

Post-Construction Stormwater Management (PCSM)

January 22, 2025

Updated July 28, 2026

Outline

- Introductions
- Background (MS4GP and CSGP)
- PCBMPs on INDOT Projects
- PCBMP Selection
- Infeasibility Analysis
- Hydrologic Design
- Overview and design for common PCBMPs
- Inspection and Maintenance Forms
- Submittal Documentation and Process
- Design Example 1
- Design Example 2
- Design Example 3
- Construction
- Frequently Asked Questions
- Q&A - PCSM@indot.in.gov



The PCSM Team

INDOT

- Sandy Bowman
- Greg Couch
- Reed Hathaway
- Jim Emerick
- Ollie the Otter



HNTB

- PCSM Implementation
- PCSM Design Reviews
- PCBMP Inspection
- PCBMP Maintenance Oversight

RGI

- PCSM Design Reviews
- PCBMP Inspection

HWC

- PCBMP Maintenance

Why are we doing this? – The Clean Water Act

- Originally the Federal Water Pollution Control Act (1948) – Significantly reorganized and expanded in 1972
- Requires stormwater discharges be permitted under the National Pollutant Discharge Elimination System (NPDES) program
 - Phase I (1987) and Phase II (1995)
- INDOT is an MS4 – Covered by IDEM's MS4GP (coverage for Phase II MS4 entities)
 - Includes 6 Minimum Control Measures
 - #4 – Management of Construction Site Runoff – In Indiana, must apply for coverage under the Construction Stormwater General Permit (CSGP) for one or more acres of land disturbance – Replaced Rule 5 in 2021 – Requires Post-Construction measures, Post-Construction measures are a permit condition of CSGP
 - #5 – Management of Post-Construction Site Runoff – Agencywide program requiring implementation, inspection, and maintenance of Post-Construction measures
- CSGP permit condition requires PCBMPs as part of the MS4 program
- To learn More: https://www.in.gov/idem/stormwater/files/final_gen_permit_ms4.pdf
- https://www.in.gov/idem/stormwater/files/final_gen_permit_inra00000_construction.pdf

What is a PCBMP?

- Post-Construction Stormwater Best Management Practice (PCBMP)
 - A method that has been determined to be the most effective and practical means of preventing or reducing non-point source pollution to help achieve water quality and quantity goals
 - Can be structural or non-structural (activity based, such as using less salt to de-ice roads)
- Structural PCBMPs for INDOT projects:
 - Dry Grass Swales (turf or native grass)
 - Vegetated Filter Strips
 - Dry Detention (modified)
 - Wet Swale
 - Wet Retention Pond
 - Infiltration (swale or basin)
 - Hydrodynamic Separators
- Post-Construction Stormwater Management (PCSM)
 - The management efforts connected to planning for, designing, constructing, and maintaining PCBMPs



Dry Grass Swale, Hendricks County, Indiana

Target Pollutant

- Sediment
 - Most common water pollutant (US EPA)
 - Primary pollutant in stormwater run-off from pavement
 - Permanent measure target
- Design to 80% sediment removal rate as Total Suspended Solids (TSS)
 - When 80% TSS removal is achieved, other contaminants and floatables are removed as well



Sediment-laden run-off in Marsh River (MN) – pca.state.mn.us

Design Memo 26-01

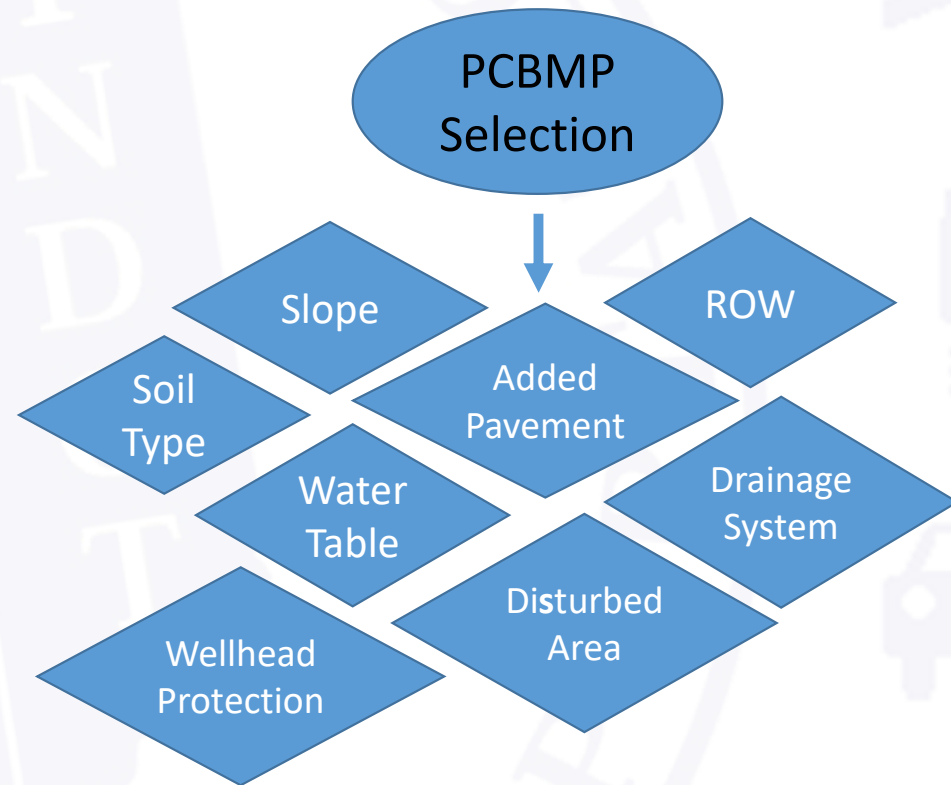
- Subject: Post-Construction Stormwater Management Updates
- From: Elizabeth Mouser, Standards and Policy Director
- Supersedes Design Memo 22-22
- Post-Construction Stormwater BMPs are required when both of the following conditions are met
 - The project requires a Construction Stormwater General Permit
 - The project includes new net impervious surface of
 - 1 acre or more, or
 - Between 10,000 sq. ft. and 1 acre as noted in Figure 1A, Post-Construction BMP Determination



PCBMP Selection Flowchart

Considerations

- Disturbed area, added pavement
- Available ROW
- Drainage system type
- Soil type
- Water table depth
- Bedrock depth
- Slope
- Wellhead protection area
- Peak flow mitigation
- Offsite drainage area



Each outfall that includes added impervious surface requires treatment in a PCBMP. If a given outfall does not include added impervious surface, a PCBMP is not required for that outfall.

Roadway Project Layout/Site-Specific Conditions

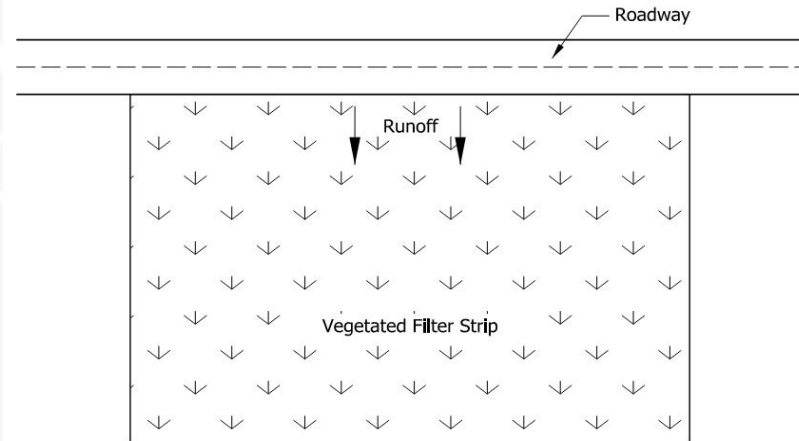
Site-specific factors that limit PCBMP selection

- Available right-of-way
- Steep slopes and other topographic constraints
- Infiltration not allowed in karst or wellhead protection areas
- High water-table, some PCBMPs must drain between rainfall events
- Bedrock near ground surface – expensive to excavate
- Large off-site areas draining to PCBMPs – require more space – velocities increased
- Adjacent land-use draining to INDOT right-of-way
- Underlying soil type – affects infiltration and support for needed vegetation

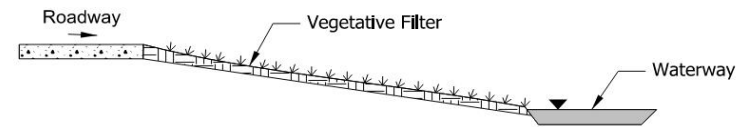
Structural Measure Selection Priority

Priority

1. Dry turf grass swale
1. Dry native grass swale
1. Filter strip
1. Dry detention
2. Wet swale
2. Wet retention pond
3. Infiltration swale
3. Infiltration basin
4. Hydrodynamic separators



Plan View



Profile View

See INDOT guidance documents for references/definitions.

Infeasibility Analysis

- Economically infeasible
 - Limited right-of-way, utility relocations, topographic constraints, and amount of added flow from offsite
 - Option to treat the same amount of pavement (could be existing pavement) in a different outfall – must go to the same receiving stream
 - First blue-lined stream on a 1:24,000 USGS Topo Quadrangle Map
 - If this option is utilized, the project is considered to meet requirements and does not need an infeasibility exception
- TMDLs
 - Must consider receiving streams on the current 303(d) list of impaired waters
 - Pollutants not from INDOT ROW may be infeasible to remove by PCBMPs
 - Work with PCSM Team if discharging to a TMDL stream

Infeasibility Documentation

- Prior coordination with INDOT is required for infeasibility exception
- For small projects, infeasibility exception may be for entire project
 - Submit documentation to PCSM Team
 - PCSM Team will provide an infeasibility memo, to be submitted with permit applications
- For larger projects infeasibility exception will be provided on a per-outfall basis and noted in the PCSM approval memo
- See PCSM guidance document for information required to submit for infeasibility



West Fork White River, Morgan County, Indiana

Hydrologic and Hydraulic Design

- Water Quality Event: A rainfall event of one inch, assumed to remove a significant percentage of pollutant from the roadway
 - Also known as the “first flush”
- Water Quality Volume: The volume of run-off generated by the Water Quality Event for treatment in PCBMPs
- Water Quality Treatment Rate: The peak flow rate of stormwater run-off generated by the Water Quality Event



Rain on grass – edu.rsc.org

Water Quality Volume

$$WQ_v = (P * R_v * A) \div 12$$

Where:

WQ_v = water quality volume, acre-feet

P = rainfall, inches (use 1.0 inches)

R_v = volumetric run-off coefficient

A = total proposed onsite drainage area, acres

And:

$$R_v = 0.05 + (0.009 * I)$$

Where:

I = percent new impervious cover, %

And:

$$I = [(P_{ia} - E_{ia}) \div A] * 100$$

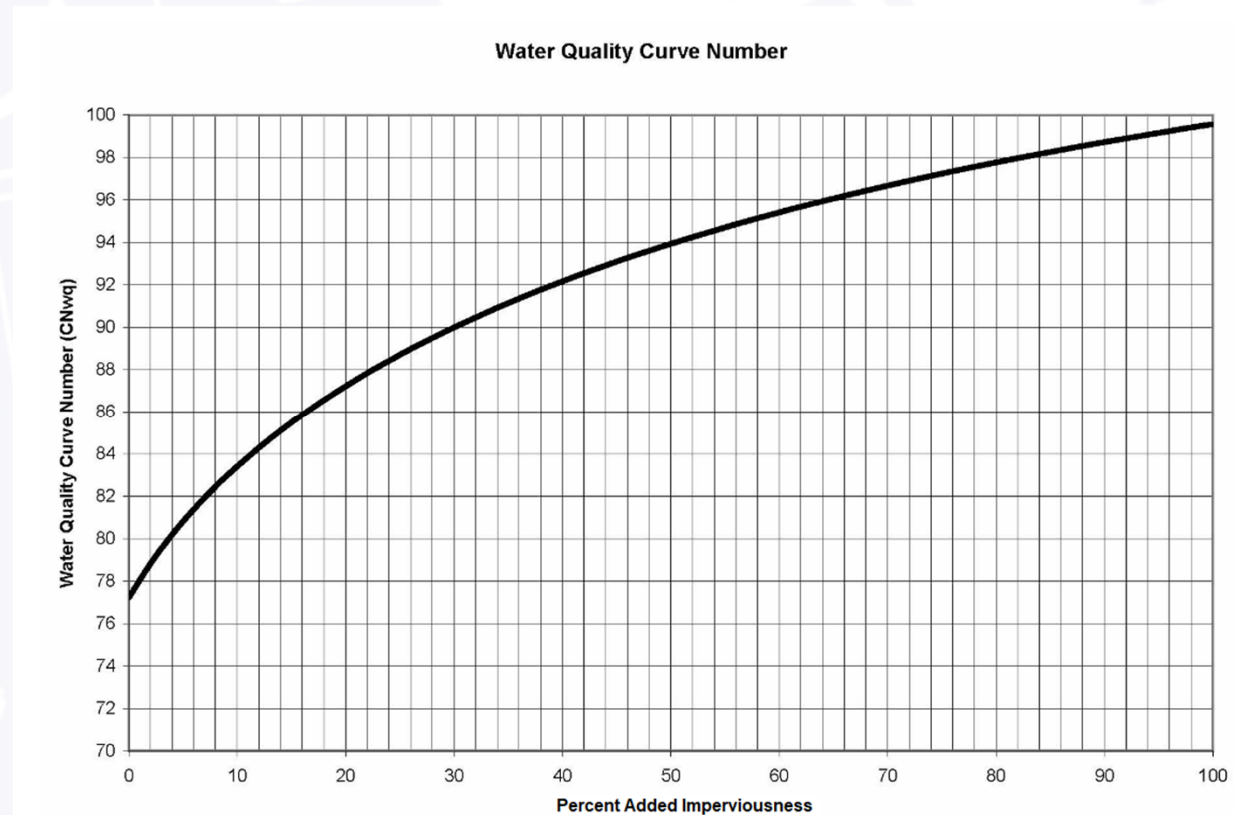
Where:

P_{ia} = Proposed Onsite Impervious Area

E_{ia} = Existing Onsite Impervious Area

Water Quality Treatment Rate

- Qwq
 - Calculate Tc using TR-55 methodology
 - Calculate CNwq using provided graph
 - Compute Qwq in cfs following hydrograph-oriented procedures approved in IDM Chapter 202
 - Use NRCS Type II rainfall distribution and depth of 1 inches



Dry Swales

- Designed to fully drain between rainfall events
- Planted with turf grass or native grasses
 - If possible, avoid using native grass if within 30 feet of the edge of pavement due to typical INDOT mowing process
- Trapezoidal, V-shaped, or natural cross section
- No underdrain
- Water depth during Water Quality Event at or below grass height (6 inches for turf, 2.5 feet for native)
- Sized using Water Quality Treatment Rate and Hydraulic Residence Time

$$T_{ahr} = (L_{swale} \div v_{wq}) \div 60$$

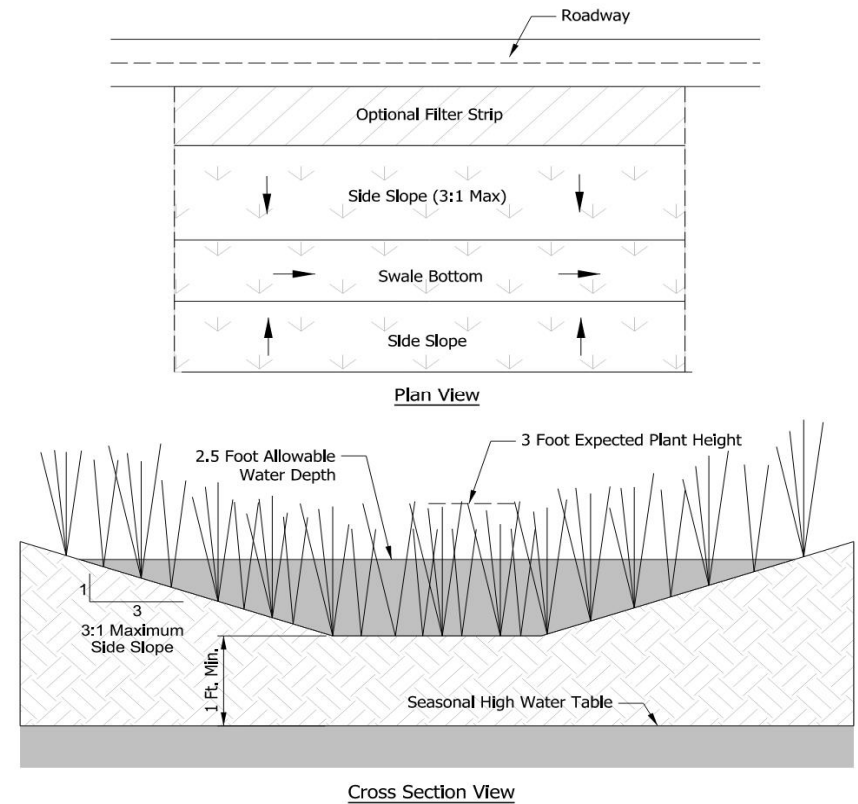
Where:

T_{ahr} = hydraulic residence time, minutes

L_{swale} = length of swale, feet

v_{wq} = peak flow velocity at water quality event, ft/s

T_{ahr} of 9 minutes = 80% TSS removal



Dry Grass Swale



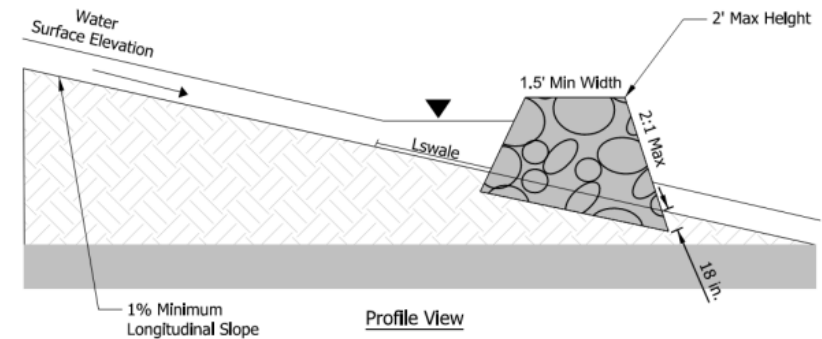
Grass Swale in I-70 Median – Maryland DOT State Highway Administration

Offsite Flow Entering a Swale

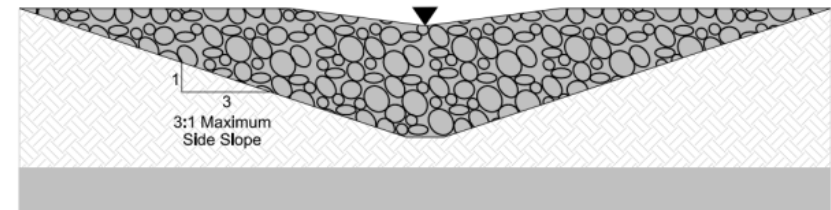
- If offsite flow cannot be bypassed it must be accounted for
- Calculations
 - Two basins can be modeled, one for onsite and one for offsite
 - Derive T_c for both basins following typical procedures
 - CN for both basins will be derived using the same process as CN_{wq} for swales
 - Use percent impervious area instead of percent *added* impervious area
 - The swale is the outlet for both basins in model
 - 1 inch of rainfall
 - Typical water quality swale sizing design process
 - Alternatively, can combine the onsite and offsite into one area with one water quality treatment rate calculation

Dry Swales with Check Dams

- Minimum longitudinal swale slope of 1%
- Check Dam Geometry
 - Foreslope and backslope 2:1 or flatter
 - 1.5-foot minimum width at the top
 - No opening
 - Revetment riprap, keyed in 1.5 feet below the flowline
 - Max height of 2 feet
- Completely made of riprap (no filter stone) and no geotextiles
- Fully dries between rainfall events
- Store Water Quality Volume behind check dam(s)
 - Use % *added* impervious for calculation



Profile View



Cross Section View

DRY SWALE CHECK DAM

Check Dam Storage Volume

Volume of Storage Behind Check Dam

$$V_1 = \left[\frac{W_1 S_p L_1^2}{2} + \frac{S_p^2}{6 S_{xf}} L_1^3 + \frac{S_p^2}{6 S_{xb}} L_1^3 \right]$$

Where:

V_1 = storage volume above swale, cubic feet

W_1 = swale bottom width, feet

S_p = profile slope of swale, feet/feet

L_1 = distance water can be stored from the toe of dam, feet

S_{xf} = swale foreslope, feet/feet

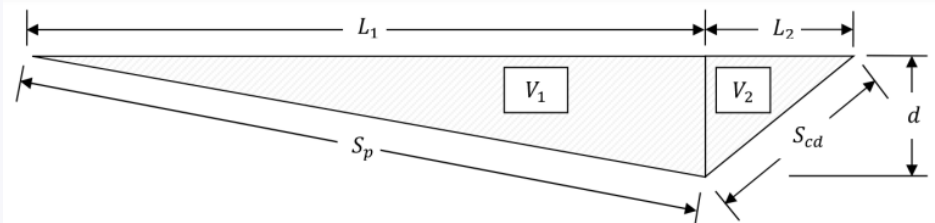
S_{xb} = swale backslope, feet/feet

S_{cd} = check dam face slope, feet/feet

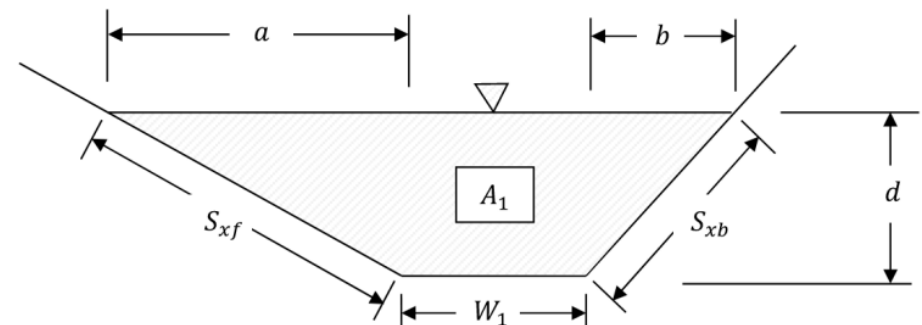
d = height of dam, feet, where $S_p L_1 \leq d$

a = horizontal distance of swale foreslope, feet

b = horizontal distance of swale backslope, feet



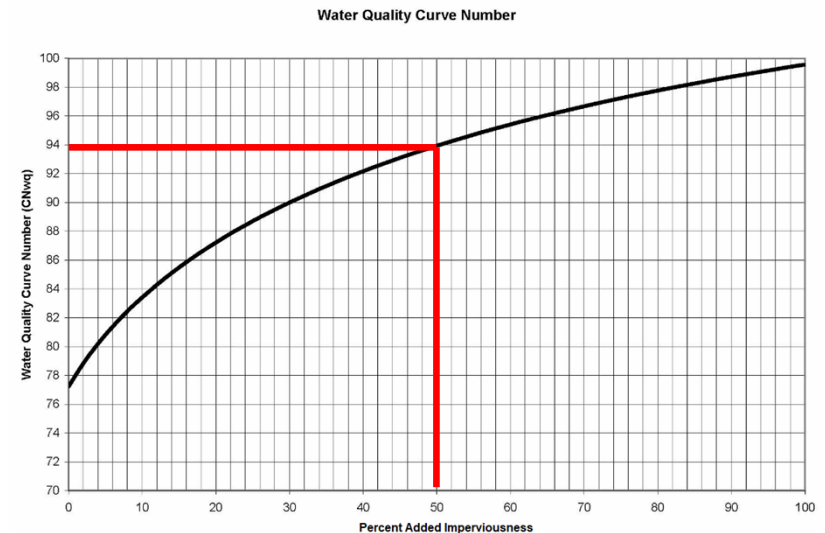
Profile View of Swale and Check Dam



Cross Section View of Swale and Check Dam

Treating in Another Outfall's Swale

- For various reasons, its sometimes infeasible or too costly to treat added pavement in a given outfall
- Option to treat the same value in acres of pavement in another outfall
 - Must drain to same receiving stream
- Outfall A: 0.15 acre of net added pavement
- Outfall B: 0.25 acre of net added pavement
- Outfall B has more right-of-way space for vegetated swales
- Solution
 - Treat 0.4 acre of pavement in Swale 1 in Outfall B
 - Total area draining to Swale 1 is 1 acre
 - 0.5 acre of pavement
 - 0.5 acre of grass
 - 0.5 acre of pavement treated in Swale 1
 - ✓ > 0.4 acre of added pavement

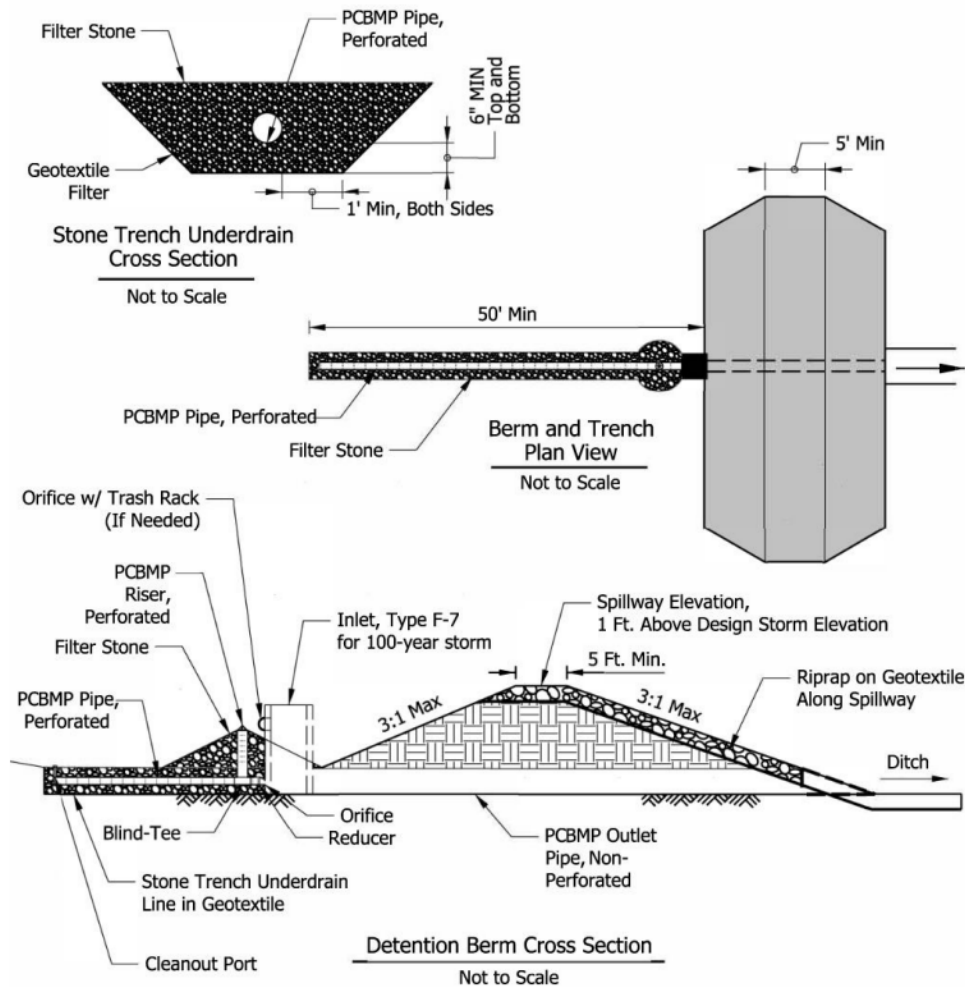


- Common mistake – calculating the water quality treatment rate for Outfall A and adding it to the water quality treatment rate for Outfall B

Dry Detention

- Capture and temporarily detain stormwater run-off
- Can be a peak flow mitigation PCBMP as well as water quality PCBMP
- 2 design options for TSS removal
- First option – model as a basin
 - Detain and release Water Quality Volume over 24 hours
 - If outlet pipe D is less than 6 inches, 50 feet of perforated pipe installed in stone trench and connected to outlet structure
 - Include a cleanout port at upstream end of perforated pipe
- Second option – model as a swale
 - Construct a meandering pilot channel (optional)
 - Design using Water Quality Treatment Rate
 - Depth of flow in channel during water quality event at or below the grass height
 - Follow design process in dry swale section
 - If modeled as a swale, the PCBMP is still referred to as a detention facility and not a swale; the swale is just how it was modeled for sediment removal

Detention Berm Detail



If detention pond or swale is riprap lined, must use option 1 on previous slide, often requires underdrain system as shown on the left. Consider using tied concrete block mat (allows for vegetation).

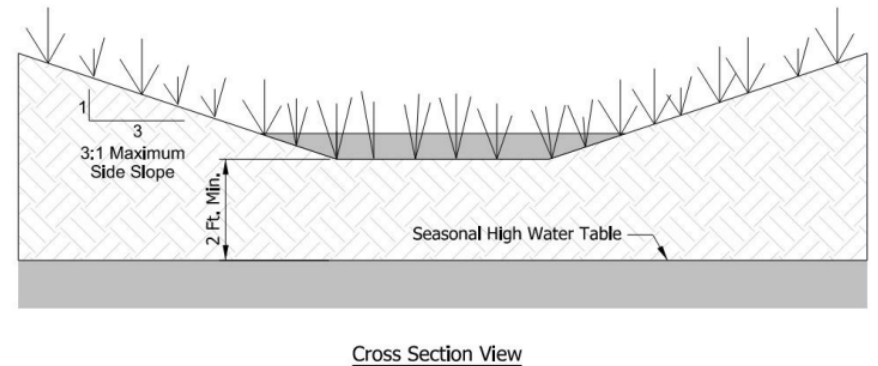
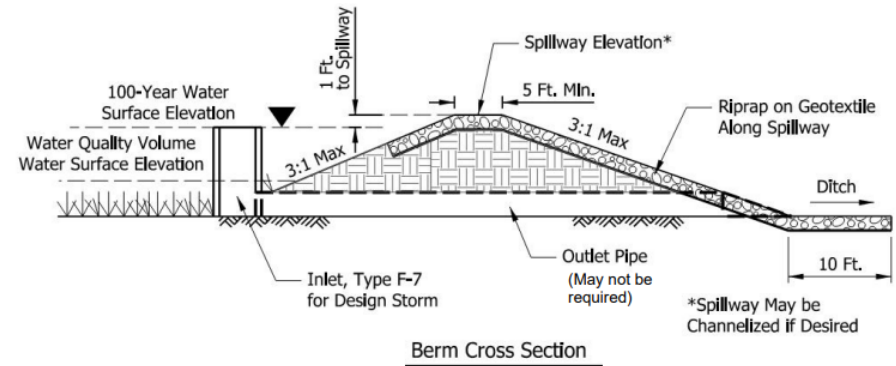
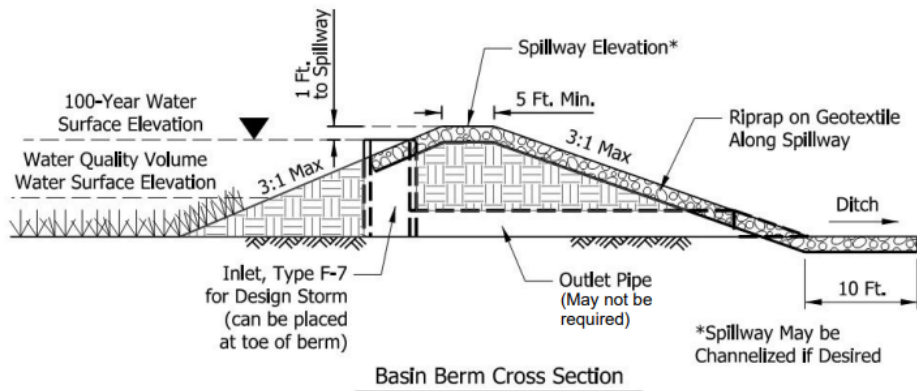
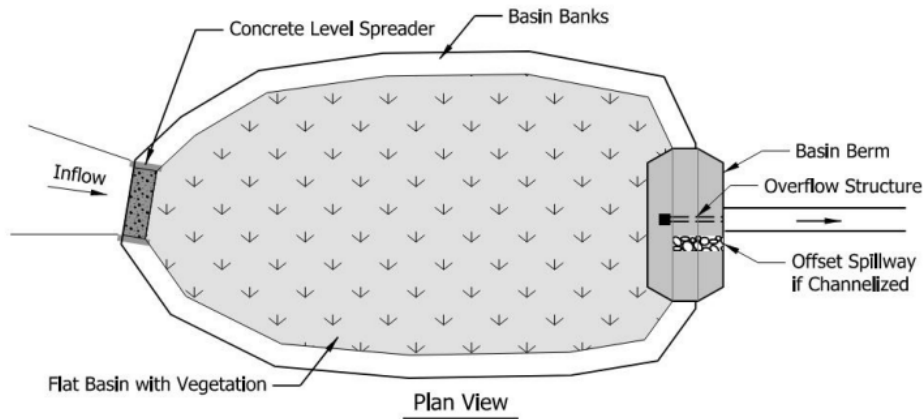
Infiltration

- Can be a swale or a basin
- Collect run-off and allow it to drain through the underlying soil
- No underdrain
- Dependent on the existing underlying soil – soil testing required per guidelines provided in IDM Chapter 203
- Can be used to meet water quantity and water quality goals
- Designed to infiltrate the Water Quality Volume
- If used for peak flow mitigation, a computer model will be submitted per requirements in IDM Chapter 203
- If used for Water Quality only, equations can be used to calculate volume infiltrated and time to drain (provided in PCSM Guidance Document)
- Demonstrate the Water Quality Volume is infiltrated



Note: Don't forget to check for karst and wellhead protection areas!

Infiltration Basin and Swale Details



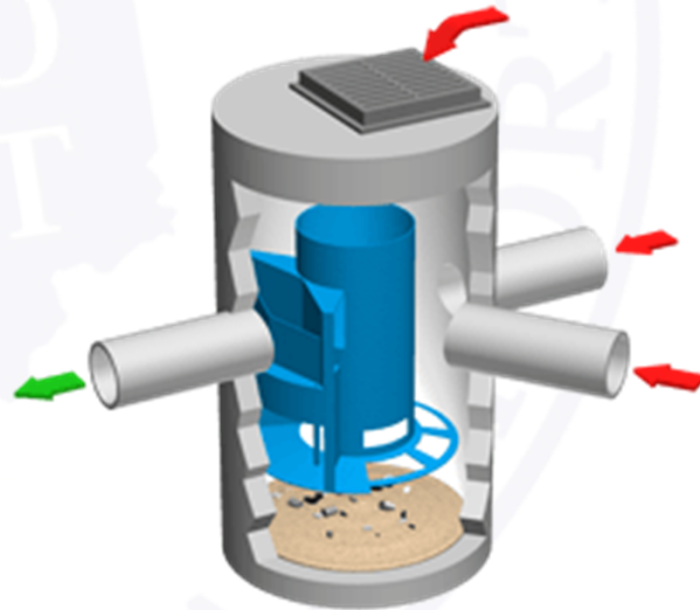
Hydrodynamic Separators

- Proprietary PCBMP device
 - Many other types available, Hydrodynamic Separators only for INDOT projects at this time
- Flow-through device
- Use a swirl or vortex to remove solids and trash via gravity from run-off
- Relatively small footprint
- Maintenance is critical – frequent inspection and cleanout required



Don't forget to consider inspection and maintenance access in the design!

- Design Criteria
 - 80% TSS Removal and Floatables
 - Treatment train may be required to achieve desired pollutant removal



INDOT Qualified Products List (1 of 2)

- Stormwater Treatment Units QPL

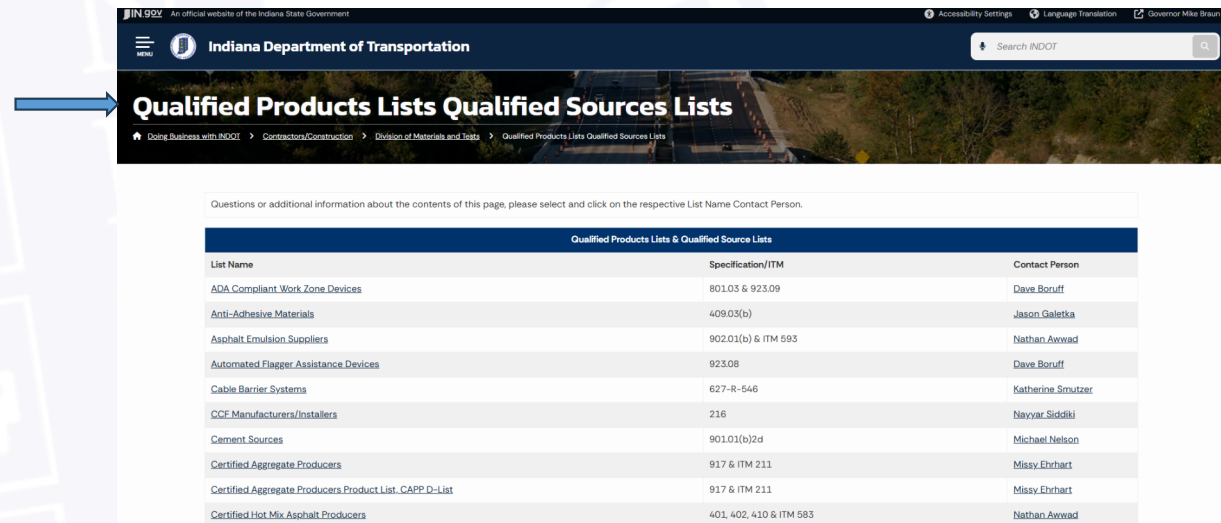
- <https://www.in.gov/indot/doing-business-with-indot/contractorsconstruction/division-of-materials-and-tests/qualified-products-lists-qualified-sources-lists/>

- ADS – Barracuda Max

- Aquashield, Inc. – Aqua-swirl Xcelerator

- Contech Engineered Solutions, LLC – Cascade Separator

- Hydro International/Oldcastle Infrastructure – First Defense Optimum



Indiana Department of Transportation

Qualified Products Lists Qualified Sources Lists

Doing Business with INDOT > Contractors/Construction > Division of Materials and Tests > Qualified Products Lists Qualified Sources Lists

Questions or additional information about the contents of this page, please select and click on the respective List Name Contact Person.

Qualified Products Lists & Qualified Source Lists		
List Name	Specification/ITM	Contact Person
ADA Compliant Work Zone Devices	801.03 & 923.09	Dave Boruff
Anti-Adhesive Materials	409.03(b)	Jason Galetka
Asphalt Emulsion Suppliers	902.01(b) & ITM 593	Nathan Awwad
Automated Flagging Assistance Devices	923.08	Dave Boruff
Cable Barrier Systems	627-R-546	Katherine Smutzer
CCE Manufacturers/Installers	216	Nayyar Siddiki
Cement Sources	901.01(b)(2)d	Michael Nelson
Certified Aggregate Producers	917 & ITM 211	Missy Ehrhart
Certified Aggregate Producers Product List, CAPP D-List	917 & ITM 211	Missy Ehrhart
Certified Hot Mix Asphalt Producers	401, 402, 410 & ITM 583	Nathan Awwad

INDOT Qualified Products List (2 of 2)

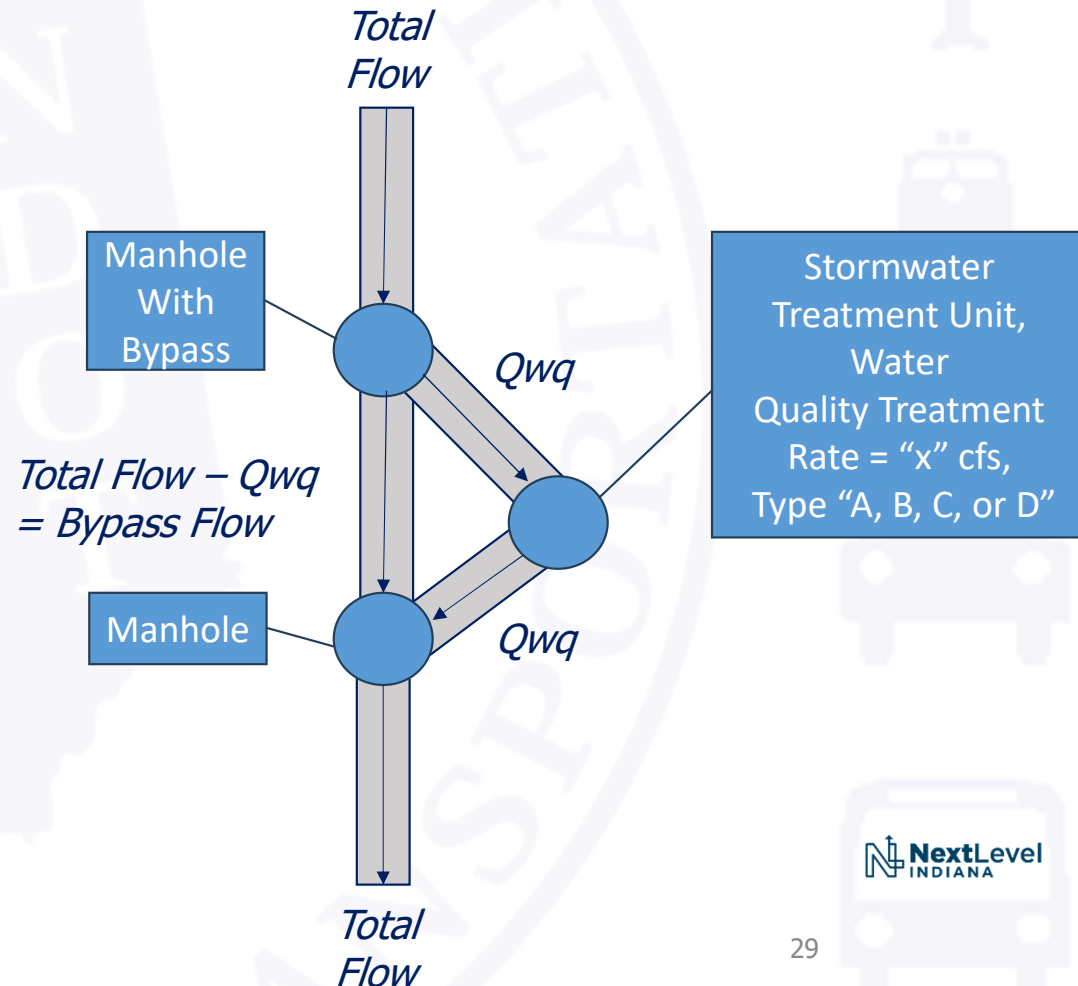
- Based on calculated treatment rates
- QPL is in excel form
 - $0.00 < Q_{wq} \leq 1.81$ cfs -> Type A
 - $1.81 < Q_{wq} \leq 4.07$ cfs -> Type B
 - $4.07 < Q_{wq} \leq 11.3$ cfs -> Type C
 - $11.3 < Q_{wq} \leq 16.2$ cfs -> Type D

The maximum treatment rate for the device and model selected shall meet or exceed the treatment rate shown on the plans.

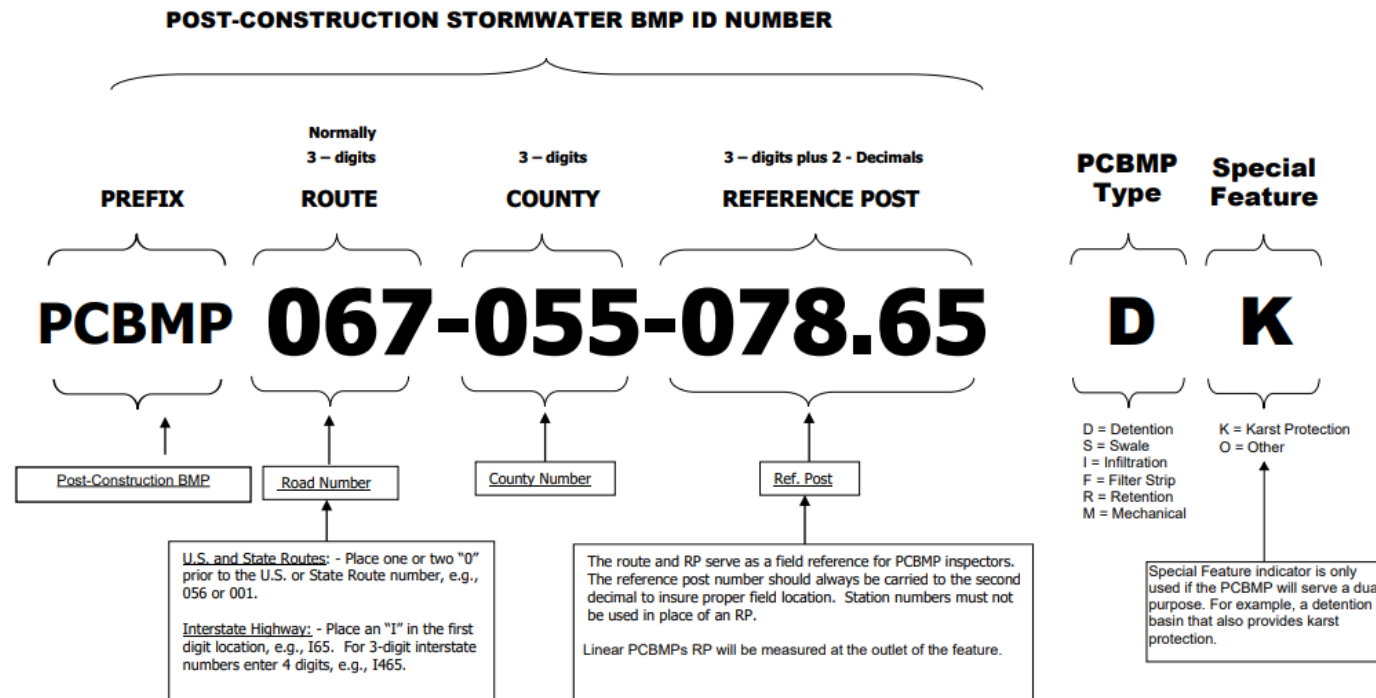
Unit Type / Material Code	Source ID	Source	Product Name	Maximum Water Quality Treatment Rate* (cfs)	Approval Number
Type A / 720M00101	STU08962	AQUASHIELD, INC.	Aqua-Swirl Xcelerator XC-2	0.57	W257029
Type A / 720M00101	STU08961	ADVANCED DRAINAGE SYSTEMS, INC.	Barracuda Max S3	0.85	W257030
Type A / 720M00101	STU08963	CONTECH ENGINEERED SOLUTIONS, LLC Hartford, CT	Cascade Separator CS-3	1.02	W257031
Type A / 720M00101	STU08964	CONTECH ENGINEERED SOLUTIONS, LLC Norwalk, OH	Cascade Separator CS-3	1.02	W257031
Type A / 720M00101	STU08965	HYDRO INT'L/OLDCASTLE INFRASTRUCTURE Elgin, IL	First Defense Optimum FDO-3	1.02	W257032
Type A / 720M00101	STU08965	HYDRO INT'L/OLDCASTLE INFRASTRUCTURE Kalamazoo, MI	First Defense Optimum FDO-3	1.02	W257032
Type A / 720M00101	STU08967	HYDRO INT'L/OLDCASTLE INFRASTRUCTURE Lexington, KY	First Defense Optimum FDO-3	1.02	W257032
Type A / 720M00101	STU08962	AQUASHIELD, INC.	Aqua-Swirl Xcelerator XC-3	1.13	W257033
Type A / 720M00101	STU08961	ADVANCED DRAINAGE SYSTEMS, INC.	Barracuda Max S4	1.52	W257034
Type A / 720M00101	STU08963	CONTECH ENGINEERED SOLUTIONS, LLC Hartford, CT	Cascade Separator CS-4	1.8	W257035
Type A / 720M00101	STU08964	CONTECH ENGINEERED SOLUTIONS, LLC Norwalk, OH	Cascade Separator CS-4	1.8	W257035
Type A / 720M00101	STU08965	HYDRO INT'L/OLDCASTLE INFRASTRUCTURE Elgin, IL	First Defense Optimum FDO-4	1.81	W257036

Hydrodynamic Separator Design Process

1. Designer calculates the Water Quality Treatment Rate (Q_{wq})
2. Designer chooses Type A-D from the QPL, based on that treatment rate
3. Designer calculates bypass flow and designs bypass (only the Q_{wq} is treated in the unit)
4. Designer calls out the treatment rate and Type in the plans
5. Contractor chooses unit from the QPL



PCBMP Naming Convention



Contact PCSM@indot.IN.gov for questions regarding PCBMP asset ID numbers

POST-CONSTRUCTION STORMWATER MANAGEMENT NUMBERING SYSTEM

- PCBMPs added to asset list during final construction review
- Given an asset ID number and added to inspection schedule
- Maintenance as needed based on inspection
- Editable maintenance plan templates
- Inspection frequency varies based on PCBMP type
- Access for inspection and maintenance very important



Inspection and Maintenance Forms (1 of 2)

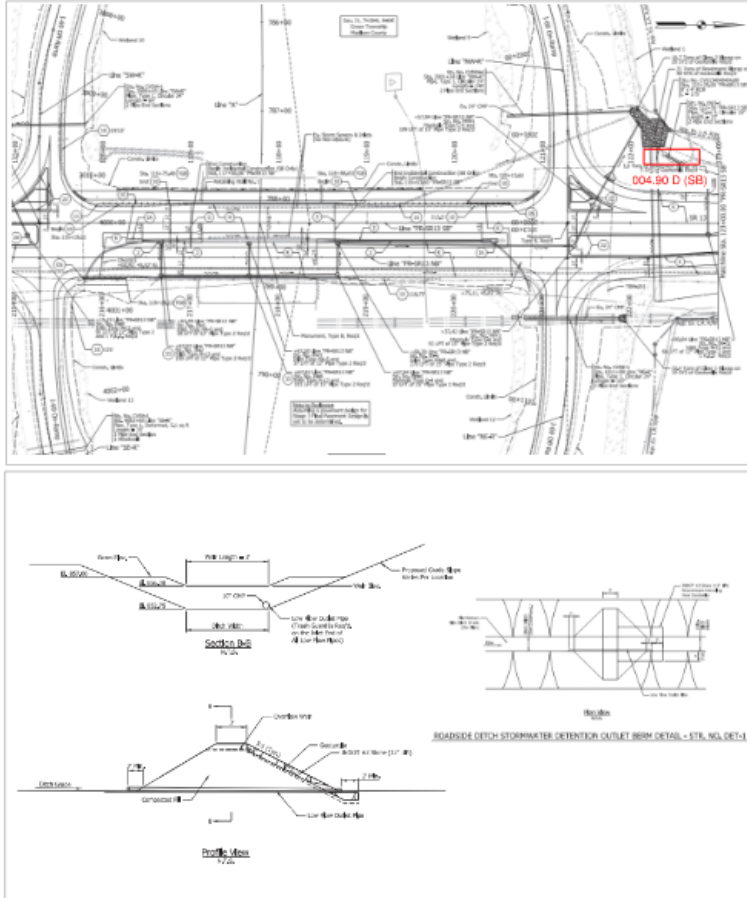
- Designer to fill out first portion of form



INDIANA DEPARTMENT OF TRANSPORTATION INSPECTION & MAINTENANCE POST-CONSTRUCTION STORMWATER MEASURE

Structure Type	Dry Detention Pond	Asset ID	PCBMP 013-048-004.90 D (SB)
Design Criteria	This dry detention pond was designed to remove Total Suspended Solids (TSS) from stormwater runoff but also serves as a peak flow mitigation measure. This pond should fully drain within 72 hours of a rainfall event and should remain dry between rainfall events.	Location	Coordinates, Driving Directions
			85.8434592°W 39.9953390°N On the west side of the SR-13 southbound travel lanes at the beginning of the on ramp to I-69

Inspection and Maintenance Forms (2 of 2)

Structure Type	Dry Detention Pond	Asset ID	PCBMP 013-048-004.90 D (SB)
Plans and Plan Cross Section(s)			
			

- Designer to add screenshots from plans to 3rd page of form
 - Plan view and profile view
 - Any other details in plans
 - Additional pages can be added
- PCBMP inspectors fill out the rest of the form during inspections

PCBMPs in GIS

Home ▾ Environmental MS4 - Post Construction - Editing 

Open in Map Viewer New Map  Jay ▾

PCSM Submittal Requirements

- See submittal guidance located here:

<https://www.in.gov/indot/engineering/files/PCSM-Submittal-Requirements-1-8-2026.pdf>

- Updates to IDM Chapter 14 have been drafted, waiting to be released, matches requirements at link above
- Common mistakes
 - Wrong naming convention for PCBMPs in plans
 - Not labeling added pavement values at each outfall
 - Not calling out PCBMPs in plan sheets or construction detail sheets
 - Not including detail sheets
 - Turning in PCSM Report after Stage 3 submittal or not resubmitting PCSM Report in time to make updates to final plans



INDIANA DEPARTMENT OF TRANSPORTATION

100 North Senate Avenue
Room N758 - Hydraulics
Indianapolis, Indiana 46204

PHONE: (317) 233-2096
FAX: (317) 233-4929

Eric Holcomb, Governor
Michael Smith, Commissioner

Post-Construction Stormwater Management (PCSM) - Submittal Requirements as of 1-8-2026

With Stage 1 Review Submission (25% Design):

- Stormwater Outfalls (locations where stormwater leaves INDOT right-of-way) identified in plan sheets with approximate added pavement values listed (acres or square feet). Total net added pavement value for the project to be listed on the title sheet.
- Preliminary locations of proposed Post-Construction Stormwater Best Management Practices (PCBMPs) identified and labeled in plan sheets.
 - Use naming convention provided on [Environmental Services Division Stormwater webpage](#)
 - List type of PCBMP (for example: PCBMP 067-055-078.65 – Dry Turf Grass Swale)
 - Show outline of the PCBMPs as a polygons (except for separators, which are shown as manholes)
- PCBMPs included in cost estimate
- Design calculations for PCBMPs are not required with Stage 1 Submittal

With Stage 2 Review Submission (55% Design):

- Stormwater Outfalls identified in plans with approximate added pavement values listed (acres or square feet). Total net added pavement value for the project to be listed on the title sheet.
- Preliminary locations of proposed PCBMPs identified and labeled in plan sheets and construction detail sheets
 - Use naming convention provided on [Environmental Services Division Stormwater webpage](#)
 - List type of PCBMP (for example: PCBMP 067-055-078.65 – Dry Turf Grass Swale)
 - Show outline of the PCBMPs as a polygons (except for separators, which are shown as manholes)
- PCBMP detail sheets for all PCBMPs. Must include beginning and ending station and offset (if linear) and all dimensions and details needed for construction.
- PCBMPs included in cost estimate
- Design calculations for PCBMPs are not required with Stage 2 Submittal

90 Days After Stage 2 Review Submission (approval required before Stage 3 Submission):

- Post-construction Stormwater Management Design Report including:
 - Narrative
 - Project Location Map
 - Outfall Locations Map
 - Existing and proposed drainage area delineations for each outfall
 - Must include existing contours with labels and proposed contours with labels, respectively
 - NRCS Soils information
 - Percolation testing results if using infiltration measure(s)

Page 1 of 2
www.in.gov/dot/

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- Water Quality Volume calculations for each outfall
- Water Quality Treatment rate calculations or model output for flow through PCBMP sizing
- All supporting calculations for proposed PCBMPs, including computer models
- Signed and sealed by a professional engineer licensed in Indiana
- PCBMP detail sheets for all PCBMPs. Must include beginning and ending station and offset (if linear) and all dimensions and details needed for construction.
- Completed maintenance plans (see templates on [Environmental Services Division Stormwater webpage](#)). Submit as separate pdfs in a zipped file. Fill out preliminary information and add screenshots from plans (plan, profile, and cross-section views).
- Shapefiles of outlines of PCBMPs as polygons (points for HDS units) in a separate zipped file.

With Stage 3 Review Submission (95% Design) and/or Final Tracings Submission (100% Design):

- All items required with Stage 2 Review Submission in addition to the following:
 - PCSM Unique Special Provisions (USP) or PCSM Recurring Special Provisions (RSP)
 - Completed maintenance plans (see templates on [Environmental Services Division Stormwater webpage](#)) if updated since PCSM Report submittal
 - PCSM Approval Memo

With SWP3 (as an Appendix):

- Approved Final Tracings plans
- PCSM Approval Memo

For PCSM Report Submittal:

- Email report to PCSM@indot.IN.gov
 - Send an external link to files for downloading if file size exceeds 20M

Page 2 of 2
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How to Submit

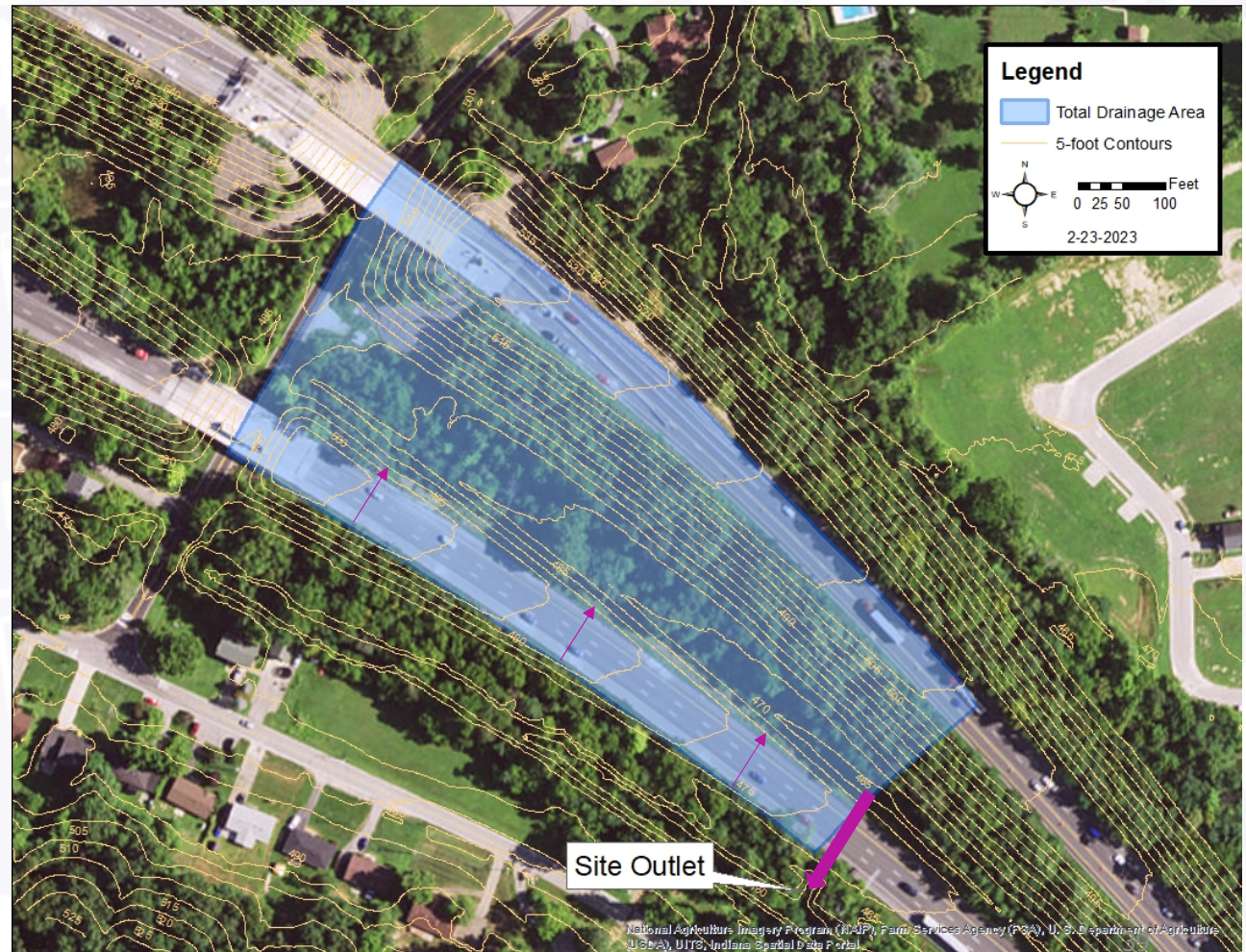
- Typical Process for Plans Submittals
 - For Stage 2, 3, and Final Tracings, notify us at PCSM@indot.IN.gov when a submittal is made (that includes PCBMPs). State in transmittal letter PCBMPs are included.
- PCSM Reports can be submitted to PCSM@indot.IN.gov
 - Due to file size, consider using a link to cloud storage
 - Reviewer will download files
- PCSM Naming Convention
 - Report – PCSM Report DES XXXXXXXX (Date) XX-XX-XXXX
 - For example: PCSM Report DES 1900162 2-23-2023
 - Models – PCSM (Model Name) DES XXXXXXXX (Date) XX-XX-XXXX
 - For example: PCSM WinTR-55 DES 1900162 2-23-2023
 - Use this basic naming convention for other file types

Review Process

- Comment Form will be sent to designer via email as needed
 - INDOT PM will be cc'd, along with INDOT Stormwater Specialists
- Approval Memo will be sent once design is approved
- Coordination meetings may be required
 - Designers are encouraged to ask questions ahead of submittals and request meetings if needed
- PCSM Reports will not be scored at this time; however, INDOT PMs will be aware of number of resubmittals
 - INDOT Roadway Engineering has indicated they do plan to score the plans based on PCBMPs once updates to Chapter 14 are released regarding PCBMPs

Water Quality Volume Example (1 of 4)

- Determine site outlet
- Delineate drainage area (acres)
 - Use LiDAR for offsite area and survey data for onsite area
 - Account for existing drainage features such as storm sewer



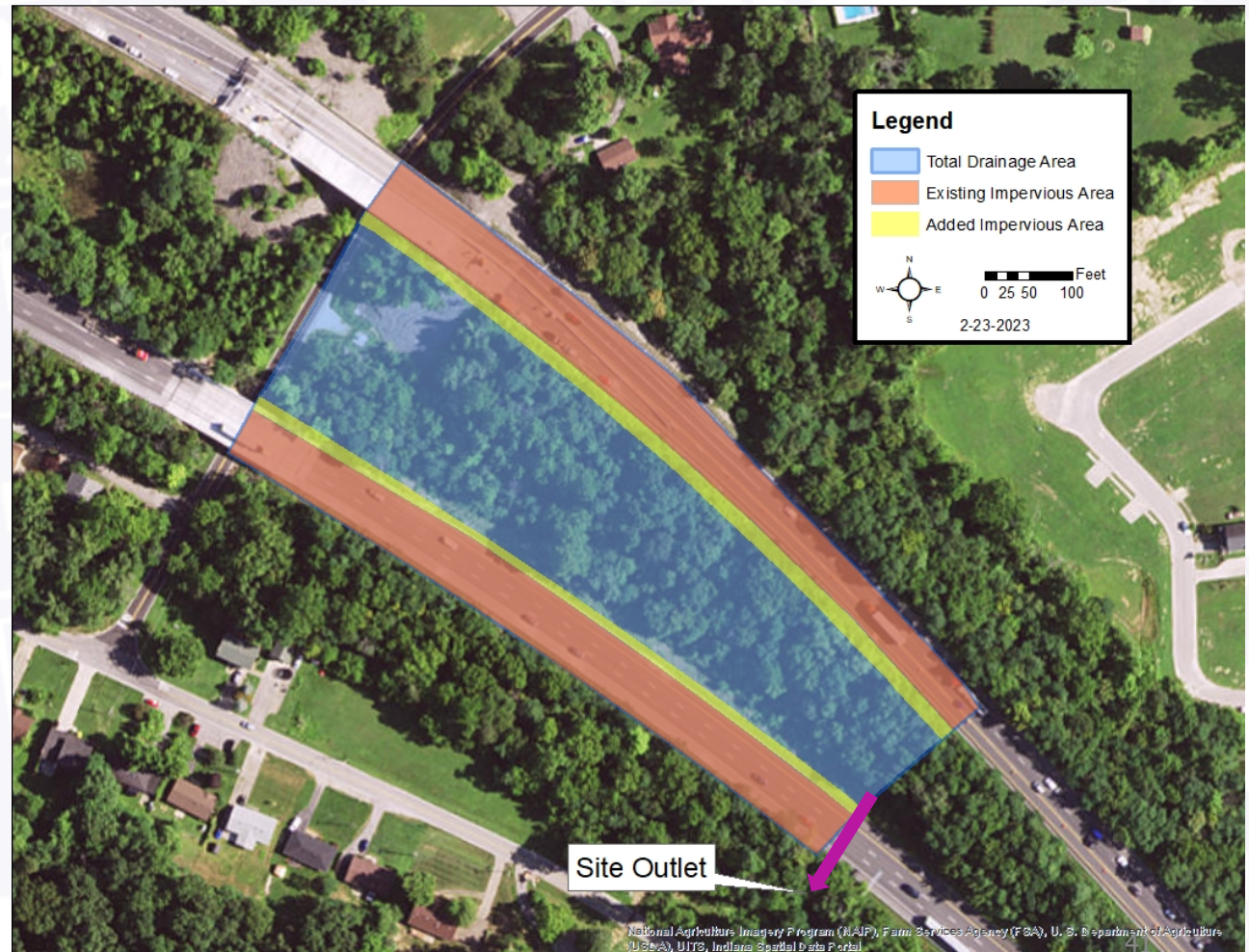
Water Quality Volume Example (2 of 4)

- Determine existing onsite impervious area
 - Include all surfaces, not just the roadway



Water Quality Volume Example (3 of 4)

- Determine proposed onsite impervious area
 - Include all surfaces, not just the roadway



Water Quality Volume (4 of 4)

Water Quality Volume Calculation Template

Cells shaded in grey will auto-populate, designer is responsible for checking results.

$$WQ_v = \frac{(P * R_v * A)}{12}$$

$$R_v = 0.05 + (0.009 * I)$$

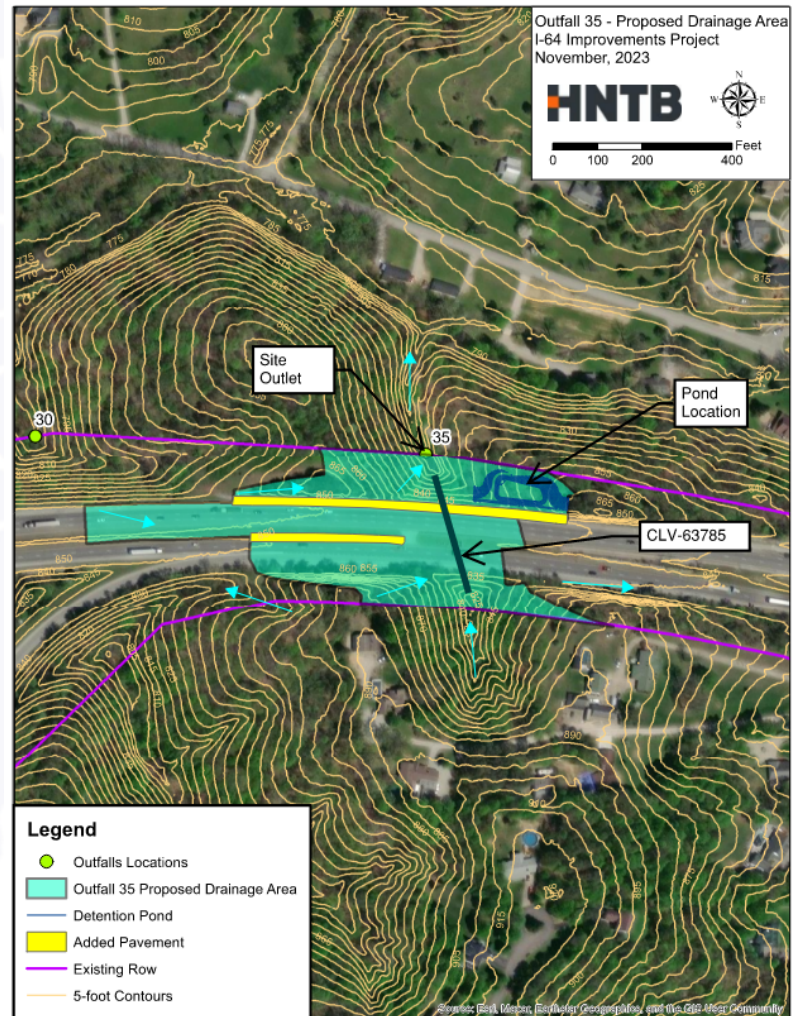
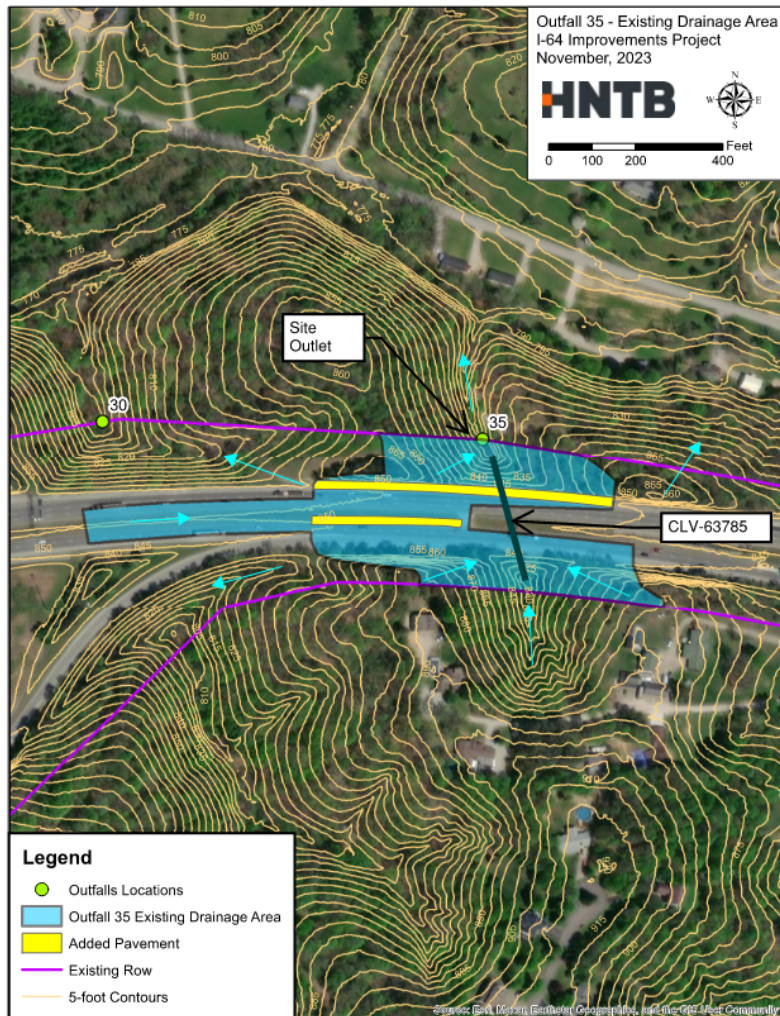
$$I = \frac{P_{ia} - E_{ia}}{A} * 100$$

P_{ia}	2.8	Proposed Onsite Impervious Area, acres
E_{ia}	2.3	Existing Onsite Impervious Area, acres
A	6.6	Total Proposed Onsite Drainage Area, acres
I	8.5	Percent New Impervious Cover, %
R_v	0.1	Volumetric Run-off Coefficient
WQ_v	0.07	Water Quality Volume, acre-ft
WQ_v	3020	Water Quality Volume, ft ³

Dry Detention Example (1 of 5)

- Assumes detention is required and model was created per typical INDOT procedure
- Calculate Water Quality Volume
- Size outlet structure such that the WQv is detained and released over a 24-hour period (use hydrograph)
- If outlet structure is <6" use a stone trench and perforated pipe
 - Set up the model to ignore the stone trench and perforated pipe – use the actual elevation of the low flow pipe in the model
 - Use Elevation-Area method with an elevation at the bottom of the trench/outlet pipe invert with zero storage and another elevation at the flowline with zero storage
 - May require multiple openings in outlet structure
- Sometimes this method will not work and the dry detention feature will have to be modeled as a swale

Dry Detention Example (2 of 5)



Dry Detention Example (3 of 5)

Water Quality Volume Calculation - Outfall 35

$$WQ_v = \frac{(P \cdot R_v \cdot A)}{12}$$

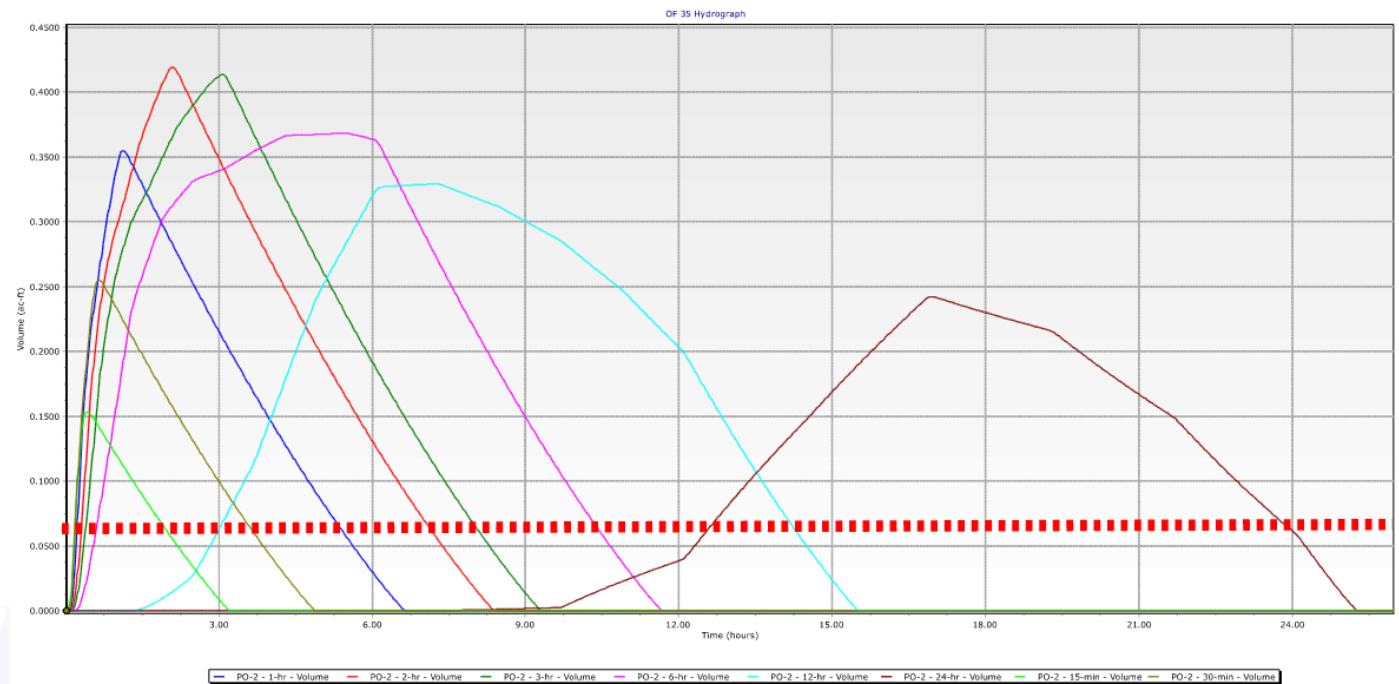
$$R_v = 0.05 + (0.009 \cdot I)$$

$$I = \frac{P_{ia} - E_{ia}}{A} \cdot 100$$

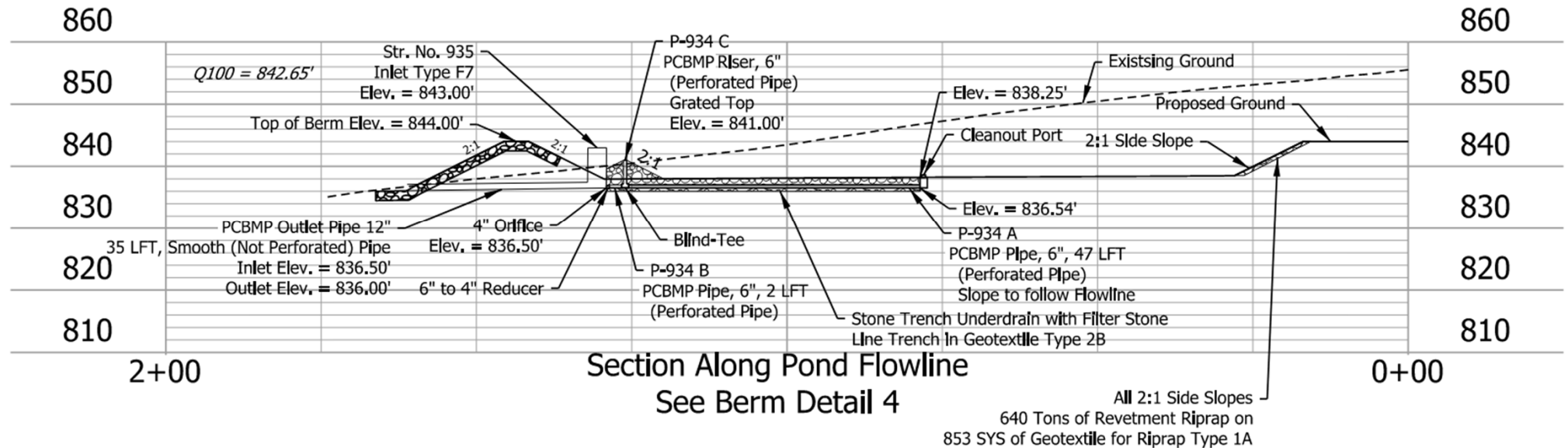
P_{ia}	2.78	Proposed Onsite Impervious Area, acres
E_{ia}	2.22	Existing Onsite Impervious Area, acres
A	5.19	Total Proposed Onsite Drainage Area, acres

I	10.79	Percent New Impervious Cover, %
R_v	0.15	Volumetric Run-off Coefficient
WQ_v	0.06	Water Quality Volume, acre-ft
WQ_v	2771	Ft ³

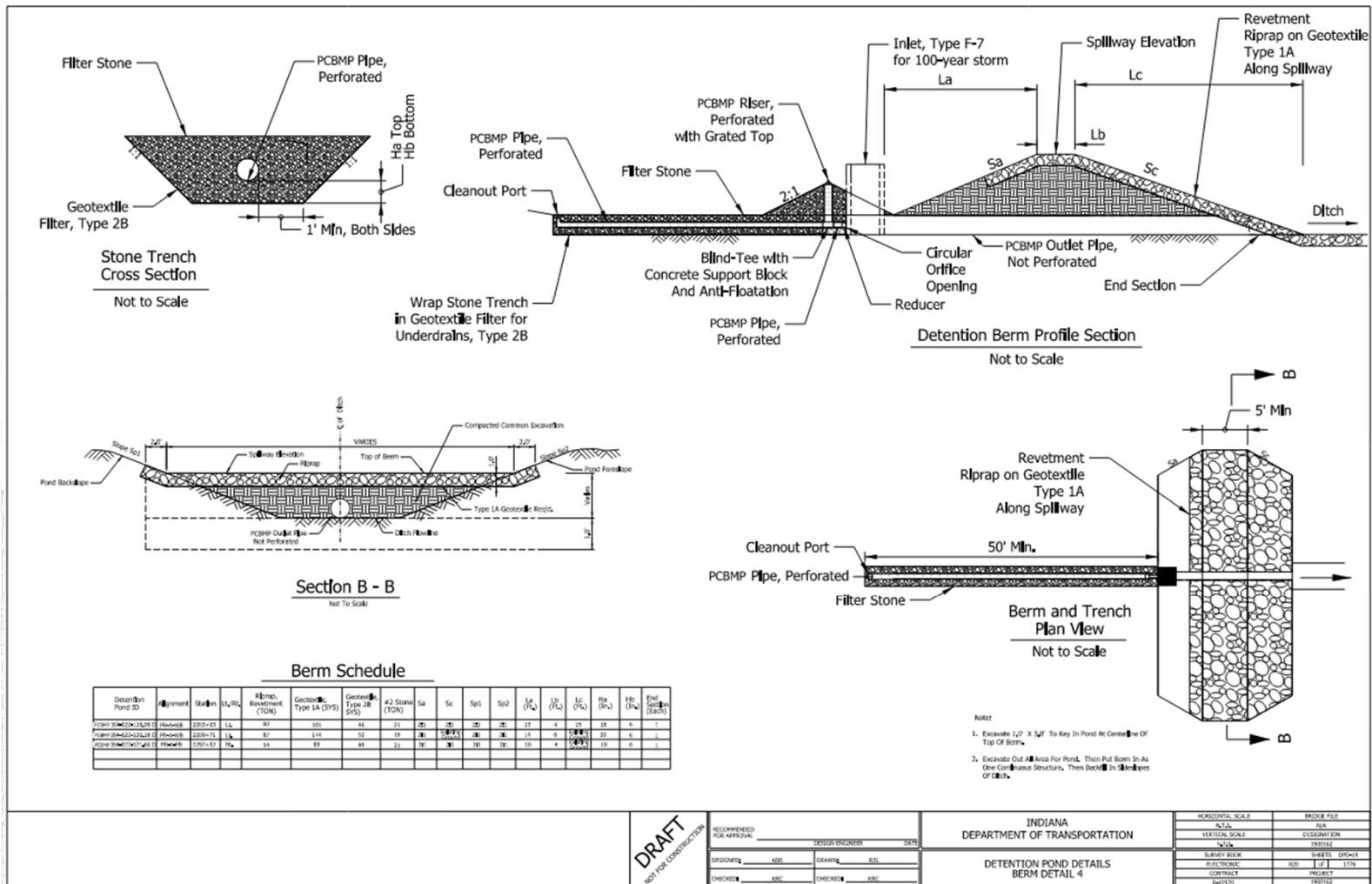
Added Pavement	0.56	acres
Treated Pavement	1.81	acres



Dry Detention Example (4 of 5)



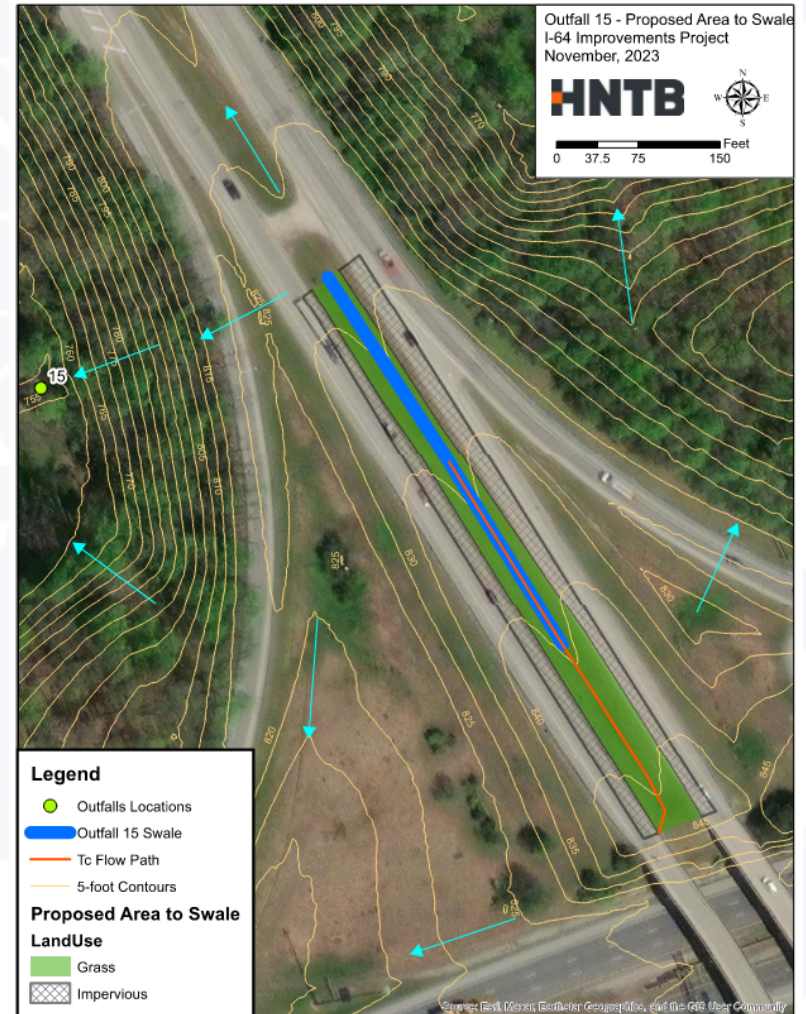
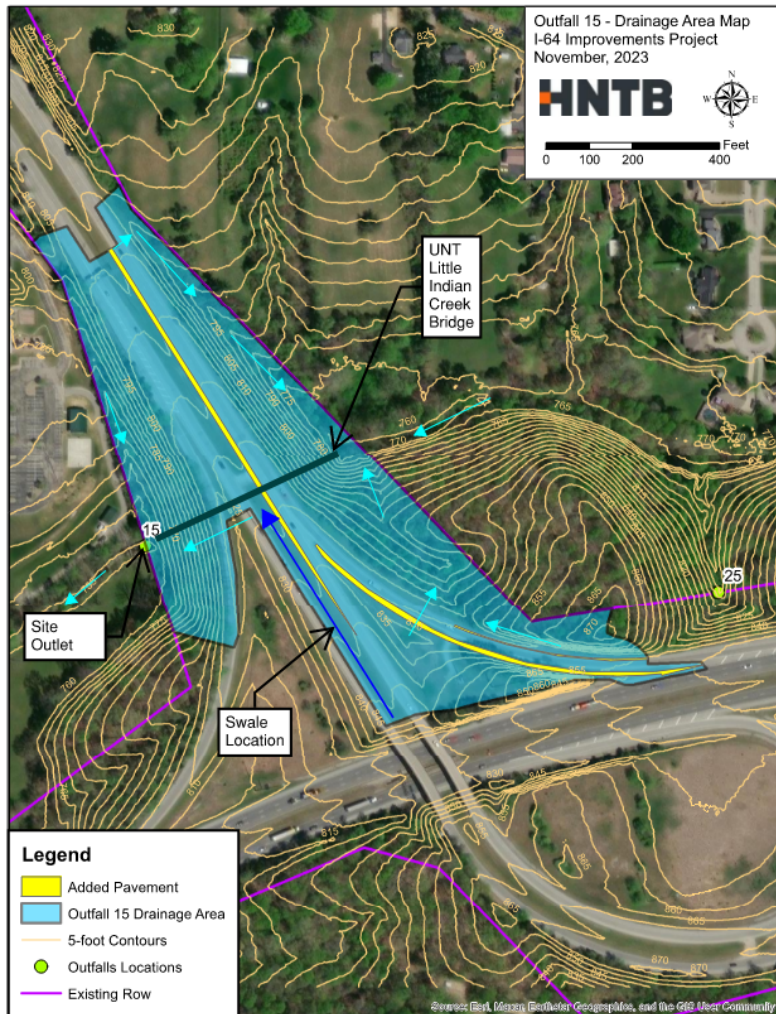
Dry Detention Example (5 of 5)



Dry Swale Example (1 of 8)

- Calculate Water Quality Volume
 - Can use Excel Template <https://www.in.gov/indot/engineering/environmental-services/storm-water/>
- Calculate Water Quality Treatment Rate
 - Can use Win TR-55
- Determine preliminary longitudinal slope
- Determine preliminary swale geometry
- Determine preliminary vegetation type (native or turf)
- Analyze swale using Manning's Equations
 - Can use Bentley FlowMaster
<https://www.in.gov/indot/engineering/environmental-services/storm-water/>
- Determine Hydraulic Residence Time
 - Can use Excel Template
 - Target – 9 minutes for 80% TSS Removal

Dry Swale Example (2 of 8)



Dry Swale Example (3 of 8)

OF15 PCSM Time of Concentration

Sheet Flow (Applicable to Tc only)

1. Surface description (Figure 202-2B)
2. Manning's roughness coefficient for sheet flow, n (Figure 202-2B)
3. Flow Length, L (total $L \leq 100$ ft)
4. Two year 24-hour rainfall, P_2 (NOAA Table)
5. Land slope, s
6. $Tt = [0.007 (\ln L)^{0.75}] / [P_2^{0.75} S^{0.4}]$

Segment ID	1	
	short grass	
	0.15	
ft	100	
in	3.072	
ft/ft	0.0460	sub total
hr	0.119	0.119

Shallow Concentrated Flow

7. Surface Description (paved or unpaved)
8. Flow Length, L
9. Watercourse slope, s
10. Average Velocity, V (Figure 202-2D)
11. $Tt = L / (3600 V)$

Segment ID	2	
	unpaved	
ft	99	
ft/ft	0.032	
ft/s	2.9	sub total
hr	0.010	0.010

Channel Flow

12. Width of ditch bottom
13. Ratio of Horizontal to Vertical of left ditch side slope (XH:1V)
14. Ratio of Horizontal to Vertical of right ditch side slope (XH:1V)
15. Bankfull depth of flow
16. Cross sectional flow area, a
17. Wetted Perimeter, p_w
18. Hydraulic radius, $r = a / p_w$
19. Channel slope, s
20. Manning's roughness coeff. for channel flow, n (Figure 202-2C)
21. $V = [1.49 P^{0.49} S^{0.5}] / n$
22. Flow Length, L
23. $Tt = L / (3600 V)$

Segment ID	3	
ft	0.5	
ft	3	
ft	3	
ft2	28.5	
ft2	19.5	
ft2	1.5	
ft/ft	0.030	
ft/ft	0.05	
ft/s	6.66	
ft	200	sub total
hr	0.008	0.008

24. Total Time of Concentration or Travel Time

Watershed Tc (hours)	0.137
Watershed Tc (minutes)	8

Water Quality Volume Calculation - Outfall 15

$$WQ_v = \frac{(P \cdot R_v \cdot A)}{12}$$

$$R_v = 0.05 + (0.009 \cdot I)$$

$$I = \frac{P_{ia} - E_{ia}}{A} \cdot 100$$

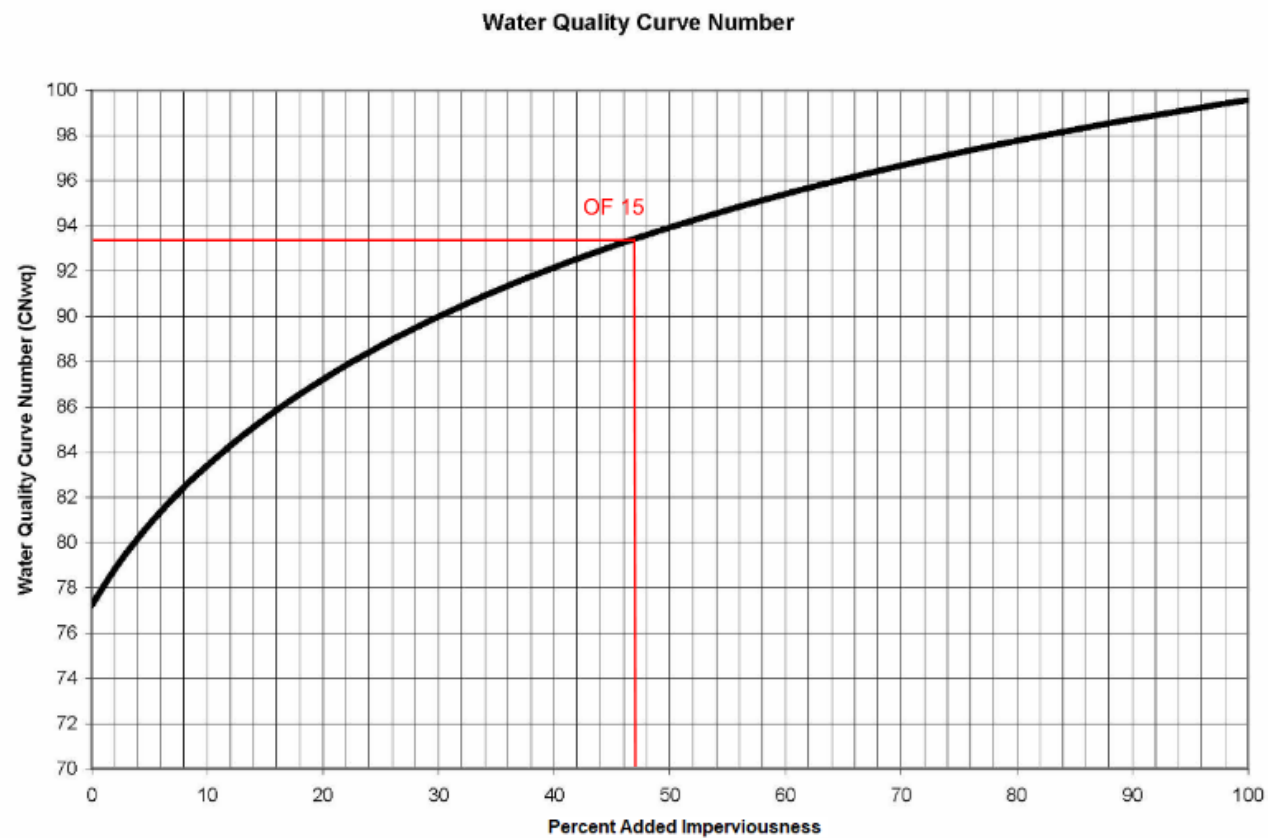
P_{ia}	3.44	Proposed Onsite Impervious Area, acres
E_{ia}	2.95	Existing Onsite Impervious Area, acres
A	13.50	Total Proposed Onsite Drainage Area, acres
I	3.63	Percent New Impervious Cover, %
R_v	0.08	Volumetric Run-off Coefficient
WQ_v	0.09	Water Quality Volume, acre-ft

Water Quality Curve Number - To Swale

Grass	0.49	acres
Pavement	0.43	acres
Total	0.92	acres
% Impervious Cover	0.47	To Swale
CNwq from Graph	93	Use in Win-TR 55
Added Pavement	0.49	acres
Treated Pavement	0.43	acres

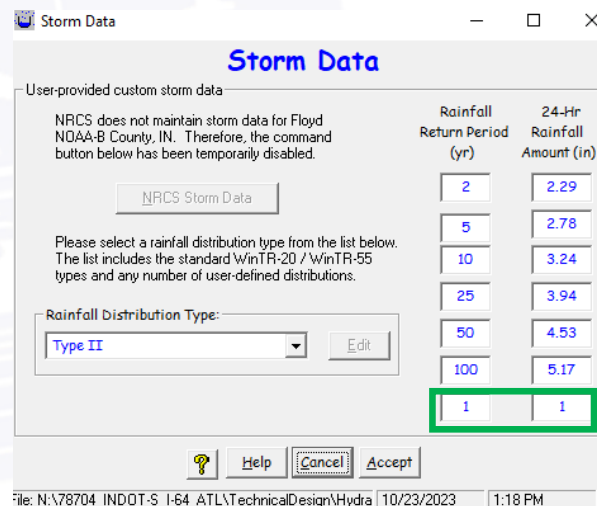
Remaining pavement will be treated in proposed detention pond.

Dry Swale Example (4 of 8)



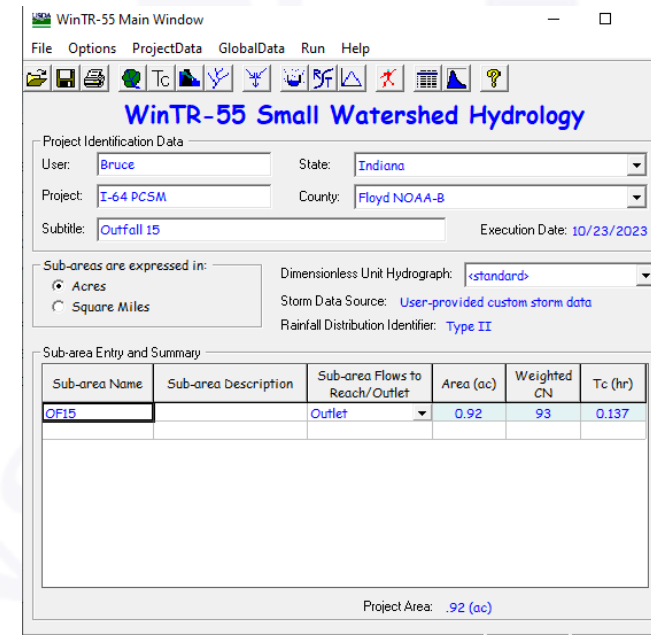
Dry Swale Example (5 of 8)

- $CN_{wq} = 93$
- $T_c = 0.14$ hours (obtained using TR-55 Methodology)
- Area draining to swale = 0.92 acre
- NRCS Type II rainfall distribution
 - Depth of rainfall = 1 inch
- NRCS Methodology
- $Q_{wq} = 0.6$ cfs



The Storm Data dialog box is titled "Storm Data". It contains a section for "User-provided custom storm data" with a message: "NRCS does not maintain storm data for Floyd NOAA-8 County, IN. Therefore, the command button below has been temporarily disabled." Below this is a disabled "NRCS Storm Data" button. A text box instructs the user to "Please select a rainfall distribution type from the list below. The list includes the standard WinTR-20 / WinTR-55 types and any number of user-defined distributions." A dropdown menu for "Rainfall Distribution Type:" is set to "Type II" with an "Edit" button. To the right is a table of rainfall return periods and amounts. The bottom row of the table, representing 1 year and 1 inch of rainfall, is highlighted with a green border. At the bottom are "Help", "Cancel", and "Accept" buttons. The status bar shows the file path "N:\78704_INDOT-S_I-64_ATL\TechnicalDesign\Hydra" and the date/time "10/23/2023 1:18 PM".

Rainfall Return Period (yr)	24-Hr Rainfall Amount (in)
2	2.29
5	2.78
10	3.24
25	3.94
50	4.53
100	5.17
1	1



The WinTR-55 Main Window is titled "WinTR-55 Small Watershed Hydrology". It features a menu bar (File, Options, ProjectData, GlobalData, Run, Help) and a toolbar. The "Project Identification Data" section includes fields for User (Bruce), State (Indiana), Project (I-64 PCSM), County (Floyd NOAA-8), Subtitle (Outfall 15), and Execution Date (10/23/2023). The "Sub-areas are expressed in:" section has radio buttons for Acres (selected) and Square Miles. The "Dimensionless Unit Hydrograph:" is set to "Standard". The "Storm Data Source:" is "User-provided custom storm data" and the "Rainfall Distribution Identifier:" is "Type II". The "Sub-area Entry and Summary" table lists sub-areas with their descriptions, flows, areas, weighted CNs, and Tc values. The first row, "OF15", shows an area of 0.92 ac, a weighted CN of 93, and a Tc of 0.137 hr. The status bar at the bottom indicates "Project Area: .92 (ac)".

Sub-area Name	Sub-area Description	Sub-area Flows to Reach/Outlet	Area (ac)	Weighted CN	Tc (hr)
OF15		Outlet	0.92	93	0.137

Dry Swale Example (6 of 8)

Worksheet : Swale 15-1

Uniform Flow | Gradually Varied Flow | Messages

Solve For: Normal Depth Friction Method: Manning Formula

Roughness Coefficient:	0.150		Flow Area:	0.9	ft ²
Channel Slope:	0.030	ft/ft	Wetted Perimeter:	3.4	ft
Normal Depth:	5.5	in	Hydraulic Radius:	3.1	in
Left Side Slope:	3.000	H:V	Top Width:	3.27	ft
Right Side Slope:	3.000	H:V	Critical Depth:	2.8	in
Bottom Width:	0.50	ft	Critical Slope:	0.655	ft/ft
Discharge:	0.60	cfs	Velocity:	0.69	ft/s
			Velocity Head:	0.01	ft
			Specific Energy:	0.47	ft
			Froude Number:	0.235	
			Flow Type:	Subcritical	

Calculation Successful.

- $Q_{wq} = 0.6$ cfs
- Length of Swale = 400 feet
- Longitudinal Slope = 0.03 ft/ft
- Bottom Width = 0.5 feet
- Side Slopes = 3:1
- Manning's $n = 0.15$
- Depth of flow in channel = 5.5" (less than 6" ->ok)
 - Vegetation = Turf Grass
- $V_{wq} = 0.69$ ft/s

Dry Swale Example (7 of 8)

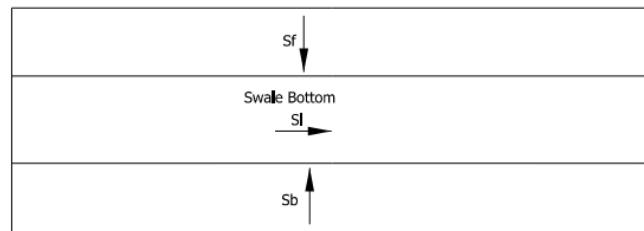
Hydraulic Residence Time Outfall 15

$$T_{ahr} = \frac{(L_{swale}/v_{wq})}{60}$$

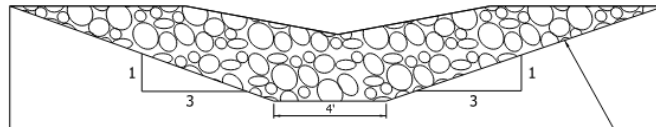
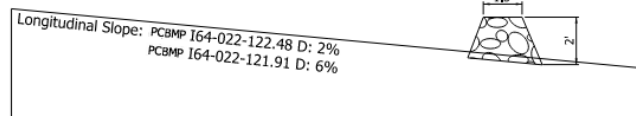
L_{swale}	400	Length of swale, feet
v_{wq}	0.69	Peak flow velocity at water quality event, ft/s
T_{ahr}	9.7	Hydraulic residence time, minutes

≥ 9 minutes = 80% TSS Removal -> OK

Dry Swale Example (8 of 8)



Plan View



Check Dams

PCBMP 164-022-122.48 D & PCBMP 164-022-121.91 D

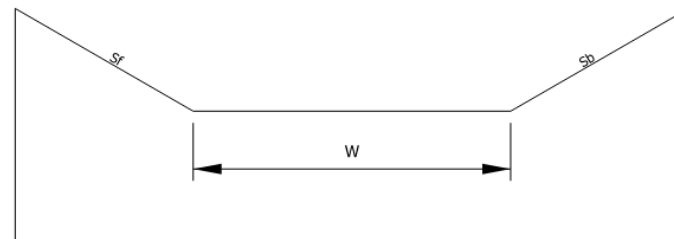
*Check Dam dimensions are the same unless otherwise noted

Do Not Use Geotextiles

Swale No.	Alignment	Start Station	End Station	Lt./Rt.	Revetment Riprap (Ton)	Sl (ft/ft)
PCBMP 164-022-122.48 D	PR-A-EB	1310+69	1310+80	Lt.	16	0.02
PCBMP 164-022-121.91 D	PR-A-EB	1302+28	1302+38	Lt.	16	0.06

Swale Schedule

Swale No.	Alignment	Start Station	End Station	Lt./Rt.	Sf	Sb	W (ft)	Length (ft)	Sl (ft/ft)	Grass Type
PCBMP 150-022-171.57 S	PR-A-EB	1527+37	1531+62	Lt.	3:1	3:1	0.50	425	0.030	Turf
PCBMP 150-022-171.92 S	PR-A-EB	1541+16	1545+22	Lt.	3:1	3:1	0.50	405	0.030	Turf
PCBMP 164-022-121.88 S	PR-A-EB	1301+80	1302+27	Lt.	3:1	2:1	0.50	51	0.045	Turf
PCBMP 164-022-122.05 S	PR-A-EB	1309+66	1310+73	Lt.	3:1	2:1	0.50	109	0.065	Turf
PCBMP 1265-022-0.66 S	PR-L-EB	2014+44	2019+00	Lt.	3:1	3:1	0.79	459	0.030	Turf
PCBMP 1265-022-0.73 S	PR-L-EB	2019+00	2023+13	Lt.	3:1	3:1	0.79	413	0.030	Turf
PCBMP 1265-022-1.39 S	PR-L-EB	2058+14	2059+50	Lt.	5.5:1	5.5:1	0.83	186	0.006	Turf
PCBMP 1265-022-1.61 S	PR-L-EB	2068+72	2069+95	Lt.	4:1	4:1	0.82	124	0.009	Turf
PCBMP 1265-022-1.72 S	PR-L-EB	2073+31	2075+16	Lt.	8:1	5.5:1	0.69	186	0.002	Turf



Cross Section View

PCSM Recurring Special Provisions

- Effective for December 01, 2025, Lettings
- <https://www.in.gov/dot/div/contracts/standards/rsp/sep25/600/626-R-796%20251201.pdf>
- New Pay Items for PCBMP Outlet Pipe and Risers
- CAD Templates for use now, will become Standard Drawings



Temporary BMP to PCBMP

- If also used as a PCBMP, must be labeled and designated as such
- RSP states requirement for PCBMPs to be restored to condition as shown in the plans
- Cannot construct stone trench with underdrain for use as a temporary BMP

Sediment Basin



Temporary sediment basins can be converted to PCBMPs with modifications and proper asset designation

Available Resources

- See Stormwater Webpage

<https://www.in.gov/indot/engineering/environmental-services/storm-water/>

- PCSM Training Video
- PCSM CAD Templates
- PCSM Submittal Guidance
- PCSM Asset Naming Guidance
- Hydraulic Residence Time Template
- Water Quality Volume Template
- PCSM FAQs
- Inspection and Maintenance Templates
- Operations and Maintenance Manuals
- And More....



QR Code to Webpage

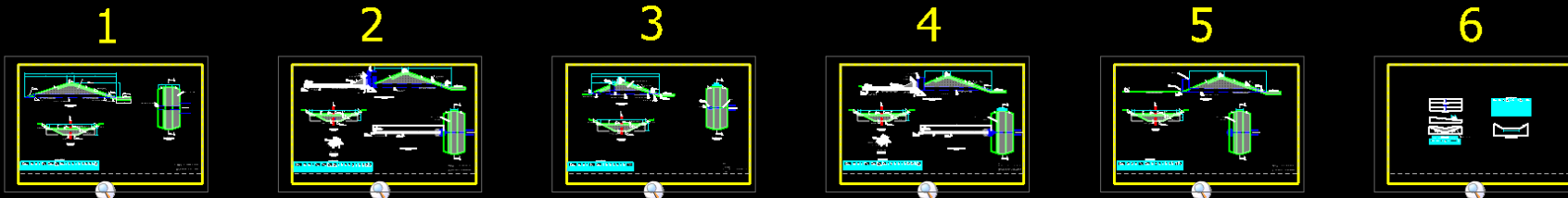
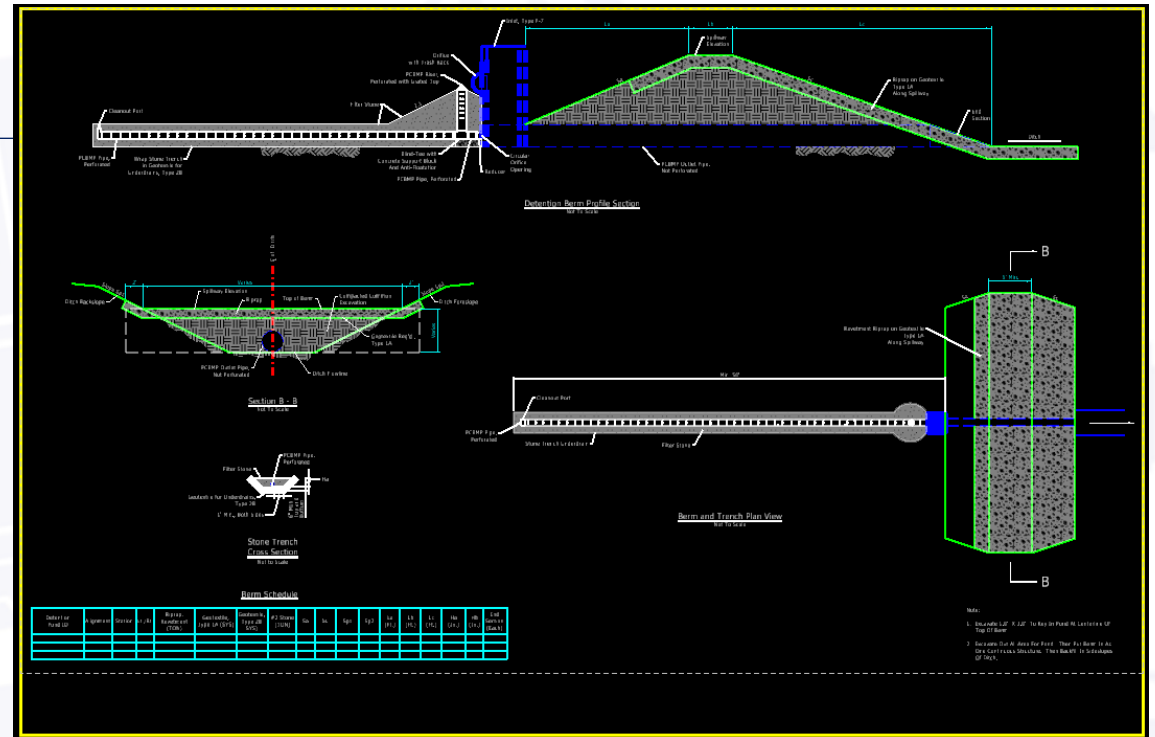
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CADD Templates

- Templates available here:

<https://www.in.gov/indot/engineering/environmental-services/storm-water/>

- Includes 5 detention outlet structure templates and 1 template for swales
- INDOT QPL for trash racks now available



Frequently Asked Questions

- ❖ When determining the value for net added impervious surface, do cross overs or other temporary pavements count?
 - ✓ No, only permanent impervious surface is included in the calculation.
- ❖ According to Table 1 in DM 26-01, my project does require PCBMPs. Please provide more guidance for what should be done to credit PCBMPs already included in the design through supporting calculations and how do we designate as a PCBMP?
 - ✓ Credit PCBMPs already included in the design means if there are detention, infiltration, or grass swales already included in the design, perform calculations to show they provide water quality treatment. Even if the full 80% TSS target removal cannot be achieved, perform the calculations to show some removal is achieved.
 - ✓ To designate as a PCBMP, include each PCBMP in the plans per the Submittal Requirements Document <https://www.in.gov/indot/engineering/files/PCSM-Submittal-Requirements-9-2024.pdf>
 - ✓ All PCBMPs require a report (one per project). See the PCSM Submittal Requirements document listed above.

Frequently Asked Questions

- ❖ If I'm already designing a detention basin for the job, does that automatically qualify as a PCBMP or do I have to specifically design one?
 - ✓ Calculations have to be developed per the PCSM Guidance Document and submitted with the PCSM Report for a detention facility to count for water quality requirements.
- ❖ How do I determine what county number to use for naming PCBMPs?
 - ✓ https://www.in.gov/fssa/dfr/files/Indiana_county_numbers_names.pdf
- ❖ How do I find the reference post numbers to use for naming PCBMPs?
 - ✓ <https://www.indianamap.org/datasets/indot-reference-posts/about>
- ❖ I have two projects with two DES numbers but under one INDOT contract. They both require a CSGP; however, their combined net added impervious surface is just over an acre. Do we consider them one project or two for determining how much net added impervious surface there is (and therefore if PCBMPs are required)?
 - ✓ The net added impervious surface for the two DES numbers should be combined when the following conditions are met:
 - ✓ The projects are less than or equal to 0.25 miles of the closest point of each other.
 - ✓ The projects outlet to the same perennial stream based on the 1:24,000 USGS Topo Quad solid blue line streams.

Questions

PCSM@indot.IN.gov

