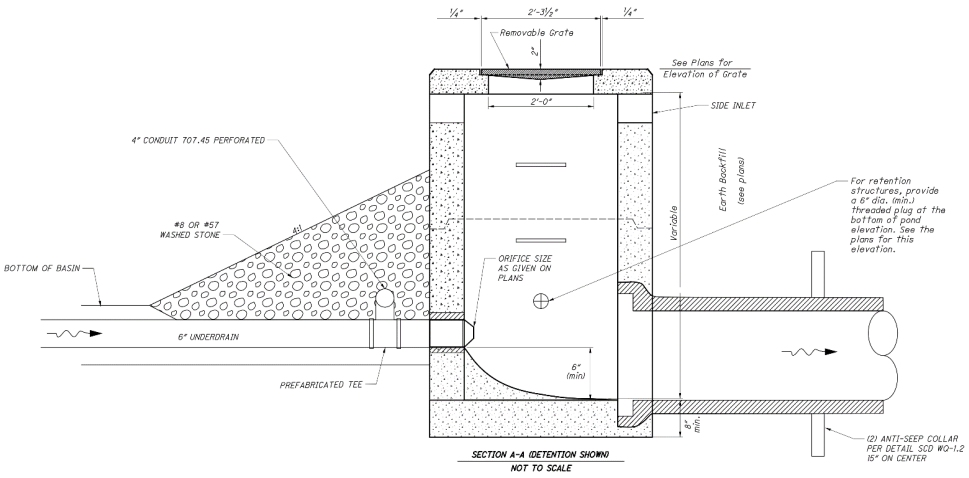
Division of Engineering Research On-Call Services 2020-2023 Task 5: *Detention Basin Water Quality Outlet Redesign*



Prepared by
Mark McCabe and Kevin White

Prepared for
The Ohio Department of Transportation
Office of Statewide Planning and Research

Project ID Number: 111439 (Task 5)

August 2022

Final Report

JEO CONSULTING GROUP
JEO Consulting Group, Inc.

E.L. ROBINSON ENGINEERING
E.L. Robinson Engineering of Ohio Co.

OHIO DEPARTMENT OF TRANSPORTATION RESEARCH

U.S. Department of Transportation Federal Highway Administration

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16. Abstract

The Ohio Department of Transportation is interested in evaluating and assessing options related to the current detention basin design to collect information from peer DOTs on design standards associated with detention basin details that include basin designs, outlet structures, low-flow channels, and emergency spillway. Based on AASHTO DOT responses and other information sources the team has proposed an alternative water quality basin outlet structure.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: Volumes greater than 1000 L shall be shown in m^3.				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact)				
°F	Fahrenheit temperature	5(°F-32)/9 or (°F-32)/1.8	Celsius temperature	°C
ILLUMINATION				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N
lbf/in^2 or psi	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
AREA				
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
VOLUME				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.71	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
TEMPERATURE (exact)				
°C	Celsius temperature	1.8°C + 32	Fahrenheit temperature	°F
ILLUMINATION				
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
FORCE and PRESSURE or STRESS				
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2 or psi

* SI is the symbol for the International Symbol of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

(Revised September 1993)

Division of Engineering Research On-Call Services 2020-2023 Task 5: *Detention Basin Water Quality Outlet Redesign*

Prepared by

Mark McCabe
JEO Consulting Group Inc.
200 E. Campus View Blvd., Suite 200
Columbus, Ohio 43235

and

Kevin White
E.L. Robinson Engineering of Ohio Co.
950 Goodale Blvd., STE 180
Grandview Heights, Ohio 43212

Prepared in cooperation with the
Ohio Department of Transportation
and the
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Final Report
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The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Ohio Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification or regulation.

The authors acknowledge the people who ensured the successful completion of this task, starting with Michelle Lucas of the Ohio Department of Transportation's Research Section. Jonathan Prier and Jeff Syar served as the subject matter expert, providing guidance and input on the technical aspects of the project.

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1 Introduction

1.1 Background

The Ohio Environmental Protection Agency (OEPA) updates the Construction General Permit (CGP) every five years. OEPA last updated the CGP in April of 2018. The permit includes requirements for developing storm water pollution prevention plans (SWPPPs) that include requirements to design and implement construction stormwater runoff control practices on project sites that disturb one acre or more. The controls for addressing construction stormwater runoff are temporary. The CGP also requires developing post-construction stormwater management practices be designed and implemented to address receiving streams water quality. These practices are permanent and become drainage or stormwater assets for the Ohio Department of Transportation that they need to operate and maintain. The Ohio Department of Transportation's (ODOT) Office of Hydraulic Engineering (OHE) is responsible for updating and maintaining the Location and Design Manual – Volume 2 that provides design guidance for engineers and consultants to appropriately select and design post-construction water quality controls that are in compliance with OEPAs CGP. The research team includes EL Robinson and JEO Consulting Group, henceforth known as the "team".

1.2 Research Needs

ODOT has developed design guidance, specifications and standard construction drawings that provides information and direction associated with designing and constructing post-construction water quality run-off controls for roadway projects to assist engineers and consultants with addressing and meeting the permit requirements. The CGP requires the detention basin outlet control structure to detain more than the first one-half of the water quality (WQ) in less than 1/3 of the drain time of 48 hours. ODOT is interested in evaluating and assessing outlet control design options that are more efficient to design or construct that still meet the compliance requirements. ODOT is also interested in evaluation of low flow channels and emergency spillway options for meeting permit requirements.

1.3 Research Outline and Scope of Work

ODOTs focus for this research was to evaluate an assess options associated with the current detention basin design to determine the determine the follow:

- Through ODOTs AASHTO's representative develop an information request that was posted on AASHTO's listserve requesting information on detention basin design standards that included outlet control structures, low flow channels and emergency spillways.
- Collect example standard drawings, specifications and construction drawings and document lessons learned from DOT's to provide assistance to ODOT with design criteria and standard drawing revisions and updates.
- Per the AASHTO DOT responses the research team will review state DOTs CGPs to document how a DOT is responding to permits and how their responses are influencing detention basin designs.

1.3.1 Scope of Work

The team's scope of work implemented to address the research needs includes the following:

- **Literature Review and Information Collection** – This activity included the development of the request for information distributed through AASHTO's listserve. Information in the request included Detention basin outlet control design information, standard construction drawings, design calculation examples, low flow channel and emergency spillway design and construction standards or drawings.
- **Collected Information Review and Organization** - This activity included review of the collected information to evaluate relevance towards meeting the research needs and organize the information that provided potential benefits to ODOT in making outlet control revision or modification decisions.
- **Develop Summary of Findings Recommendations Table** – This activity developed recommendations for ODOT to consider and these were organized in table format.

2 AASHTO Survey Results

The project team collected survey information form the following DOTs through the Survey as shown in table 2-1.

DOTs Responding to Survey		
Washington DC- District DOT	Delaware DOT	Oregon DOT
Indiana DOT	South Carolina DOT	New Jersey DOT
Iowa DOT	Kansas DOT	New Hampshire DOT
Tennessee DOT	Maine DOT	CalTrans
Massachusetts DOT	Montana DOT	

Table 2-1 - DOT Survey Respondents

The team researched the following DOTs that did not respond to the survey:

- North Carolina
- Colorado
- Washington
- Florida
- Virginia

2.1 DOT Geographic Summary

Table 2-2 is a summary of the DOTs that responded and a breakdown of geographic areas represented by the DOTs that responded.

DOT Geographic Region	Number of Responses
East	6
Mid-West	3
South	2
West	3

Table 2-2 - DOT Geographic Response Summary

Table 2-2 includes 14 DOTs responding out of 50 (28%). The team did research on an additional five DOTs that the team felt were DOTs that would have significant information associated with their post-construction water quality program based on the following economic or environmental drivers:

- Water based recreation options

- Coastal water quality permit requirements
- Waste Load Allocation (WLA) based total Maximum Daily Load (TMDL) watersheds

With the team including five more researched DOTs, the total is 19 DOTs reviewed with a revised total of 38%.

2.2 Breakdown of DOT Responses per Survey Question

Table 2-3 represents a summary of collected information per the responding or researched DOTs. The information collected was used to develop recommendations for modifying ODOTs outlet controls, low flow channel and emergency spillways associated with water quality basins.

Information Requested	DOTs Responding
Standard Detention Basin Drawings/Plans	11
Design information or guidance related to outlet controls, low flow channels and Emergency spill ways	12
Regulatory requirements for WQv detention storage	13
Detention basin design specifications	10
Sample Plan Sheets	8
Maintenance Requirements	8

Table 2-3 - DOT Information Requested Response Numbers

Table 2-4 provides a summary of the DOTs that responded to the questions included in the request for information. Table 2-2 only includes the 14 DOTs that responded to the survey. The additional five DOTs researched by the team were asked these questions. The responses are the number of DOTs that responded.

2.3 Lessons Learned

Table 2-5 organizes the DOTs responding that shared lessons learned. Of the 14 DOTs that responded to the survey six provided feedback on the Lessons Learned.

Request for Information Questions from Survey	DOTs Responding
Have you had to re-design or modify your detention basin outlet control based on municipal separate storm sewer (MS4) or construction general permit (CGP) requirements in the last 5 years? If yes, can you provide a short explanation as to the changes that were made?	6
Has the regulatory agency suggested any detention basin or outlet control revisions? If yes, can you provide a short explanation as to what they suggested?	0
Have any detention basin outlet controls been modified or re-designed based on constructability issues? If yes, Please provide a short explanation as to what those changes/revisions were or included	1
Please list any lessons learned with your departments experience with design, construction/ installation and maintenance of detention basin outlet controls.	8

Table 2-4 - DOTs Responding to Survey Questions

DOT	Lessons Learned Response
Indiana	We have required riprap protection for overflow berms when the detention facility is designed to hold less than a 1% EP event.
Delaware	1.) The best type of outlet structure to use is a weir wall with assorted weirs designed into it. For water quality, a v-notch can usually handle the very low flows required for those standards and then assorted rectangular sized weirs above that for water quantity. When forming up the structure for a concrete pour, inverts and weir sizes can be placed accurately as well as the emergency spillway can be instituted into the weir wall itself versus having to construct a 'dip' into the embankment and sometimes a dedicated swale. No trash/safety racks required. Inspection and maintenance are also easier, because everything is out in the open and the maintenance requirements are roughly the same as for the concrete components of a bridge. 2.) The negatives are not every location can utilize a weir wall. Sometimes weir walls can become quite long, so overturning along with 'excessive' amounts of concrete are needed. We don't have a maximum weir wall length, but that is an excellent study problem that is on my wish list (one of many). 3.) The outlet aspect doesn't have to be straight, it could be curved, which saves on horizontal length, but your weir length could be quite long, plus with sheet pile (at least on the lower flows), the weir length is in essence multiplied due to the shape of the sheet pile itself. And with a curved weir wall, the outlet, which would be on the inside of the curve, could be smaller, so less riprap or maybe even just pour a concrete slab. And instead of curved, it could even be rectangular. The curve and rectangular aspects could also be used on a concrete weir wall, but we have not done that to date.
South Carolina	Allowing more flexibility in the design while still ensuring the CGP requirements are met. The design standards need to be applicable to most situations and must be flexible enough to fit into limited rights of way boundaries. In addition, the guidance for how to utilize a permanent detention pond design during construction as a sediment basin will be clearly documented
New Hampshire	No metal parts that reside in pooled water. All concrete precast structures must have butyl seals, All spillways need concrete cut-off walls, open rock trash racks are a must, do not build on rock fill, Need drive up access as maintenance is a problem.
Massachusetts	They are vulnerable to erosion without adequate armoring
Montana	Coordinate with the local municipality on the local permit requirements including the operations and maintenance plans.

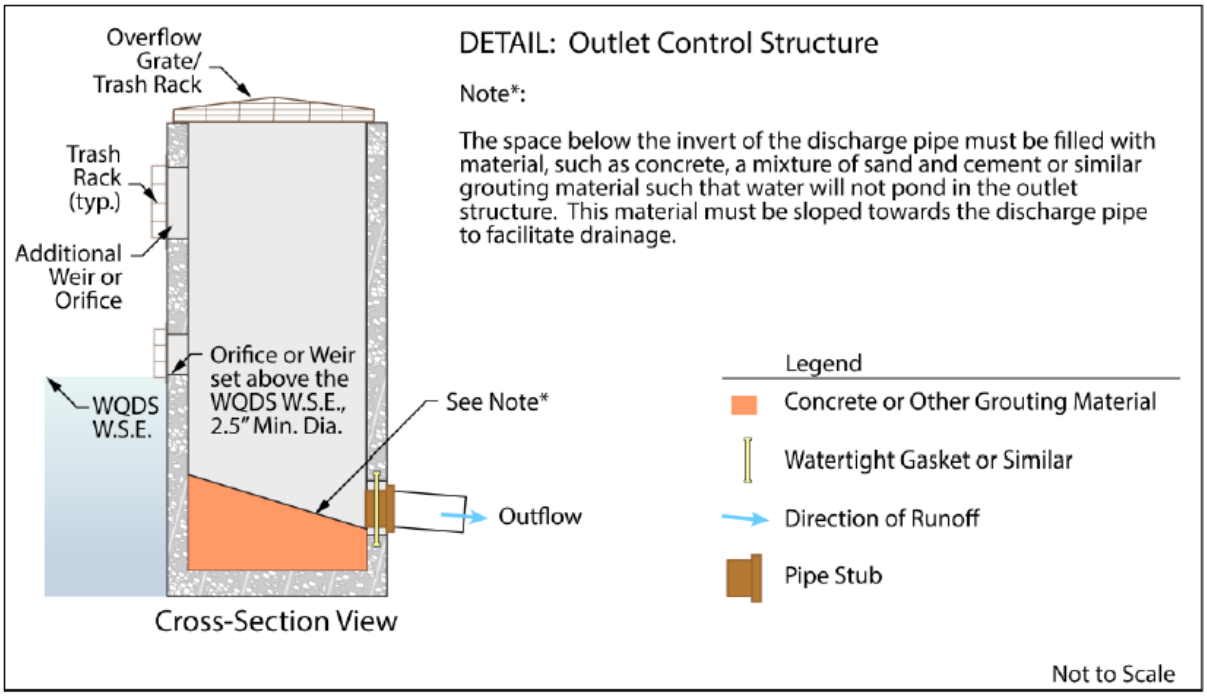
Table 2-5 - Lessons Learned

3 Findings and Recommendations

3.1 Outlet Control Options

The following includes examples of potential outlet control information collected and shared as part of the surveys. The team also collected links to resources provided by peer DOTs that the team reviewed and extracted example outlet controls for review by ODOT as possible options.

Figure 3-1 - NJDEP Extended Detention Basins

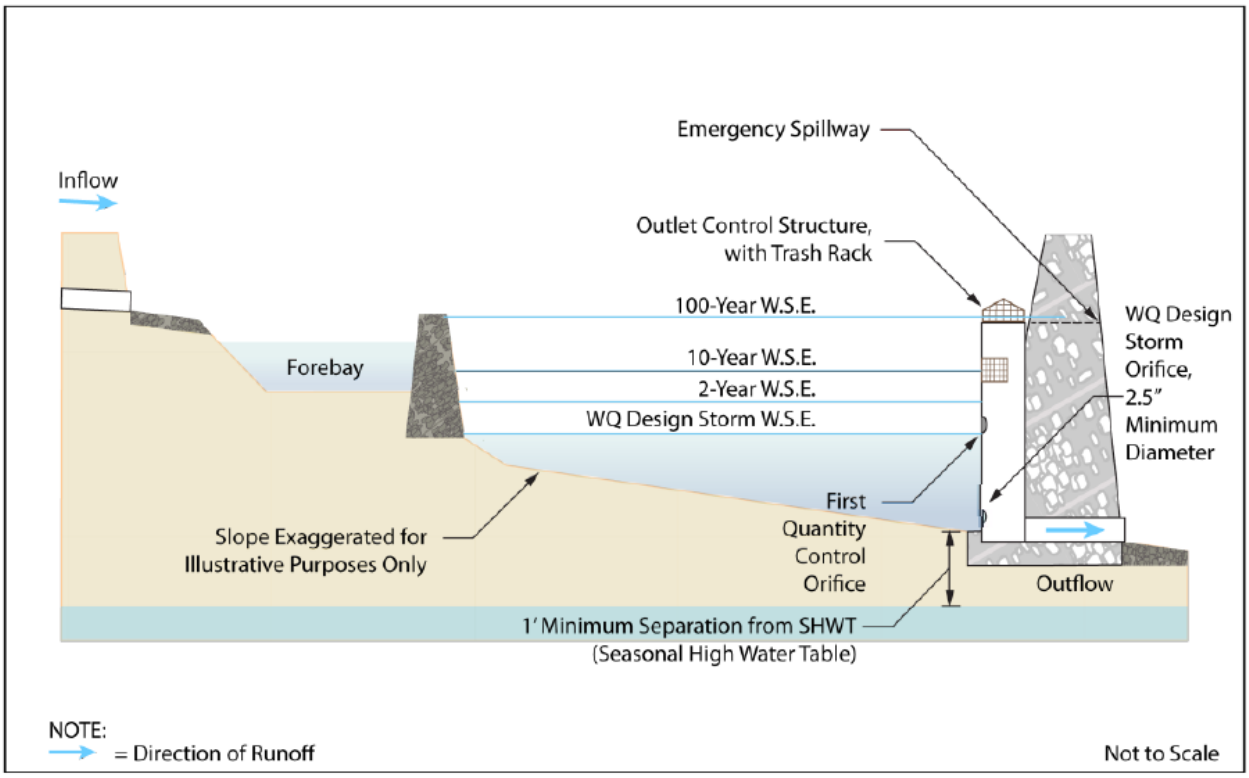


Source: NJ Stormwater best practices manual, Chapter 11.2 Extended Detention Basins

Observations associated with this information:

- This Design approach would eliminate perforated riser pipe.
- Larger opening w/ trash rack could reduce clogging. Also eliminate need for placement of No. 2 aggregate.
- Would require field modification for orifice placement and trash rack installation. This could play a role in the overall cost of this outlet control option.
- Defining acronyms:
  - WQDS – Water Quality Design Storm
  - WSE – water surface elevation

Figure 3-2 - NJDEP Extended Detention Basins

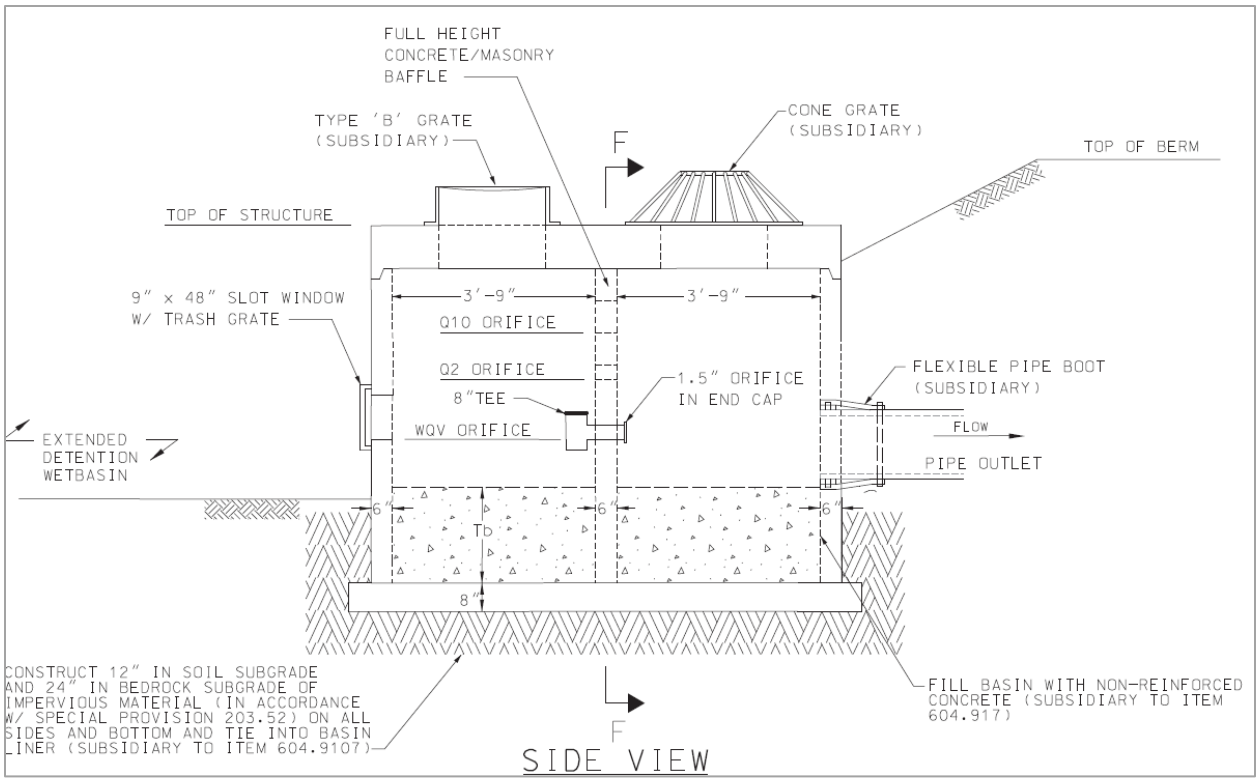


Source: NJ Stormwater best practices manual, Chapter 11.2 Extended Detention Basins

Observations associated with this information:

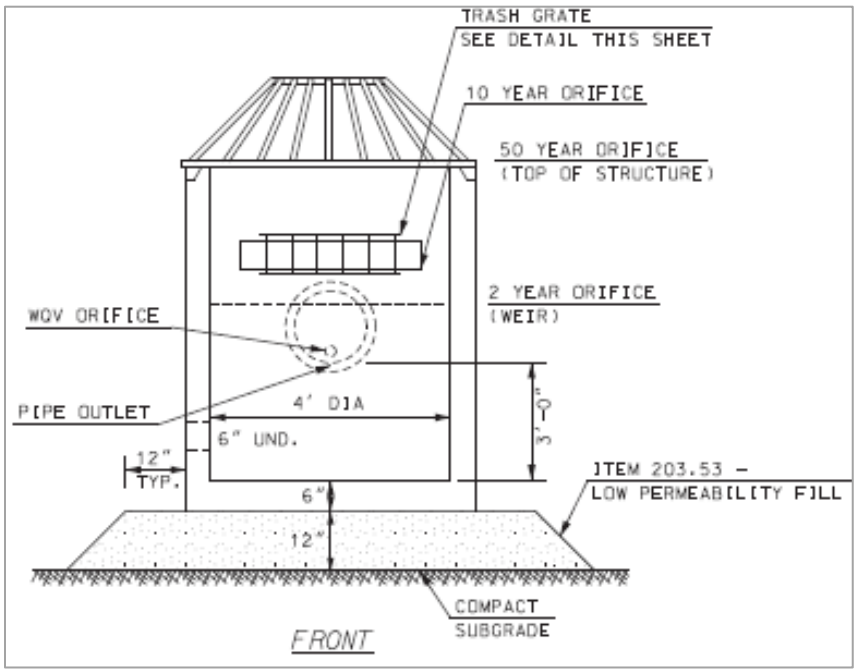
- This Design approach would eliminate perforated riser pipe.
- Larger opening w/ trash rack could reduce clogging. Also eliminate need for placement of No. 2 aggregate.
- Water quality design storm orifice can be set as needed to meet requirements.
- With the WQ orifice set at the bottom, this design would need modified to prevent clogging

Figure 3-3 - New Hampshire DOT - Wet Extended Basin Details



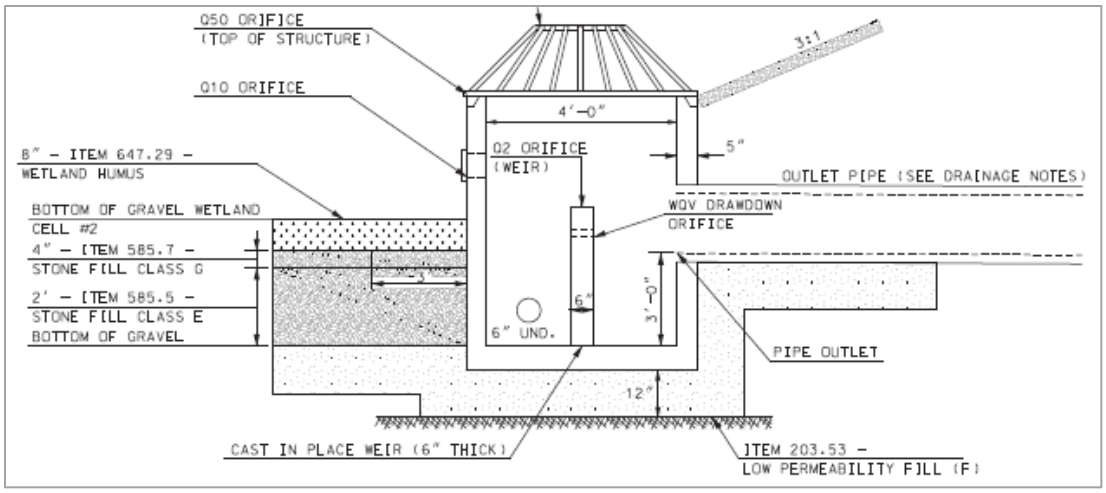
Source: NJ Stormwater best practices manual, Chapter 11.2 Extended Detention Basins

Figure 3-4 - New Hampshire DOT - Wet Extended Basin - Side View



Source: New Hampshire DOT – Wet Extended Basin Details

Figure 3-5 - New Hampshire DOT - Wet Extended Basin - Front View

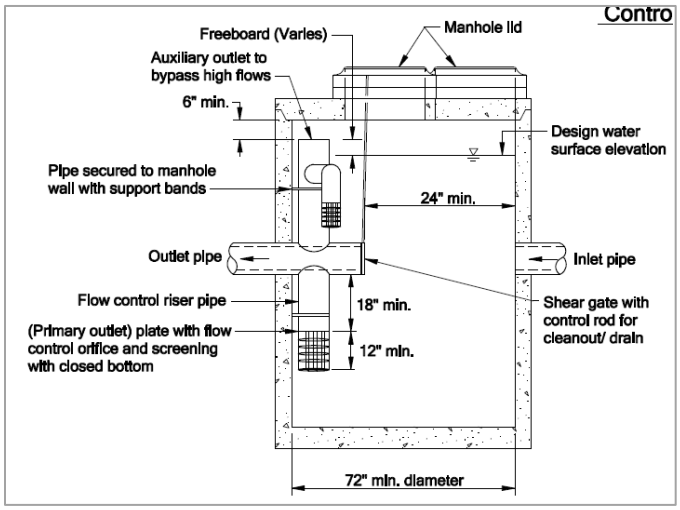


Source: New Hampshire DOT – Wet Extended Basin Details

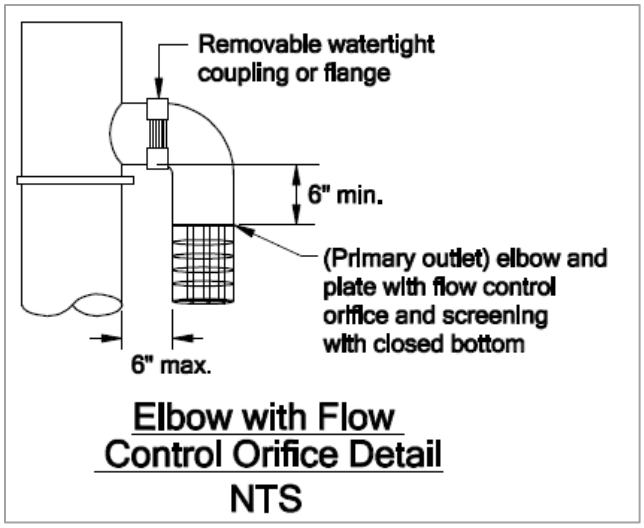
Observations associated with this information:

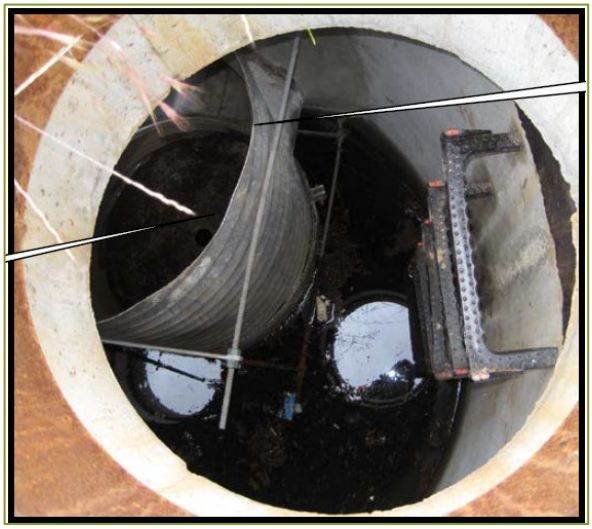
- These outlet control structures appear to require significant labor and costs to install.
- The orifice opening is a minimum of 2.5" and this may present clogging and maintenance issues or needs.
- Possibly require more frequent maintenance to remove sediment or solids from the inside of the structure on the inlet side of the constructed weir.

Figure 3-6 - Oregon DOT - Outlet Control Structure



Source: Oregon DOT – Hydraulics Manual



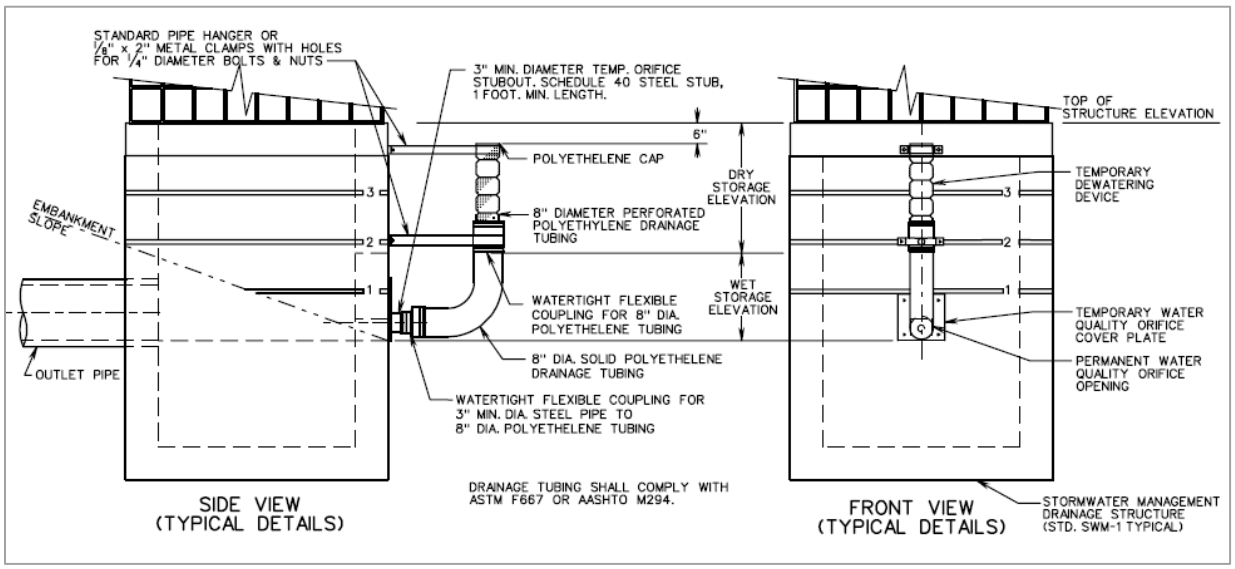


Outlet Flow Control Structure pipe riser photo

Observations associated with this information:

- The rationale behind showing this detail is focused on the riser pipe as a possible option for consideration.
- The pipe configuration could be designed to place inside an ODOT standard catch basin.
- For maintenance and repair access ODOT may need a larger catch basin.

Figure 3-7 - Virginia DOT - Riser to WQ Outlet



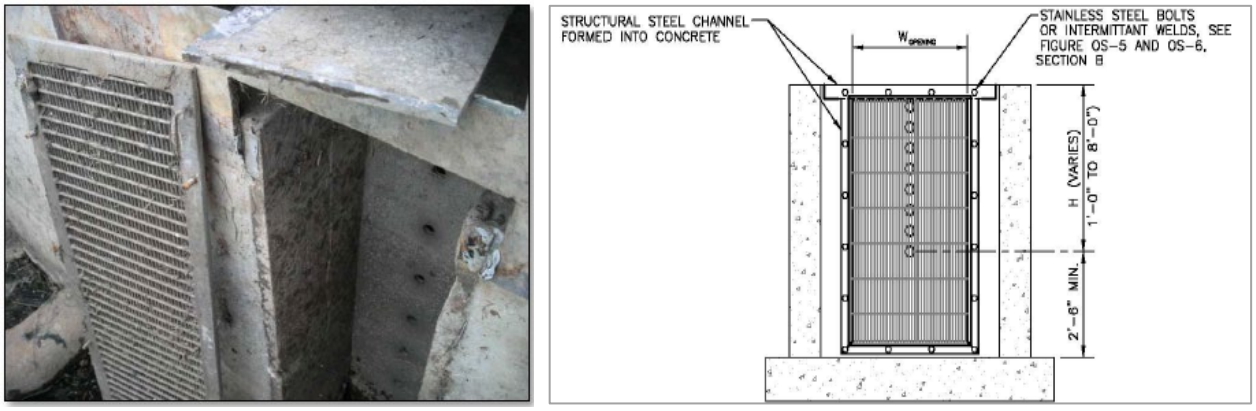
Source: Virginia DOT – C section 100 - Standards

Observations associated with this information:

- This Design approach would eliminate perforated riser pipe.

- Orifice size shall be determined to meet the required WQ draw down requirements.
- Could the concept of the temporary riser pipe be converted into a WQ outlet control system that could be adopted and inserted on the inside of the catch basin.

Figure 3-8 - Colorado DOT - Detention Basin Alternative Outlet Design Study Information

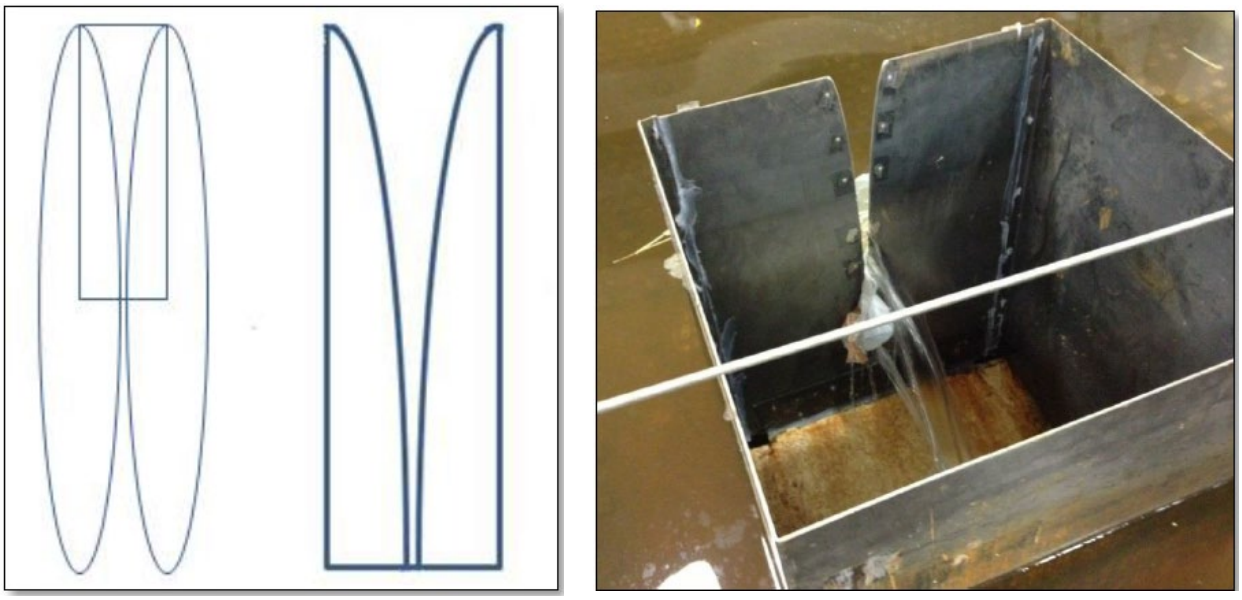


Source: Colorado DOT – Current Standard for water quality outlet design

Outlet Control Structure – Current Standard Information:

- The photograph on the left is a version of the constructed outlet shown in the detail to the right
- Includes a column of small orifices, protected from clogging by a well screen.
- Well screen becomes clogged and requires significant maintenance.

Figure 3-9 - Colorado DOT - Visual of Elliptical Slot Weir



Source: Colorado DOT – Detention Basin Alternative Outlet Design Study. Shown is visualization of the construction of the elliptical slot weir.

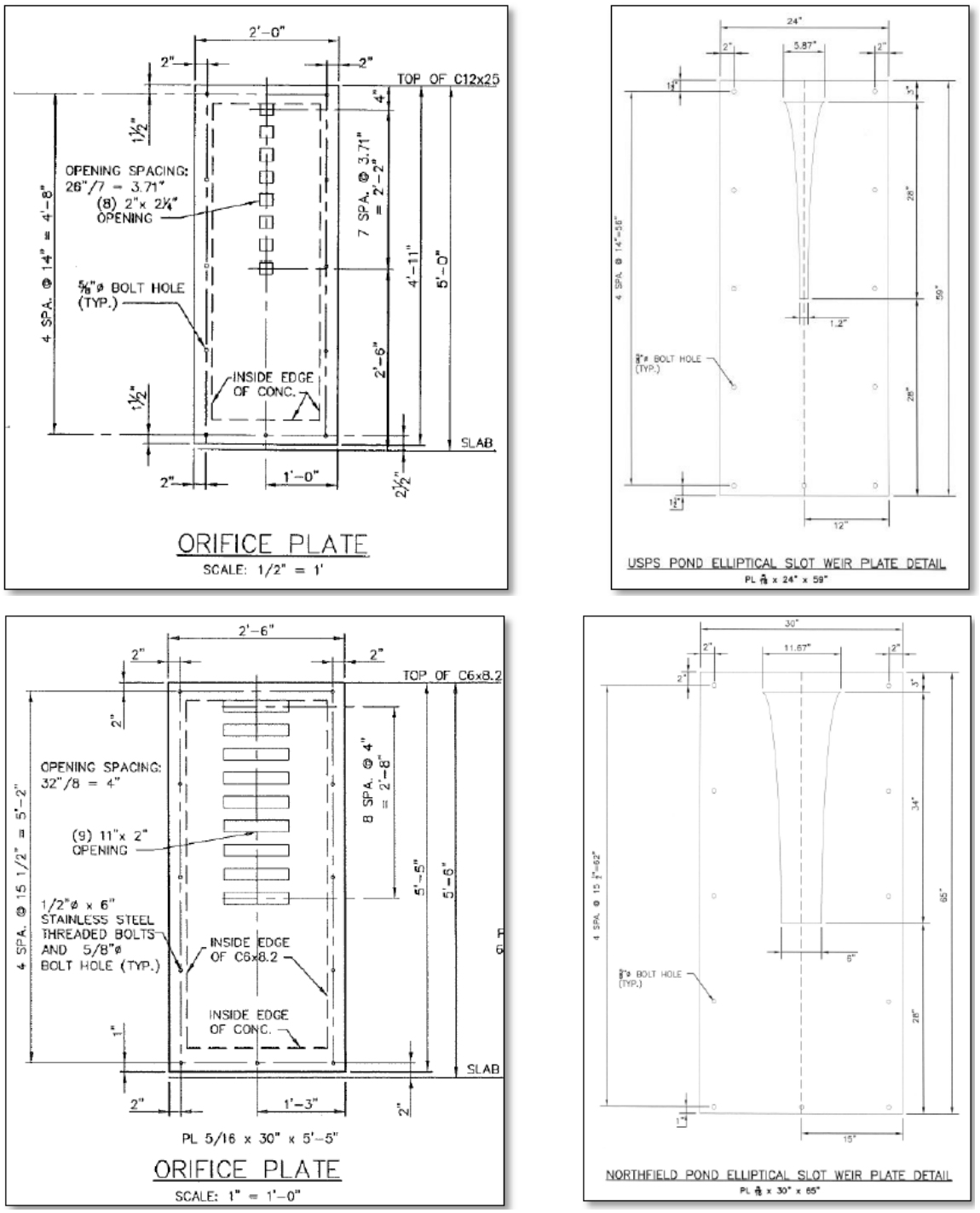
Elliptical Slot Weir:

- CDOT analyzed a "V" notch weir as an option to provide slow metered WQV release to remove sediment through settling.
- During the analysis it was determined that the "V" notch would need to be quite narrow to control release rate and not drain too quickly.
- The "V" notch was modified and resulted in an "Elliptical" shape. The primary benefit observed was that the elliptical shape consistently drained the top zone of the detained water much more rapidly and drained the lower zones more slowly. The observed performance was that this shape allowed for more settling of the storage volumes resulting in much cleaner stormwater discharges.

Key Research Findings and Recommendations:

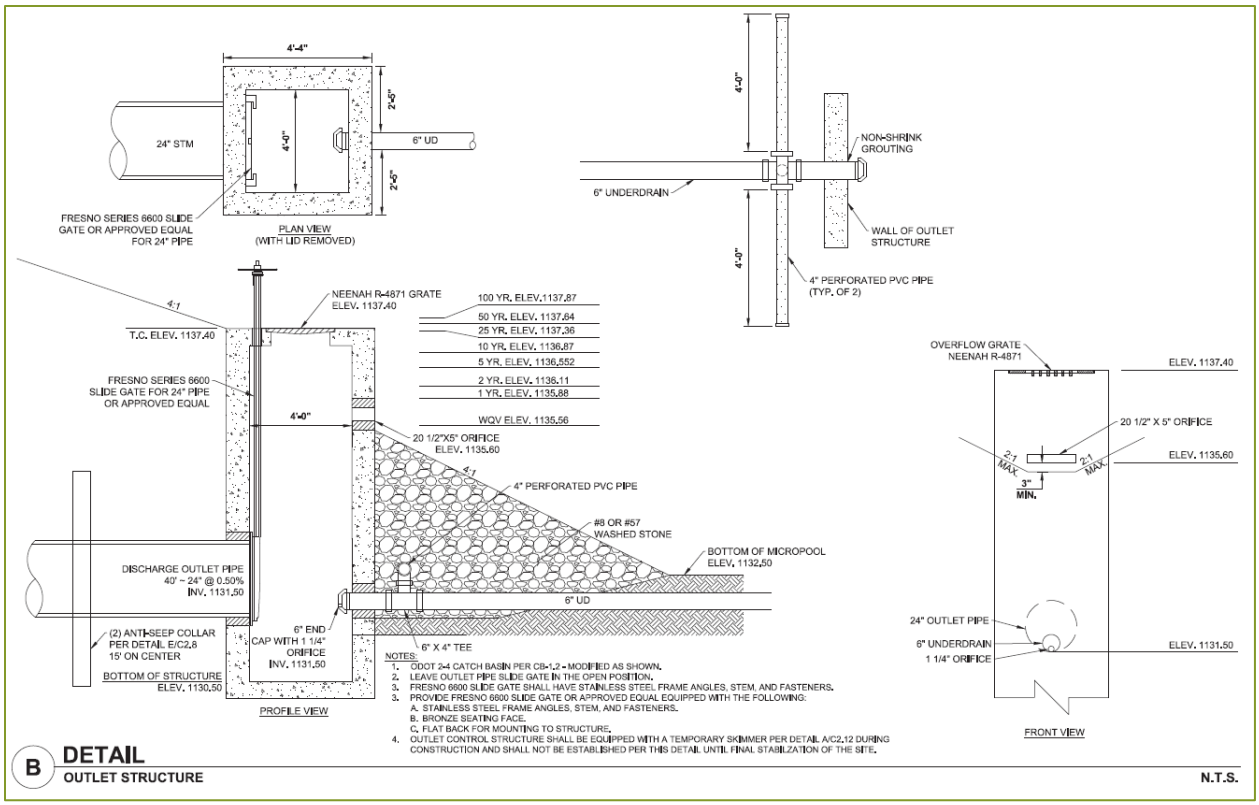
- In general the elliptical slot weir was much better at handling trash like plastic bags, vegetative debris and still maintained function.
- Elliptical slotted weir performed efficiently with flow patterns characterized by high flows at greater ponding depths and low flows at lower ponding depths. The hypothesized results indicated more efficient sediment removal as it aligns more closely with the sediment-based settling velocities defined by Stokes Law. Further research is recommended to verify the stated hypothesis.
- Elliptical slotted weir – not recommended for small or smaller detention basins. The dimensions of the slotted weir would require the notch to be small, less than 3/8" wide and the research identified any notch width smaller than 3/8" wide was prone to repeated clogging. The research estimated the 3/8" slotted weir size equated to an estimated WQV of one-acre foot or larger assuming a 40 hour drain time.

Figure 3-10 - Colorado DOT - Orifice Plate Types Compared to Elliptical Slot Weir



Source: Colorado DOT – Detention Basin Alternative Outlet Design Study. Research study outlet control fabrication details. Comparison with orifice plate outlet control. Note width of elliptical notch – 6"

Figure 3-11 - Ohio DOT - Outlet Structure Detail

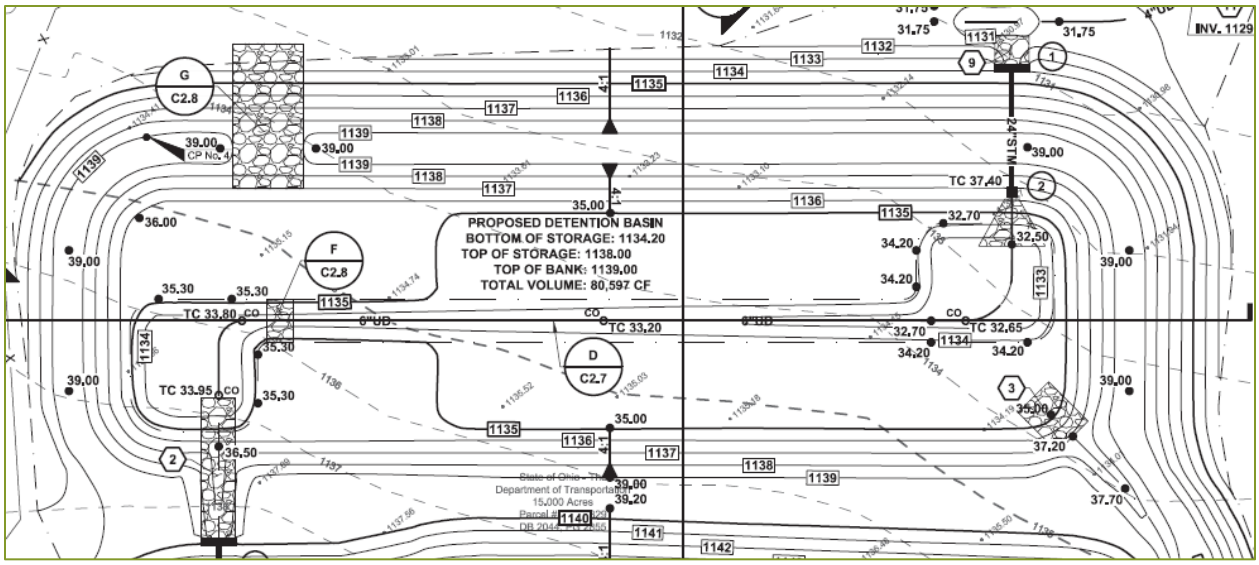


Source: Ohio DOT – Geauga County FSMF Outlet Structure Detail

Observations associated with this information:

- During project status calls, ODOT shared this detail sheet associated with a post-construction control designed and installed at the Geauga County FSMF.
- ODOT discussed potential for limited or reduced clogging with the placement of the washed stone protecting the underdrain.
- The orifice is located at a higher elevation and is of a minimal size to reduce debris and litter from entering the manhole.
- The underdrain penetrates the MH wall and has a configuration that is "T"ed into the underdrain and extends into the stone.
- Figure 3-12 – shows the low flow channel with a micro-pool design.

Figure 3-12 - Ohio DOT - Dry Detention Basin with Micro-pool and Low Flow Channel



Source: Ohio DOT – Geauga County FSMF Outlet Structure Detail

3.2 Recommendations

During the information collect phase of the project, the team conducted two status updated calls to review the progress of the surveys and to being to gain an understanding of the type of information being shared through the survey.

The second status call the team developed a summary of information collected that included sharing preliminary options for ODOT s consideration as possible modifications for their outlet control structure. The shared information from the preliminary options focused on the Colorado DOT research and the elliptical weir. There was a level of interest in this option. However, ODOT had recently completed an ODOT facility structure and included in the facility construction plans were plans for an extended dry detention control for the facility. ODOT shared the grading, SWPPP and detail sheets with the team and ODOT indicated that they were interested in this design and wanted to use this as the basis for updating their existing outlet control for their detention basins.

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Appendices

Appendix A

Master DOT Survey Response Table

Ohio Department of Transportation
Research on Call- Detention Basin Outlet Control Re-Design
AASHTO Survey Response Information

			Information Requested							Question Responses			
Responding Agency	**DOT Responder Contact information**	**Responder Notes**	**Standard detention basin drawings/Plans**	**Design information or guidance related to outlet controls, low flow channels and Emergency spill ways**	**Regulatory requirements for WQv detention storage**	**Detention basin design specifications**	**Sample Plan Sheets**	**Maintenance Requirements**	**Modified basin outlet controls per TMDL requirements**	**Have you had to re-design or modify your detention basin outlet control based on municipal separate storm sewer (MS4) or construction general permit (CGP) requirements in the last 5 years? If yes, can you provide a short explanation as to the changes that were made?**	**Has the regulatory agency suggested any detention basin or outlet control revisions? If yes, can you provide a short explanation as to what they suggested?**	**Have any detention basin outlet controls been modified or re-designed based on constructability issues? If yes, Please provide a short explanation as to what those changes/revisions were or included.**	**Please list any lessons learned with your departments experience with design, construction/ installation and maintenance of detention basin outlet controls.**
Washington DC-District Department Of Transportation	Stephine Dock stephanie.dock@dc.gov 202.359.6965	DDOT indicated that DC does not have any standards for detention basins. No responses were provided for the questions.											
Indiana DOT	Tommy Nantung (765) 463-1521 ext. 248 tnantung@indot.in.gov	Unfortunately we are in a similar situation as Ohio. We are currently developing water quality guidelines due to the revised MS4 requirements.								We are currently developing chapter 204 in our design manual which will cover MS4 requirements.	No, our regulatory agencies have not offered any suggestions.	No	We have required riprap protection for overflow berms when the detention facility is designed to hold less than a 1% EP event.
Iowa DOT	Melissa Serio 515 239 1280 Melissa.serio@iowadot.us	I'm assuming this is regarding detention basins for use as a post-construction control. If this is correct, the Iowa DOT does not have any design guidance or standards for detention basins. IowaDOT had no other responses to the request.											
Tennessee DOT	Melanie Murphy 615-253-2158 Melanie.Murphy@TN.gov	Links to several documents and specifications were included in the e-mail.	No standard detention basin drawings/plans. Only sediment basin standards used for EPSC.	When possible, floating outlet structure design is recommended.	Refer to TDEC - E&S control handbook section 7-31	TDOT Drainage Manual Chapter 8	When needed EC-STR-15 is modified based on site conditions.	There is no guidance about maintaining outlet control structures.	There is no guidance about TMDL. TDOT sediment basin design is based on capturing first 1" rainfall. Therefore, the design requirement is st/l 134CY storage volume for per acre. See note D on EC-STR-15.	No new requirements in the last 5 years. However, currently TDOT -TDEC is working on MS4 permit language.	Only the use of floating outlet structures	Sediment basins used rarely, so far there is no constructability issue.	Due to design complexity, size, ROW, and construction sediment basins has been avoided. To improve the design and efficiency of such devices TDOT has been working on a research project with University of TN for several years. Let me know if you like to learn more about it.
DelDot	Vincent Davis (302) 760-2180 Vince.Davis@delaware.gov	Word document is responses to the questions and the pdf contains SWM sheets from two of our projects. One project shows weir walls and the other is a modified catch basin with pipe outfall.	In attachment	Technically, our design is based on our law/regs, which is dictated by our state EPA / DEQ, which here in DE is known as DNREC (Division of Natural Resources and Environmental Control). Here is a link to their "Post Construction Stormwater BMP Standard and Specifications". In here you can find all the required aspects we're supposed to do. They also have design tables that state what is needed for assorted BMP's versus having to read all the verbiage. Here is another link. Under the 'Engineering' tab, you can find links for some other design parameters like Pond Code 378. And FYI – Pond Code 378 was supposed to be redone, but still waiting on that one. And another FYI, our water quality is based on what is called the Resource Protection Event (RPv), i.e. 1yr storm. Water quantity is based on the Conveyance Event (Cv – 10yr) and Flooding Event (Fv - 100yr).	In simplest terms it's the runoff from the RPv up to 1" maximum. And depending on a particular facility chosen, there are design parameters for extended detention, infiltration, etc. More in-depth explanation in the above link for the DNREC "BMP Stds and Specs".	See DNREC "BMP Stds and Specs".	In attachment.	This is mentioned in the DNREC documentation, but those were really written for developers / HOA's. The DOT is "special" in the sense that we design, construct, and maintain our own BMP's; hence, our Maintenance forces technically maintain, but within DelDOT, the inspection, rating, and sometimes maintenance contracts are done via our NPDES group. I believe they have their own manual on inspection and rating. The inspection work is also done by consultants that work under the DelDOT NPDES group. At present they inspect every facility either once a year or I think they may have worked at a deal with DNREC to inspect some every 2 years like ponds.	At present, we do not design to a TMDL standard per say, but I could certainly see that happening in the future. The work around'ish that happened a few years ago as done by DNREC and agreed with by the EPA was with their last reg update (officially Feb 2019) was by designing for the RPv and looking at infiltration as the first option (until proving that it can't be done for various reasons). This way, all of Delaware did not have to do different design standards per watershed or water body. IMO, a smart move, so now everyone is on the same page throughout the whole state (DOT and developer). Also, especially with DOT projects, you don't have to have different design standards at assorted outfalls in the same project. Of course, these changes were met with some resistance at first, because change is always bad, but like anything, once it's around for a while, it's the way things have always been done. ☺	No	This was per the adoption of the Feb 2019 regulations, which is also covered throughout the DNREC "BMP Stds and Specs". All verbiage in **bold** type is regulatory and everything else is suggested. Link to the actual regulations:	? It's very rare and may have only happened once or twice in my 25+ years of doing this type of work. If yes, please provide a short explanation as to what those changes/revisions were or included. The last one I remembered happening was because of a utility issue. It was a gas line that was never accounted for that "appeared" out of nowhere so to say. LONG story short, the original outlet structure was a modified catch basin with a pipe outfall and got changed to a weir wall.	IMO, the best type of outlet structure to use is a weir wall with assorted weirs designed into it. For water quality, a v-notch can usually handle the very low flows required for those standards and then assorted rectangular sized weirs above that for water quantity. When forming up the structure for a concrete pour, inverts and weir sizes can be placed fairly accurately as well as the emergency spillway can be instituted into the weir wall itself versus having to construct a 'dip' into the embankment and sometimes a dedicated swale. No trash/safety racks required. Inspection and maintenance are also way easier, because everything is out in the open and the maintenance requirements are roughly the same as for the concrete components of a bridge. For example, cracks can be fixed with epoxy injection and spalls are fairly easy to repair as well. Also with a weir wall, a hole could be built into it at a low level for attaching a skimmer during construction when using the facility as a sediment basin and later sealed up when no longer needed. I always look at this as a first choice for an outlet structure when possible. The negatives are not every location can utilize a weir wall. Sometimes weir walls can become quite long, so overturning along with 'excessive' amounts of concrete are needed. We don't have a maximum weir wall length, but that is an excellent study problem that is on my wish list (one of many). And to go along with a weir wall idea on my wish list, I always thought the use of sheet
SCDOT	**Jackie Williams, P.E.** Stormwater Manager South Carolina Department of Transportation 803-737-6378 O | 803-360-0743 C williamsja1@scdot.org									The SCDOT design was approved slightly over 5 years ago, but was the result of the current construction general permit term. SCDOT created sediment basin standard drawings in 2016 due to requirements for surface withdrawal in the current construction general permit (CGP) (SCR160000) effective 1/2013.	The SCDOT construction general permit (SCR160000) issued by SCDHEC requires surface withdrawal, which is achieved with the use of skimmers and a riser configuration designed to ensure weir flow conditions. SCDHEC had no suggestion of how to achieve surface	The Standard Drawings are currently being reevaluated and edited to allow more flexibility to site conditions. The next edition will have length to width ratios, and minimum values for surface area, and depth. In addition, the next edition will contain clear instructions	The lesson learned is allowing more flexibility in the design while still ensuring the CGP requirements are met. The design standards need to be applicable to most situations, and must be flexible enough to fit into limited rights of way boundaries. In addition the guidance for how to utilize a permanent detention pond design during construction as a sediment basin will be clearly documented.
KDOT	Sally Mayer, P.E. Assistant Bureau Chief - Research	The LA852h standard can be accessed at https://kart.ksdot.org/ under "KDOT Standard Drawings." You will need to set up an account, which	LA852h standard drawing and the sizing of the basin in the plan sheets.	We follow the information in LA852h.	NPDES permit requirement of 3,600 CUFT of storage per acre that drains into the basin	LA852h or what individual plan sets require	LA852h or what individual plan sets require	KDOT rarely has any permanent sediment basins. Our maintenance of the sediment basins is to clean them out on an as needed basis.	Not currently required				
MaineDOT	Kerem Gungor Stormwater Engineer MaineDOT Environmental Office 207-592-3489	- https://www.maine.gov/dep/land/stormwater/stormwaterbmps/vol3/chapter3.pdf	MaineDOT does not have any dry detention basins. So, no standard drawings/plans. MaineDOT uses Maine Department of Environmental Protection (DEP) BMP Manual. In case a dry detention basin is required for peak flow control, MaineDOT will use Chapter 3 of the DEP BMP Manual:	See the link given for "a".	Dry detention basins do not receive water quality treatment credit as stated in Chapter 3 of the DEP BMP Manual. The regulatory WQv requirement for the stormwater ponds (e.g. wetponds, vegetated filter ponds, infiltration ponds) is "One-inch x impervious drainage area + 0.4-inch x landscaped (lawn) drainage area".	No MaineDOT detention basin specifications at the moment. If a MaineDOT project requires a dry detention basin in the future, the specifications given in Chapter 3 of the DEP BMP Manual will be	No sample MaineDOT plan sheet showing detention basins available. The Department doesn't have any dry detention basins.	No maintenance requirement specific to outlet c	None	No	No	No	MaineDOT only has retention (wet) ponds with permanent pools. (Unfortunately) no lesson to share.

Oregon DOT	Lu Saechao, PE Senior Stormwater Hydrauluic Engineer Environmental & Hydraulic Engineering Section ODOT (503) 986-3365	Lu.SAECHAO@odot.oregon.gov	https://www.oregon.gov/odot/GeoEnvironmental/Docs_Hydraulics/SOM_Ponds.pdf	https://www.oregon.gov/odot/GeoEnvironmental/Pages/Hydraulics-Manual.aspx	Chapter 14, Section 14.10.2 WQ design storm, volume Chapter 12, Section 12.5.1.1 Flow Control design storm, volume	01011, Ponds 01012, WQ Biofiltration Swale		Chapter 12, Section 12.5.1.6- Flow control facility Chapter 14, Section 14.9.3 Maintenance Requirements Chapter 14, Section 14.10.15 WQFacility O&M		No	No	No Response	No Response
NJDOT	Stephanie Nock Management Assistant Bureau of Research Division of Statewide Planning New Jersey Department of Transportation PO Box 600 Trenton, NJ 08625-0600	Stephanie.Nock@dot.nj.gov	We do not have standard detention basin plans.	We utilize a combination of the NJDOT Roadway Design Manual and the NJDEP Stormwater Management Best Management Practices Manual for basin design. The outlet control structure is based on the target for the design storm. Since detention basins are not typically sufficient to address water quality requirements, we use other means to treat the runoff (bioretention basins/biofiltration media, infiltration, wet ponds, constructed wetlands, Manufactured Treatment Devices reviewed and certified by NJDEP). Section 10 Drainage. The following subsections may be of most use:10.11.2, 10.11.4, and 10.12.3	The water quality volume is based on 1.25 inches of storm in 2 hours, using a non-uniform storm event. See Page 40 of the attached SWM rules for the rainfall distribution.		I don't have a sample plan sheet. However, I have attached some recent basin designs that may be useful to you.	Generally, the detention basin maintenance is to mow, clean the outlet, removed sediment and trash, and fix whatever may be cracked or eroding. However, many water quality basins rely on filtration through media or infiltration to meet the target 80% TSS removal since detention basins generally is insufficient to address water quality.	TMDL criteria have not been placed into the stormwater management criteria as yet. In some areas, we used constructed gravel wetlands basins, not a detention basins. Details regarding the gravel wetlands design is in the NJDEP BMP manual.	The SWM rules were updated in 2004 with the onset of the MS4 permit in NJ. At that time, a new BMP manual along with new SWM requirements occurred. Originally, the standard method of achieving water quality was by putting in a 3" orifice as the only outlet for the water quality design storm. The regulations required an 80% TSS removal and maintaining 100% of average annual recharge. Those regulations pushed designs towards more filtration/infiltration BMPs, vegetation, and sand filters, as well as Manufactured Treatment Devices (MTDs). These MTDs were cited in the regulations and needed to go through a DEP certification process to be used.		Detention basins are the simpler of our BMPs. The issue is not the outlet structure but there has been more focus on ensuring that a detention basin not intercept the water table since it is contrary to maintaining groundwater recharge and may cause the basin to not drain dry.	
NHDOT	Deidre. T. Nash, PE Assistant Research Engineer NHDOT Bureau of Materials and Research 5 Hazen Drive PO Box 483 Concord, NH 03302-0483 603-271-8995 Deirdre.T.Nash@dot.nh.gov	Just a note on our regulatory requirements: New Hampshire is a non-delegated state. Our NPDES discharge permits; General Permits for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4) and, the Construction General Permits come directly from EPA. We have a totally separate State land development permit that is administered though our New Hampshire Department of Environmental Services (NHDES). However, that administration has been delegated to the NH Department of Transportation through a Memorandum of Agreement.	The NHDOT does not have Standard Plans for these elements. The details are generally developed on a project by project basis depending on the project needs, commitments, and constraints/limitations. Our recent I-93 widening corridor project included extensive water quality measures, and provides recent samples of our layouts/designs. A few samples from a couple of these projects are attached. These projects are identified as Salem-Manchester 14633D and 14633H, and the full project plan sets can also be referenced on the NHDOT Website, under Project Center and Project Plan Inventory.	See links provided	The Department designs for 1" of runoff as the WQV.	The design specifications are detailed in the plans, and based upon the above noted AoT Rules and Stormwater Manual.	See attached, and as noted in a. above.	This is left pretty loose by our State regulators and EPA. The State requires "on-going inspection and maintenance". EPA require the same but also include annual inspections but only for facilities within the MS4 program (about 30% of treatment facilities). As such, the DOT has developed a Stormwater BMP inspection Manual which is included in Appendix Q of the State's Stormwater Management Plan	None so far. We have made it a point to note retrofit is not feasible due to inverts. In order to get enough head to run a treatment facility, the inverts in drainage system that feed the treatment facility must high enough to get an approximate 3-foot drop to the receiving water body. Therefore, we concentrate on new facilities to all waters. We are not rebuilding entire road sections to install new drainage (MS4s) in order to treat stormwater without a highway purpose.	Yes, for MS4 or Alteration of Terrain (State Land Development Permit). The modifications are usually associated with a larger catchment and the basin is enlarged or the flow dynamics are altered. We will use existing basins for CGP purposes and require a clean out once the construction is completed.	No, the Department is self-regulating. If changes are to be made, they are initiated by the Department of Transportation.	Yes, the State regulatory agency published a Stormwater Manual (noted above). We also have a Memorandum of Agreement with our State regulators to be "substantially equivalent" to the State regulation. This "substantially equivalent" agreement allows the Department to make modifications as necessary to fit the structures into the Right of Way.	Notables as Follows: No metal parts that reside in pooled water, All concrete precast structures must have butyl seals, All spillways need concrete cut-off walls, open rock trash racks are a must, do not build on rock fill, Need drive up access as maintenance is a problem.
CalTrans	Sang Le, PE Cooperative Research Specialist Office of Safety Innovation and Cooperative Research Division of Research, Innovation and System Information (DRISI) California Department of Transportation (Caltrans) 916.701.3998 Mobile sang.le@dot.ca.gov	For Cal Trans - no direct response to the questions. Information shared contains question responses.											
MassDOT	Henry Barbaro MassDOT Stormwater Program 617-838-7419 henry.barbaro@state.ma.us		See attached for example detail sheets for a MassDOT project with an infiltration basin. MassDOT promotes infiltration basins (as opposed to detention basins because they lack capacity for water quality treatment).	See attached for example detail sheets for MassDOT project with outlet control structures and emergency spillways (overflow stone spillways). MassDOT has a draft version of their Stormwater Design Guide (accessible at link below but expires in 21 days) where guidance is provided on the design for outlet control.	See draft MassDOT SDG.	See attached for example detail sheets. Also provided are the special provisions for the project which includes items specific to basins (e.g., Item 170.3; however there is no specification explicitly for basins).	See attached for Sheet 10 of a MassDOT project that shows a plan view of an infiltration basin. Note that there was no room on this example design to fit a sediment forebay but typically an infiltration basin would have a sediment forebay incorporated into the design.	Maintain on an as-needed basis.	General approach is to promote infiltration to the maximum extent practicable and allow ponding up to 2 feet but needs to drain completely within 72 hours.	No	No	Nothing specific, but generally the OCS is built into side slope so the structure does not protrude and create a potential hazard for vehicles that drive off the road. OCS designs vary by site, depending on need to control peak flows, reduce flooding, etc. See Section 4.9.2 in the draft MassDOT SDG which includes a subsection on outlet control structures and auxiliary spillways.	They are vulnerable to erosion without adequate armoring.
Montana DOT	David Hedstrom, PE Hydraulics Engineer Montana Department of Transportation 406-444-7961		MDT doesn't have standard detention basin drawings. Detention basins are typically designed specific to each site. Additionally, most of our projects are rural and only a small percentage of the projects are in MS4 areas.	We typically follow this document which was developed by the Montana MS4 communities.	See link to the Montana Post Construction Storm Water BMP Design Guidance Manual above.	No information.	No information.	No information.	No information.	We have modified our detention basin outlet control in MS4 areas to include the required infiltration volume in the pond.	NO	No, Each basin is designed on a site by site basis.	Coordinate with the local municipality on the local permit requirements including the operations and maintenance plans.