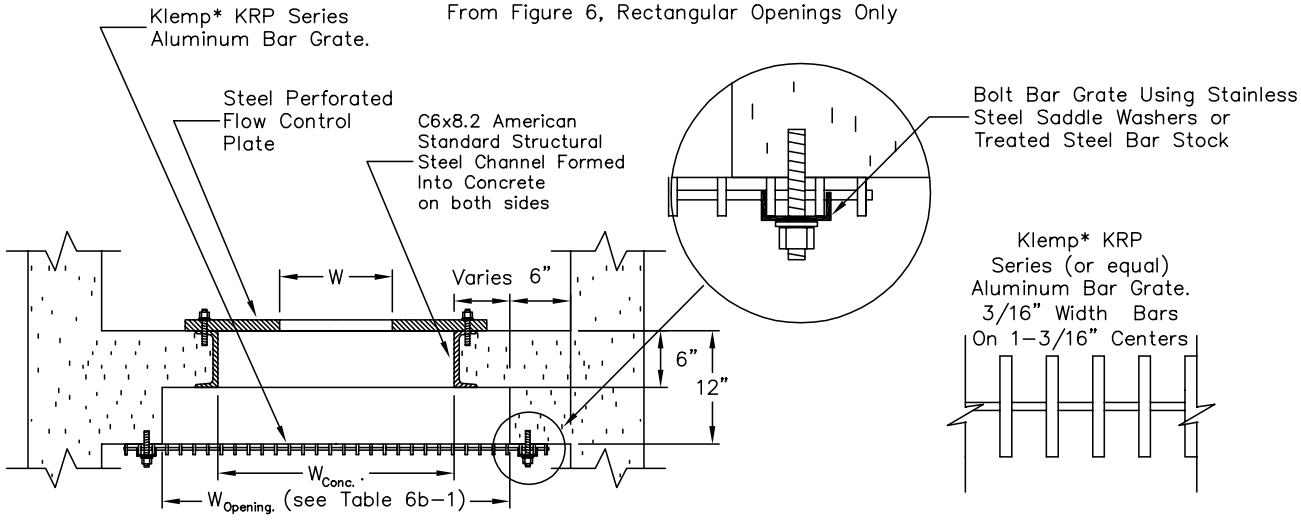
*U.S. Filter, St. Paul, Minnesota, USA

Urban Drainage and Flood Control District Drainage Criteria Manual (V.3) File: Details.dwg	Figure 6–a Suggested Standardardized Trash Rack and Outlet Design For WQCV Outlets With Circular Openings



Section A–A

From Figure 6, Rectangular Openings Only



Section B–B – Plan View

From Figure 6, Rectangular Openings Only

Section C–C

From Figure 6, Rectangular Openings Only

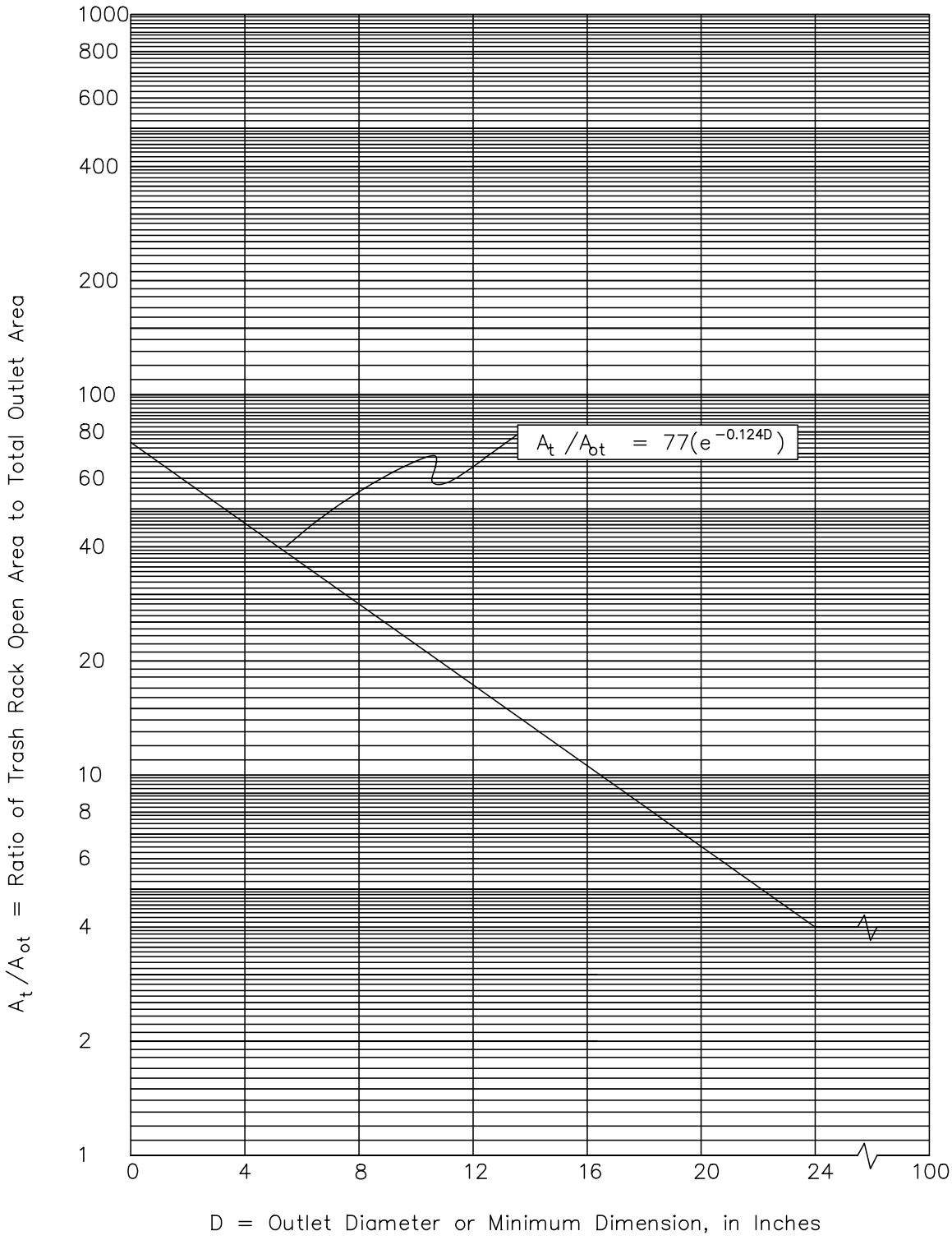
Limits for this Standardized Design:

1. All outlet plate openings are rectangular.
2. Height of all rectangular openings = 2 inches.
3. For trash rack opening width ($W_{Opening}$), see Table 6b–1
4. Concrete opening for outlet plate ($W_{Conc.}$) = W + 12 inches

R Value = (net open area)/(gross rack area)
= 0.71 for cross rods on 2" centers
= 0.77 for cross rods on 4" centers

*Klemp Corporation, Orem, Utah, USA

Urban Drainage and Flood Control District Drainage Criteria Manual (V.3) File: Details.dwg	Figure 6–b Suggested Standardardized Trash Rack and Outlet Design For WQCV Outlets With Rectangular Openings



Urban Drainage and Flood Control District Drainage Criteria Manual (V.3) File: Details.dwg	Figure 7 Minimum Trash Rack Open Area – Extended Range

Table 6a-1: Standardized WQCV Outlet Design Using 2" Diameter Circular Openings.
Minimum Width ($W_{conc.}$) of Concrete Opening for a Well-Screen-Type Trash Rack.
See Figure 6-a for Explanation of Terms.

Maximum Dia. of Circular Opening (inches)	Width of Trash Rack Opening ($W_{conc.}$) Per Column of Holes as a Function of Water Depth H					
	H=2.0'	H=3.0'	H=4.0'	H=5.0'	H=6.0'	Maximum Number of Columns
≤ 0.25	3 in.	3 in.	3 in.	3 in.	3 in.	14
≤ 0.50	3 in.	3 in.	3 in.	3 in.	3 in.	14
≤ 0.75	3 in.	6 in.	6 in.	6 in.	6 in.	7
≤ 1.00	6 in.	9 in.	9 in.	9 in.	9 in.	4
≤ 1.25	9 in.	12 in.	12 in.	12 in.	15 in.	2
≤ 1.50	12 in.	15 in.	18 in.	18 in.	18 in.	2
≤ 1.75	18 in.	21 in.	21 in.	24 in.	24 in.	1
≤ 2.00	21 in.	24 in.	27 in.	30 in.	30 in.	1

Table 6a-2: Standardized WQCV Outlet Design Using 2" Diameter Circular Openings.
US Filter™ Stainless Steel Well-Screen[1] (or equal) Trash Rack Design Specifications.

Max. Width of Opening	Screen #93 VEE Wire Slot Opening	Support Rod Type	Support Rod, On-Center, Spacing	Total Screen Thickness	Carbon Steel Frame Type
9"	0.139	#156 VEE	¾"	0.31'	3/8"x1.0"flat bar
18"	0.139	TE .074"x.50"	1"	0.655	¾" x 1.0 angle
24"	0.139	TE .074"x.75"	1"	1.03"	1.0" x 1½" angle
27"	0.139	TE .074"x.75"	1"	1.03"	1.0" x 1½" angle
30"	0.139	TE .074"x1.0"	1"	1.155"	1 1/4"x 1½" angle
36"	0.139	TE .074"x1.0"	1"	1.155"	1 1/4"x 1½" angle
42"	0.139	TE .105"x1.0"	1"	1.155"	1 1/4"x 1½" angle

[1] US Filter, St. Paul, Minnesota, USA

DESIGN EXAMPLE:

Given: A WQCV outlet with three columns of 5/8 inch (0.625 in) diameter openings.
Water Depth H above the lowest opening of 3.5 feet.

Find: The dimensions for a well screen trash rack within the mounting frame.

Solution: From Table 6a-1 with an outlet opening diameter of 0.75 inches (i.e., rounded up from 5/8 inch actual diameter of the opening) and the Water Depth H = 4 feet (i.e., rounded up from 3.5 feet). The minimum width for each column of openings is 6 inches. Thus, the total width is $W_{conc.}$ = 3•6 = 18 inches. The total height, after adding the 2 feet below the lowest row of openings, and subtracting 2 inches for the flange of the top support channel, is 64 inches. Thus, Trash rack dimensions within the mounting frame = 18 inches wide x 64 inches high

From Table 6a-2 select the ordering specifications for an 18", or less, wide opening trash rack using US Filter (or equal) stainless steel well-screen with #93 VEE wire, 0.139" openings between wires, TE 074" x 50" support rods on 1.0" on-center spacing, total rack thickness of 0.655" and ¾" x 1.0" welded carbon steel frame.

Table 6b-1: Standardized WQCV Outlet Design Using 2" Height Rectangular Openings.
Minimum Width ($W_{opening}$) of Opening for an Aluminum Bar Grate Trash Rack.
See Figure 6-b for Explanation of Terms.

Maximum Width W of 2" Height Rectangular Opening (inches)	Minimum Width of Trash Rack Opening ($W_{opening}$) as a Function of Water Depth H					
	H=2.0 ft.	H=3.0 ft.	H=4.0 ft.	H=5.0 ft.	H=6.0 ft.	Spacing of Bearing Bars, Cross Rods
≤ 2.0	2.0 ft.	2.5 ft.	2.5 ft.	2.5 ft.	3.0 ft.	1-3/16", 2"
≤ 2.5	2.5 ft.	3.0 ft.	3.0 ft.	3.5 ft.	3.5 ft.	1-3/16", 2"
≤ 3.0	3.0 ft.	3.5 ft.	3.5 ft.	4.0 ft.	4.0 ft.	1-3/16", 2"
≤ 3.5	3.5 ft.	4.0 ft.	4.5 ft.	4.5 ft.	5.0 ft.	1-3/16", 2"
≤ 4.0	3.5 ft.	4.5 ft.	5.0 ft.	5.0 ft.	5.5 ft.	1-3/16", 2"
≤ 4.5	4.0 ft.	4.5 ft.	5.0 ft.	5.5 ft.	5.5 ft.	1-3/16", 4"
≤ 5.0	4.0 ft.	5.0 ft.	5.5 ft.	6.0 ft.	6.0 ft.	1-3/16", 4"
≤ 5.5	4.5 ft.	5.5 ft.	6.0 ft.	6.5 ft.	7.0 ft.	1-3/16", 4"
≤ 6.0	5.0 ft.	6.0 ft.	6.5 ft.	7.0 ft.	7.5 ft.	1-3/16", 4"
≤ 6.5	5.5 ft.	6.5 ft.	7.0 ft.	7.5 ft.	8.0 ft.	1-3/16", 4"
≤ 7.0	6.0 ft.	7.0 ft.	7.5 ft.	8.5 ft.	8.5 ft.	1-3/16", 4"
≤ 7.5	6.0 ft.	7.5 ft.	8.5 ft.	9.0 ft.	9.5 ft.	1-3/16", 4"
≤ 8.0	6.5 ft.	8.0 ft.	9.0 ft.	9.5 ft.	10.0 ft.	1-3/16", 4"
≤ 8.5	7.0 ft.	8.5 ft.	9.5 ft.	10.0 ft.	N/A	1-3/16", 4"
≤ 9.0	7.5 ft.	9.0 ft.	10.0 ft.	N/A	N/A	1-3/16", 4"
≤ 9.5	8.0 ft.	9.5 ft.	N/A	N/A	N/A	1-3/16", 4"
≤ 10.0	8.5 ft.	10.0 ft.	N/A	N/A	N/A	1-3/16", 4"
≤ 10.5	8.5 ft.	N/A	N/A	N/A	N/A	1-3/16", 4"
≤ 11.0	9.0 ft.	N/A	N/A	N/A	N/A	1-3/16", 4"
≤ 11.5	9.5 ft.	N/A	N/A	N/A	N/A	1-3/16", 4"
≤ 12.0	10.0 ft.	N/A	N/A	N/A	N/A	1-3/16", 4"

Table 6b-2: Standardized WQCV Outlet Design Using 2" Height Rectangular Openings.
Klemp™ KRP Series Aluminum Bar Grate[1] (or equal) Trash Rack Design Specifications.

Water Depth Above Lowest Opening, H	Minimum Bearing Bar Size, Bearing Bars Aligned Vertically
2.0 ft.	1" x 3/16"
3.0 ft.	1-1/4" x 3/16"
4.0 ft.	1-3/4" x 3/16"
5.0 ft.	2" x 3/16"
6.0 ft.	2-1/4" x 3/16"

[1] Klemp Corporation, Orem, Utah, USA

DESIGN EXAMPLE:

Given: A WQCV outlet with 2" height by 6.5" width openings.
Water Depth H above the lowest opening of 4.5 feet.

Find: The dimensions for an aluminum bar grate trash rack.

Solution: Using Table 6b-1for openings having a width of 6.5 inches and Water Depth H = 5 feet (i.e., rounded up from 4.5 feet). The minimum width is 7'-6". The net height, after accounting for the 2 feet below the lowest opening, is 6'-6". An additional 6" must be added to the width and an additional 4" to the height to allow for mounting hardware. Thus,

Trash rack dimensions = 8'-0" wide by 6'-10" high

Note also from Table 6b-1, that for orifice plate rectangular openings wider than 4", cross rod spacing of 4" is allowed.

From Table 6b-2, select the ordering specifications for H = 5.0 feet or less, a 8.0' wide by 6'-10" high trash rack using Klemp Corporation aluminum bar grate (or equal) with 2" by 3/16" bearing bars spaced 1-3/16" on-center, cross rods spaced 4" on-center. **Bearing bars are to be aligned vertically.**