NORTH CAROLINA
Department of Transportation

Hydraulic Planning, Now with Hydroplaning

Stephen Morgan, PE
State Hydraulics Engineer

May 17, 2023

NORTH CAROLINA
Department of Transportation

NCDOT Hydraulic Planning Report

Brian Radakovic, PE

May 17, 2023

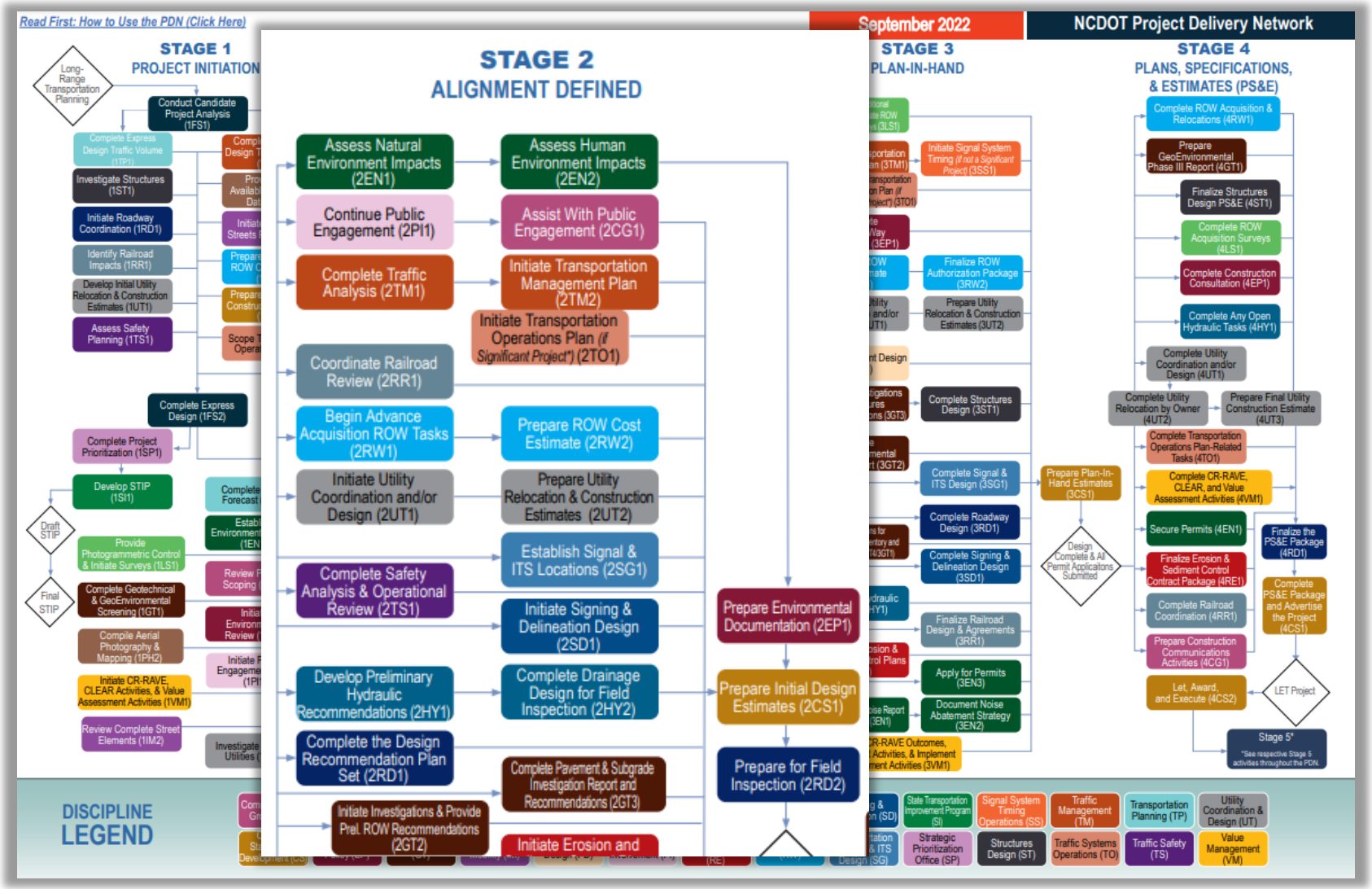
What is the Hydraulic Planning Report?

- Preliminary hydraulic information to refine line and grade
- Establish the hydrologic performance standards for the project.
- identify permitting requirements;
- Identify risk
- Define avoidance and minimization opportunities;
- Estimate major drainage structure sizes where appropriate.
- Assesses potential Hydroplaning issues (When Necessary)

It's scalable and can cover all project types.

If necessary, preliminary hydraulic modelling is conducted to inform project impacts and revise final alternative.

When Does It Occur?



Hydraulic Planning Report Format

Hydraulic Planning Report (submitted as a single PDF, listed here in order of appearance)	Cover Page
	General Information
	Roadway Alignment & Site Map *
	Preliminary Major Crossing Table
	Site Data *
	Preliminary Plan & Profile Sketch
	FEMA Site Maps with Sites Labeled
	Photos as Needed
	Preliminary Hydroplaning Assessment (as needed)
	Miscellaneous Data as agreed upon by the QA reviewer

What is the Hydraulic Planning Report?

NEW

NCDOT - HYDRAULIC PLANNING REPORT

TIP/PROJECT NO.	BR-0168
WBS ELEMENT NO.	50603.1.1
PROJECT DESCRIPTION:	Replace Bridge 330289 on SR 4000 over US 52
PROPOSED RDWY TYPICAL:	Unknown - Requested from Rdwy 04/27/2023
EXISTING RDWY TYPICAL:	5 Lanes on bridge with 2 southbound and 3 northbound lanes. One northbound lane is left turn lane to ramp onto US 52 northbound.
COUNTY:	Forsyth
DIVISION:	9
DESIGNER:	Ray D. Lovinggood
DATE:	1-May-23
SEAL:	NORTH CAROLINA PROFESSIONAL SEAL 019775 ENGINEER RAY D. LOVINGGOOD
PREPARED BY:	NCDOT Hydraulics Unit
PROJECT MANAGER:	**Ray Lovinggood, PE**
QA REVIEWED BY:	**Matthew York, PE**

PROJECT NUMBER:	BR-0168	DATE:	5/1/2023
WBS ELEMENT #:	50603.1.1	DESIGN FIRM:	45047
COUNTY:	Forsyth	DESIGNED BY:	Ray D. Lovinggood
DIVISION:	9	REVIEWED BY:	

NCDOT - HPR

GENERAL INFORMATION

MISCELLANEOUS PROJECT INFORMATION ①

From Greg Dellacona, County Maintenance Office: The ponded water within the northern loop was created by blocking the outlet pipe. Too much water was flowing in the ditch behind the Applebees, Steak 'n Shake, and Allegacy Federal Credit Union many years. By blocking the pipe, water heads up in the low spot within the loop and finds relief to flow down and into the channel identified as SA in the NRTR. As far as he know, the water has never gotten into the roads. Mr. Dellacona had no other drainage concerns for this immediate area.

No existing stormwater treatment devices
No FEMA floodplain involvement
No current flooding issues
No issues related to roadway drainage are in the NRTR.

Spread Check on Deck:
Assume Length = 327' (with approach slabs) Width = 1/2 x (90') = 45' Cross Slope = 0.02 ft/ft Mannings 'n' = 0.013
Minimum slope of 0.0125 ft/ft produces spread of 6.9' which stays inside of 7.0' bike lane and shoulder.

GREEN SHEET COMMITMENTS No Green Sheets yet.

FEMA INVOLVEMENT?
☐ YES ☑ NO

RISK IDENTIFICATION

While there doesn't appear to be FEMA involvement at this time, there is a FEMA studied stream to the south and southeast of the bridge. Mill Creek passes under Patterson Ave, the US-52 westbound exit ramp, east and westbound lanes of US-52, and north and southbounad lanes of SR-4000. By keeping the project limits contained near the existing bridge, the stream should not be a factor.

AVOIDANCE AND MINIMIZATION

Avoid crossing Mill Creek.

SELDM was used and determined a BMP toolbox item will be required in the project. However, only conceptual sketches were available to provide input data into SELDM and results may differ when final design plans are available.

What is the Hydraulic Planning Report?

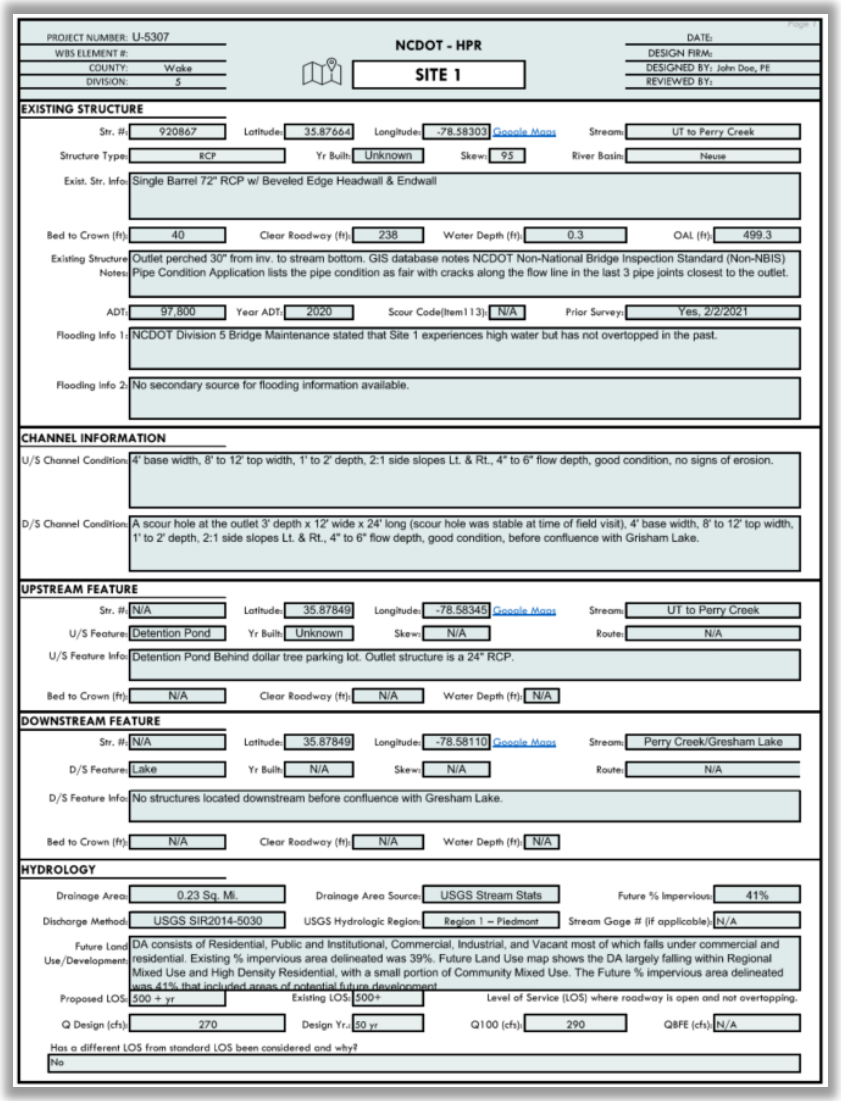
PROJECT NUMBER: U-5307
WBS ELEMENT #:
COUNTY: Wake
DIVISION: 5

PRELIMINARY HYDRAULIC RECOMMENDATIONS FOR MAJOR CROSSINGS

DATE:
DESIGN FIRM:
DESIGNED BY: John Doe, PE
REVIEWED BY:

SITE NUMBER	ALTERNATIVE ID (2)	ROUTE	STATION	LAT	LONG	STREAM/ WETLAND ID	STREAM NAME	FEMA STUDY TYPE	DRAINAGE AREA (Mi^2)	EXISTING STRUCTURE	MINIMUM RECOMMENDED STRUCTURE	Notes
										Number, Size, Structure Type	Number, Size, Structure Type	
1	Northern Wake Expy	I-540	-Y1- Sta. 21+43	35.87664	-78.58303	N/A	Unnamed Tributary	N/A	0.23	72" RCP	Retain existing 72" RCP	
2	Northern Wake Expy	I-540	-Y1- Sta. 62+86	35.87383	-78.56939	N/A	Unnamed Tributary	N/A	1.27	2 @ 8' x 6' RCBC	Retain 2 @ 8' x 6' RCBC and add a supplemental 72" WSP by Trenchless Installation.	Infiltration was observed along the joints on the sidewalls of the culvert and
3	Gresham Lake Rd.	SR-2023	-Y9C- Sta. 52+00	35.87597	-78.56850	27-25-(2)	Perry Creek	Detailed Study	5.33	N/A	Propose 300' reinforced concrete bridge on girders	
4	Capital Boulevard	US-1	-L- Sta. 60+35	35.87935	-78.57339	27-25-(2)	Perry Creek	Detailed Study	3.74	3 @ 8' x 8' RCBC	Retain and extend 3 @ 8' x 8' RCBC approx. 40' D/S and add a supplemental 84" WSP by Trenchless Installation.	
5	Capital Boulevard	US-1	-L- Sta. 101+92	35.88815	-78.56454	27-25-3-(2)	Unnamed Tributary Near Neuse	N/A	3.14	2 @ 8' x 8' RCBC	Retain 2 @ 8' x 8' RCBC and add a supplemental 84" WSP by Trenchless Installation.	
6	N/A	N/A	-Y10- 52+32	35.88733	-78.56097	27-25-3-(2)	Unnamed Tributary Near Neuse	N/A	3.49	N/A	3 @ 10' x 10' RCBC	
7	N/A	N/A	-Y10- 65+86	35.88973	-78.55756	N/A	Unnamed Tributary	N/A	0.1	N/A	1 @ 6' x 7' RCBC	
8	Capital Boulevard	US-1	-L- 185+00	35.90891	-78.55459	27-(22.5)	Neuse River	Detailed Study	792	248' Dual Bridges w/ RC Floor/Prestressed Conc. Girders	3 proposed 280' reinforced concrete bridges on girders	
9	N/A	N/A	-Y18A- 62+36	35.94112	-78.53702	N/A	Unnamed Tributary	N/A	0.21	N/A	1 @ 7' x 8' RCBC	
10	Capital Boulevard	US-1	-L- Sta. 388+50	35.96153	-78.54240	27-21-(1.5)	Richland Creek	Detailed Study	10.4	4 @ 10' x 11' RCBC	Retain and extend 4 @ 10' x 11' RCBC approx. 10' U/S and 10' D/S.	
11	N/A	N/A	-Y10F- Sta. 10+81	35.88767	-78.56358	27-25-3-(2)	Unnamed Tributary Near Neuse	N/A	3.15	N/A	3 @ 9' x 8' RCBC	

What is the Hydraulic Planning Report?



PROJECT NUMBER: U-5307
WBS ELEMENT #:
COUNTY: Wake
DIVISION: 5

NCDOT - HPR

SITE 1

DATE:
DESIGN FIRM:
DESIGNED BY: John Doe, PE
REVIEWED BY:

EXISTING STRUCTURE

Str. #:	920867	Latitude:	35.87664	Longitude:	-78.58303 Google Maps	Stream:	UT to Perry Creek
Structure Type:	RCP	Yr Built:	Unknown	Skew:	95	River Basin:	Neuse

Exist. Str. Info: Single Barrel 72" RCP w/ Beveled Edge Headwall & Endwall

Bed to Crown (ft):	40	Clear Roadway (ft):	238	Water Depth (ft):	0.3	OAL (ft):	499.3

Existing Structure Notes: Outlet perched 30" from inv. to stream bottom. GIS database notes NCDOT Non-National Bridge Inspection Standard (Non-NBIS) Pipe Condition Application lists the pipe condition as fair with cracks along the flow line in the last 3 pipe joints closest to the outlet.

ADT:	97,800	Year ADT:	2020	Scour Code(Item113):	N/A	Prior Survey:	Yes, 2/2/2021

Flooding Info 1: NCDOT Division 5 Bridge Maintenance stated that Site 1 experiences high water but has not overtopped in the past.

Flooding Info 2: No secondary source for flooding information available.

CHANNEL INFORMATION

U/S Channel Condition: 4' base width, 8' to 12' top width, 1' to 2' depth, 2:1 side slopes Lt. & Rt., 4" to 6" flow depth, good condition, no signs of erosion.

D/S Channel Condition: A scour hole at the outlet 3' depth x 12' wide x 24' long (scour hole was stable at time of field visit), 4' base width, 8' to 12' top width, 1' to 2' depth, 2:1 side slopes Lt. & Rt., 4" to 6" flow depth, good condition, before confluence with Grisham Lake.

UPSTREAM FEATURE

Str. #:	N/A	Latitude:	35.87849	Longitude:	-78.58345 Google Maps	Stream:	UT to Perry Creek
U/S Feature:	Detention Pond	Yr Built:	Unknown	Skew:	N/A	Route:	N/A

U/S Feature Info: Detention Pond Behind dollar tree parking lot. Outlet structure is a 24" RCP.

Bed to Crown (ft):	N/A	Clear Roadway (ft):	N/A	Water Depth (ft):	N/A

DOWNSTREAM FEATURE

Str. #:	N/A	Latitude:	35.87849	Longitude:	-78.58110 Google Maps	Stream:	Perry Creek/Gresham Lake
D/S Feature:	Lake	Yr Built:	N/A	Skew:	N/A	Route:	N/A

D/S Feature Info: No structures located downstream before confluence with Gresham Lake.

Bed to Crown (ft):	N/A	Clear Roadway (ft):	N/A	Water Depth (ft):	N/A

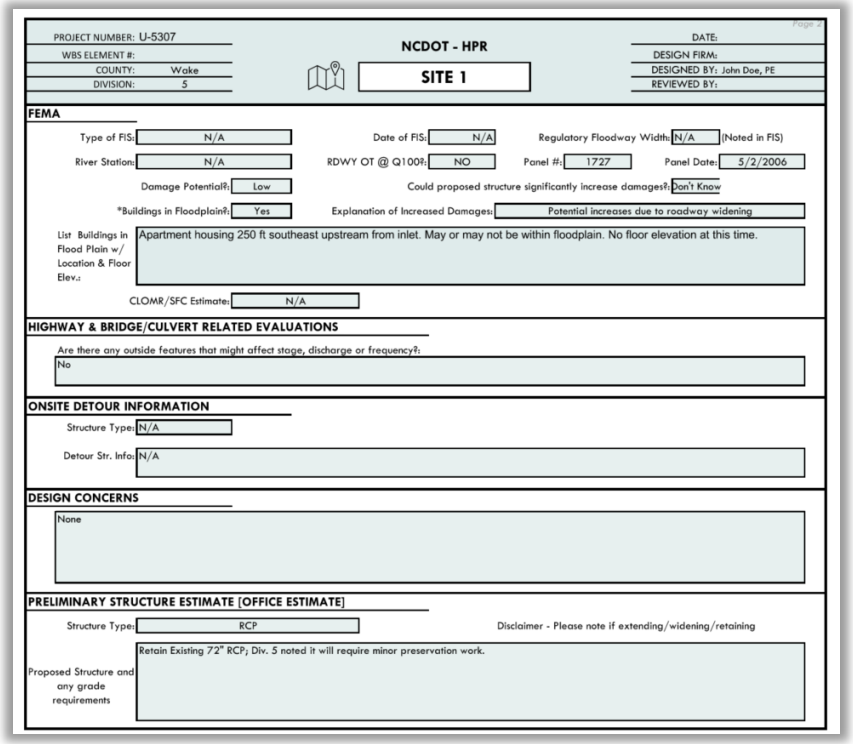
HYDROLOGY

Drainage Area:	0.23 Sq. Mi.	Drainage Area Source:	USGS Stream Stats	Future % Impervious:	41%
Discharge Method:	USGS SIR2014-5030	USGS Hydrologic Region:	Region 1 -- Piedmont	Stream Gage # (if applicable):	N/A

Future Land Use/Development: DA consists of Residential, Public and Institutional, Commercial, Industrial, and Vacant most of which falls under commercial and residential. Existing % impervious area delineated was 39%. Future Land Use map shows the DA largely falling within Regional Mixed Use and High Density Residential, with a small portion of Community Mixed Use. The Future % impervious area delineated was 41% that included areas of potential future development

Proposed LOS:	500 + yr	Existing LOS:	500+	Level of Service (LOS) where roadway is open and not overtopping.	
Q Design (cfs):	270	Design Yr.:	50 yr	Q100 (cfs):	290
QBFE (cfs):	N/A				

Has a different LOS from standard LOS been considered and why?
No



PROJECT NUMBER: U-5307
WBS ELEMENT #:
COUNTY: Wake
DIVISION: 5

NCDOT - HPR

SITE 1

DATE:
DESIGN FIRM:
DESIGNED BY: John Doe, PE
REVIEWED BY:

FEMA

Type of FIS:	N/A	Date of FIS:	N/A	Regulatory Floodway Width:	N/A	(Noted in FIS)	
River Station:	N/A	RDWY OT @ Q100?:	NO	Panel #:	1727	Panel Date:	5/2/2006
Damage Potential?:	Low	Could proposed structure significantly increase damages?:	Don't Know				
*Buildings in Floodplain?:	Yes	Explanation of Increased Damages:	Potential increases due to roadway widening				

List Buildings in Flood Plain w/ Location & Floor Elev.: Apartment housing 250 ft southeast upstream from inlet. May or may not be within floodplain. No floor elevation at this time.

CLOMR/SFC Estimate: N/A

HIGHWAY & BRIDGE/CULVERT RELATED EVALUATIONS

Are there any outside features that might affect stage, discharge or frequency?:
No

ONSITE DETOUR INFORMATION

Structure Type: N/A

Detour Str. Info.: N/A

DESIGN CONCERNS

None

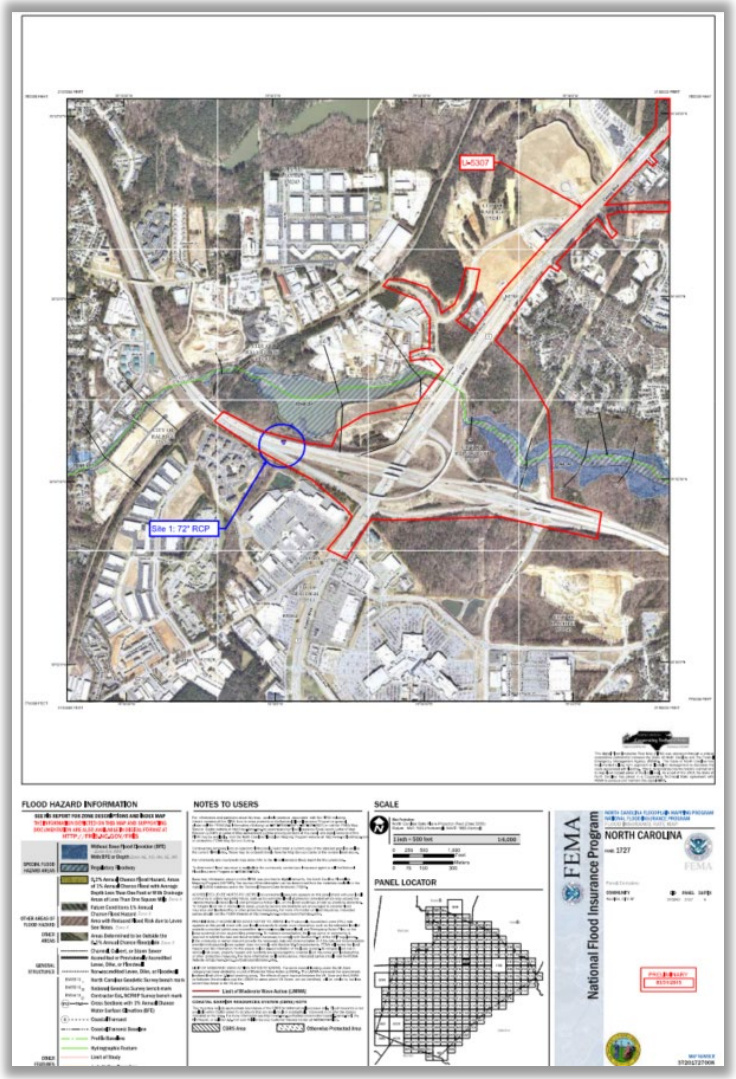
PRELIMINARY STRUCTURE ESTIMATE [OFFICE ESTIMATE]

Structure Type: RCP

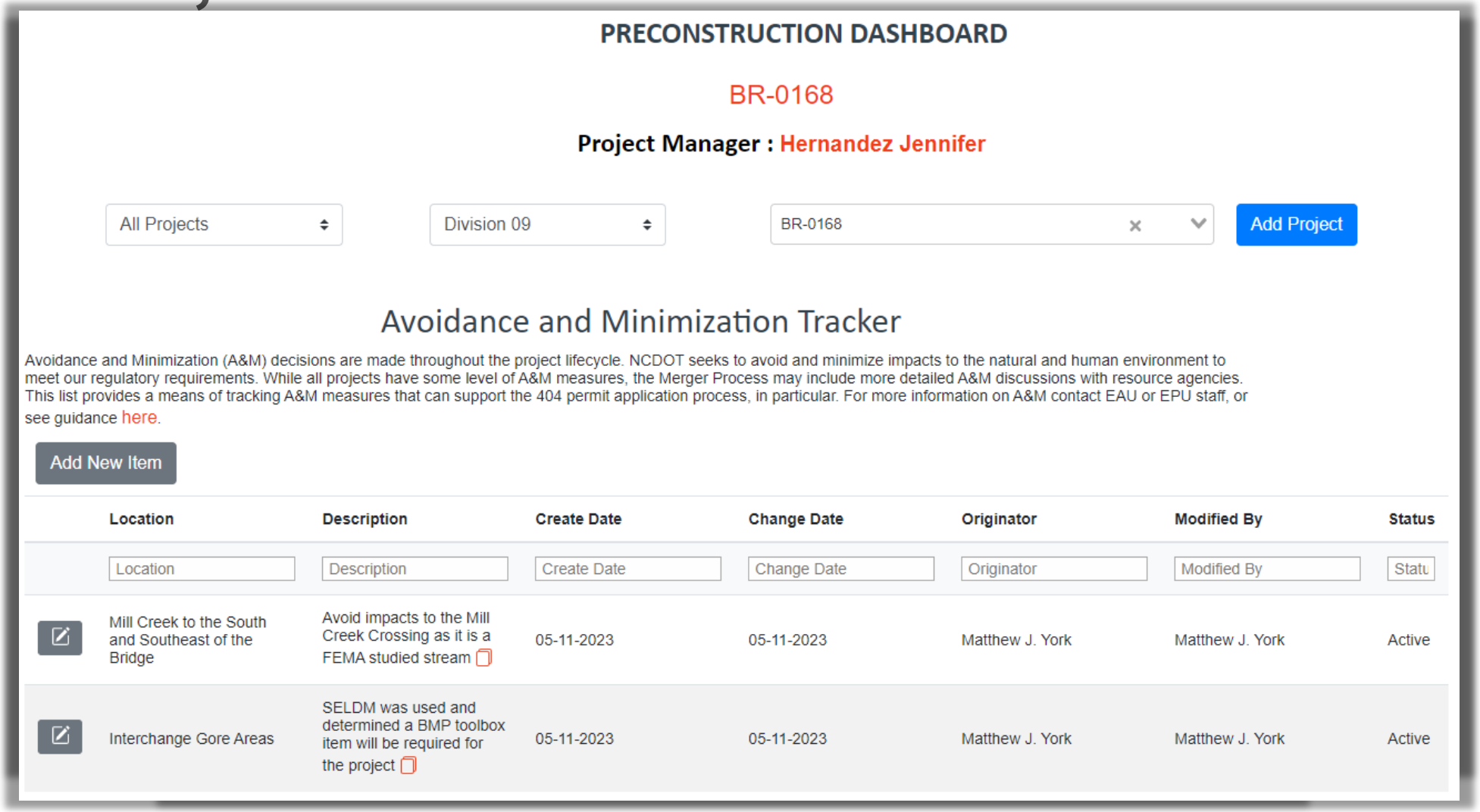
Disclaimer - Please note if extending/widening/retaining

Proposed Structure and any grade requirements: Retain Existing 72" RCP; Div. 5 noted it will require minor preservation work.

What is the Hydraulic Planning Report?



Capturing Special Project Commitments, Risk, and Avoidance & Minimization



PRECONSTRUCTION DASHBOARD

BR-0168

Project Manager : Hernandez Jennifer

All Projects | Division 09 | BR-0168 | Add Project

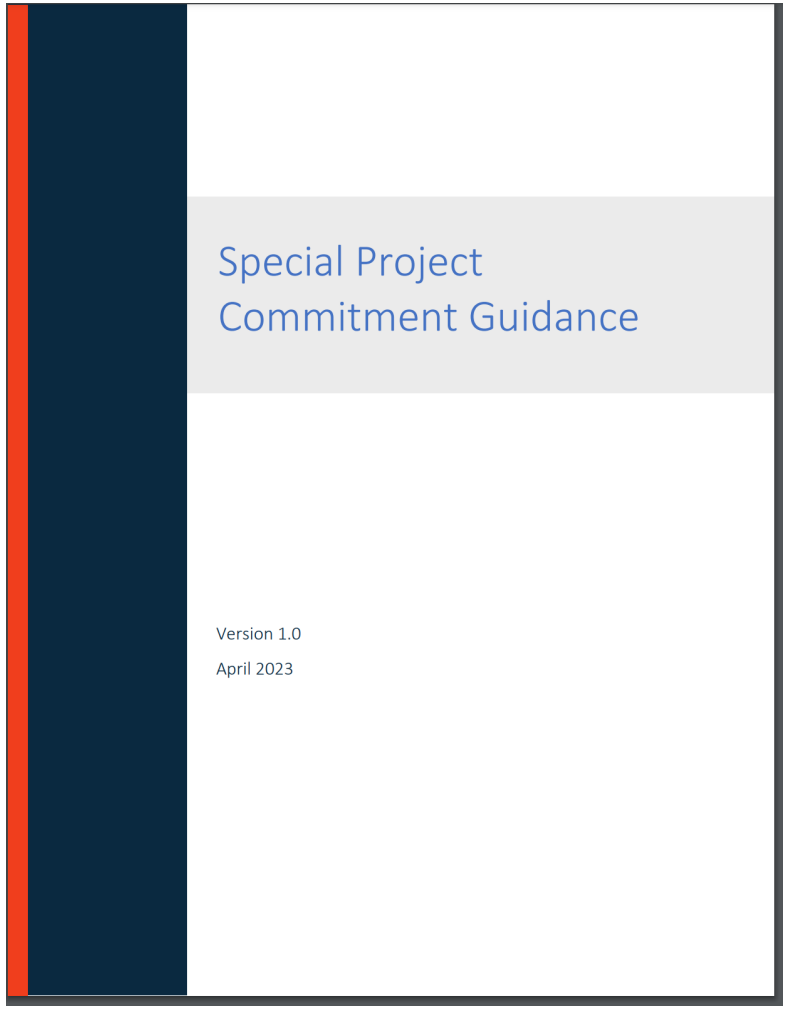
Avoidance and Minimization Tracker

Avoidance and Minimization (A&M) decisions are made throughout the project lifecycle. NCDOT seeks to avoid and minimize impacts to the natural and human environment to meet our regulatory requirements. While all projects have some level of A&M measures, the Merger Process may include more detailed A&M discussions with resource agencies. This list provides a means of tracking A&M measures that can support the 404 permit application process, in particular. For more information on A&M contact EAU or EPU staff, or see guidance here.

Add New Item

	Location	Description	Create Date	Change Date	Originator	Modified By	Status
	Location	Description	Create Date	Change Date	Originator	Modified By	Statu
	Mill Creek to the South and Southeast of the Bridge	Avoid impacts to the Mill Creek Crossing as it is a FEMA studied stream	05-11-2023	05-11-2023	Matthew J. York	Matthew J. York	Active
	Interchange Gore Areas	SELDM was used and determined a BMP toolbox item will be required for the project	05-11-2023	05-11-2023	Matthew J. York	Matthew J. York	Active

Special Project Commitment
(aka GreenSheets)



FEMA Floodplain (Hydraulics)

Title: Construction in FEMA Floodplain

Project Commitment Standard Language:

This project involves construction activities on or adjacent to FEMA-regulated stream(s). Therefore, the Division shall: (1) construct all vertical and horizontal elements within the floodplain as designed; and (2) consult with the Hydraulics Unit of any planned deviation of these elements within the floodplain prior to commencing any such changes; and (3) submit sealed as-built construction plans to the Hydraulics Unit upon completion of project construction. The Hydraulics Unit will then verify either: (1) the drainage structure(s) and roadway embankment located within the 100-year floodplain were built as shown in the construction plans, both horizontally and vertically; or (2) any changes made to the plans were reviewed and approved to meet FEMA SFHA compliance; or (3) appropriate mitigation measures will be achieved prior to project close-out.

Commitment Reason: STIP Project [TIP #] crosses FEMA-regulated stream [Stream name].

Stakeholder: Highway Floodplain Program

Stakeholder Email(s):

Phase: Post-Construction

Commitment Validation

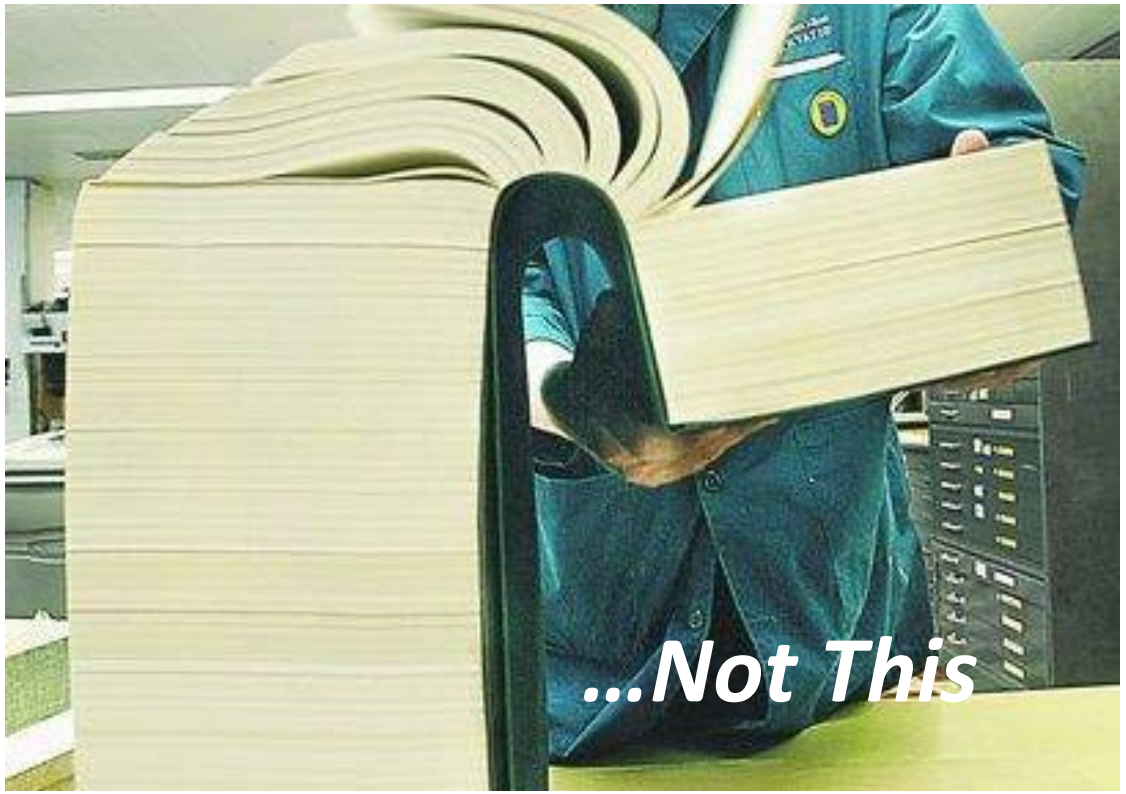
Discipline Responsible: Hydraulics Unit

Person Assigned to Validate: [Hydraulics Unit Representative]

Validation Due Date: [Two weeks from entry]

https://connect.ncdot.gov/resources/Environmental/EPU/Policy/Documents/Special_Project_Commitment_Guidance.pdf

What is the Hydraulic Planning Report?



NORTH CAROLINA
Department of Transportation

NCDOT Outlet Analysis Tool

Matthew York, PE

May 17, 2023

NCDOT OUTLET ANALYSIS

PROJECT INFORM

TIP #	HL-0008F
COUNTY	WAKE
DATE	2/23/2023
DESIGN FIRM	NCDOT
DESIGNER	PMT
PROJECT DESCRIPTION	SR 1006 (OLD STAGE ROAD) AND SR 1010 (TEN TEN ROAD) INTERSECTION
CUSTOM IDF DATA?	NO (County IDF)

Custom IDF Data

	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
5 min						
10 min						
15 min						
30 min						
60 min						

Finish / Save | Exit Without Saving

INFORMATION

	4
	1
	35.65373
	-78.66742
	RATIONAL
ANALYSIS POINT	DOWNSTREAM PAST R/W

*ANALYSIS POINT IS 55 FT. DOWNSTREAM PAST R/W

CLICK TO GENERATE SHEET FOR THIS OUTLET


TIP Project: HL-0008F
Date: 2/22/2023
Enter Pre Sub DA & C value
Drainage Area Impervious within R/W / Easement / NCDOT Contribution (Acres)
1.18
Drainage Area Impervious Outside R/W / Easement (Acres)
1.95
C Value Impervious
0.9
Drainage Area Grass within R/W / Easement / NCDOT Contribution (Acres)
0.00
Drainage Area Grass Outside R/W / Easement (Acres)
25.95
C Value Grass
0.3
Drainage Area Woods within R/W / Easement / NCDOT Contribution (Acres)
0.00
Drainage Area Woods Outside R/W / Easement / NCDOT Contribution (Acres)
0.00
C Value Woods
0.2
Drainage Area Other #1 within R/W / Easement / NCDOT Contribution (Acres)
0.00
Drainage Area Other #1 Outside R/W / Easement / NCDOT Contribution (Acres)
0.00
C Value Other #1
0
Drainage Area Other #2 within R/W / Easement / NCDOT Contribution (Acres)
0.00
Drainage Area Other #2 within R/W / Easement / NCDOT Contribution (Acres)
0.00
C Value Other #2
0
Drainage Area Other #3 within R/W / Easement / NCDOT Contribution (Acres)
0.00
Drainage Area Other #3 within R/W / Easement / NCDOT Contribution (Acres)
0.00
C Value Other #3
0
Compute & Save
Exit Without Saving
Enter Post Sub DA & C value
Drainage Area Impervious within R/W / Easement / NCDOT Contribution (Acres)
2.89
Drainage Area Impervious Outside R/W / Easement (Acres)
1.95
C Value Impervious
0.9
Drainage Area Grass within R/W / Easement / NCDOT Contribution (Acres)
0.00
Drainage Area Grass Outside R/W / Easement (Acres)
24.8
C Value Grass
0.3
Drainage Area Woods within R/W / Easement / NCDOT Contribution (Acres)
0.00
Drainage Area Woods Outside R/W / Easement / NCDOT Contribution (Acres)
0.00
C Value Woods
0.2
Drainage Area Other #1 within R/W / Easement / NCDOT Contribution (Acres)
0.00
Drainage Area Other #1 Outside R/W / Easement / NCDOT Contribution (Acres)
0.00
C Value Other #1
0
Drainage Area Other #2 within R/W / Easement / NCDOT Contribution (Acres)
0.00
Drainage Area Other #2 within R/W / Easement / NCDOT Contribution (Acres)
0.00
C Value Other #2
0
Drainage Area Other #3 within R/W / Easement / NCDOT Contribution (Acres)
0.00
Drainage Area Other #3 within R/W / Easement / NCDOT Contribution (Acres)
0.00
C Value Other #3
0
Compute & Save
Exit Without Saving

TIP Project:	HL-0008F	Date:	2/22/2023
County:	WAKE	Design Firm:	0
Description:	SR 1006 (OLD STAGE ROAD) AND SR 1010 (TEN TEN ROAD) INTERSECTION IMPROVEMENTS	Designed By:	PMT
	PSH 4 OUTLET -L- 26+89 LT ANALYSIS POINT TAKEN 55' DOWNSTREAM PAST R/W	Reviewed By:	

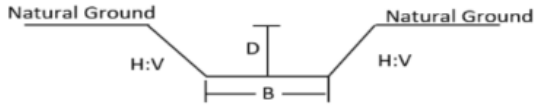
Outlet UID Number: OA-HL-0008F-4-1 Latitude: 35.65373 Longitude: -78.66742 Google Maps

PRE-CONSTRUCTION (RATIONAL METHOD)					POST-CONSTRUCTION (RATIONAL METHOD)					CHANGE	
		Q_2 =	40.3	cfs			Q_2 =	44.8	cfs	Q_2 =	11.3%
		V_2 =	1.9	ft./s			V_2 =	2.0	ft./s	V_2 =	2.7%
$C_{composite}$ =	0.36	D_2 =	3.3	ft.	$C_{composite}$ =	0.40	D_2 =	3.5	ft.	D_2 =	5.4%
T.O.C (min.)	15.0	Q_5 =	46.6	cfs	T.O.C (min.)	15.0	Q_5 =	51.9	cfs	Q_5 =	11.3%
I_2 (in/hr) =	3.80	V_5 =	2.0	ft./s	I_2 (in/hr) =	3.80	V_5 =	2.0	ft./s	V_5 =	2.7%
I_5 (in/hr) =	4.40	D_5 =	3.6	ft.	I_5 (in/hr) =	4.40	D_5 =	3.8	ft.	D_5 =	5.3%
I_{10} (in/hr) =	4.89	Q_{10} =	51.8	cfs	I_{10} (in/hr) =	4.89	Q_{10} =	57.7	cfs	Q_{10} =	11.3%
I_{25} (in/hr) =	5.39	V_{10} =	2.0	ft./s	I_{25} (in/hr) =	5.39	V_{10} =	2.1	ft./s	V_{10} =	2.7%
I_{50} (in/hr) =	5.76	D_{10} =	3.8	ft.	I_{50} (in/hr) =	5.76	D_{10} =	4.0	ft.	D_{10} =	5.3%
$DA_{imp\ in\ R/W}$ =	1.18 ac.	Q_{25} =	57.1	cfs	$DA_{imp\ in\ R/W}$ =	2.89 ac.	Q_{25} =	63.6	cfs	Q_{25} =	11.3%
DA_{total} =	29.08 ac.	V_{25} =	2.1	ft./s	DA_{total} =	29.64 ac.	V_{25} =	2.1	ft./s	V_{25} =	2.7%
		D_{25} =	3.9	ft.			D_{25} =	4.1	ft.	D_{25} =	5.2%
% Imp. Area		Q_{50} =	61.1	cfs	% Imp. Area		Q_{50} =	67.9	cfs	Q_{50} =	11.3%
(NCDOT Contribution)	4.06%	V_{50} =	2.1	ft./s	(NCDOT Contribution)	9.75%	V_{50} =	2.2	ft./s	V_{50} =	2.7%
		D_{50} =	4.1	ft.			D_{50} =	4.3	ft.	D_{50} =	5.2%
										DA_{total}=	1.9%
										$DA_{imp\ R/W}$ =	1.71 ac.
										% $_{imp\ Area}$ =	5.7%

Railroad / 100-YR Design?	No	Existing Erosion / Potential Future Erosion?	Both
Post Const. D/S Channel liner type	Soil		

SOIL TYPE (Guidance Link)	Sandy loam	PRE-CONSTRUCTION OUTLET GEOMETRY	Trapezoidal
V_{10} Permissible	2.5 ft./s	POST-CONSTRUCTION OUTLET GEOMETRY	Geometry Same as Pre-Construction
τ_{10} Permissible	N/A	Case 3A ← Case Type	

PRE-CONSTRUCTION OUTLET GEOMETRY



Depth (ft) =	6	H:V (Lt) =	1.0
Slope (ft/ft) =	0.004	H:V (Rt) =	1.0
Manning's N =	0.07	Base Width (ft.) =	3

Notes (lining, condition, etc.): VEGETATED. EROSION ALONG BANKS. STEEP BANKS

POST-CONSTRUCTION OUTLET GEOMETRY

Same Geometry as Pre-Construction (See Image and Variables to the Left)

SUMMARY

Analysis Point 55' D/S of Proposed ROW at Hydraulics Proposed TDE (as of 2.22.23).

OUTLET SITE PHOTOS PAGE 1

D/S

Farther D/S

OUTLET SITE PHOTOS PAGE 2

Current Outfall (1)

Current Outfall (2)

Current Outfall (3)

Current Outfall (4)

How the Tool Accounts for 15A NCAC 04B .0109

- Brings Cor
- Brings Cor Documenta
- Formalizes
- Eliminates
- Assists St Audits
- The Guidel between m and commonly available Soil Information

15A NCAC 04B .0109 STORMWATER OUTLET PROTECTION

(a) Persons shall provide a design for the land-disturbing activity so that the post-construction velocity of the ten-year storm runoff in the receiving stormwater conveyance to, and including, the discharge point, does not exceed the greater of:

(1) the velocity established by the table in Paragraph (d) of this Rule; or

rmwater conveyance prior to

be met, then the receiving constructed to withstand the n percent.

rnative measures to control

s by designing measures to

ted or roughened swales and

v velocities to the discharge

improving cross sections or

n accelerated erosion in the

issible
ters Per Second*

Material	Maximum Permissible Velocities in feet and Meters Per Second* F.P.S.	M.P.S.
Fine Sand (noncolloidal)	2.5	.8
Sandy Loam (noncolloidal)	2.5	.8
Silt Loam (noncolloidal)	3.0	.9
Ordinary Firm Loam	3.5	1.1
Fine Gravel	5.0	1.5
Stiff Clay (very colloidal)	5.0	1.5
Graded, Loam to Cobbles (noncolloidal)	5.0	1.5
Graded, Silt to Cobbles (colloidal)	5.5	1.7
Alluvial Silts (noncolloidal)	3.5	1.1
Alluvial Silts (colloidal)	5.0	1.5
Coarse Gravel (noncolloidal)	6.0	1.8
Cobbles and Shingles	5.5	1.7
Shales and Hard Pans	6.0	1.8

*For sinuous channels, multiply allowable velocity by 0.95 for slightly sinuous, by 0.9 for moderately sinuous channels, and by 0.8 for highly sinuous channels. Source: Adapted from recommendations by Special Committee on Irrigation Research, American Society of Civil Engineers, 1926, for channels with straight alignment.

History Note: *Authority G.S. 113A-54(b); 113A-54(c);*
Eff. February 1, 1976;
Amended Eff. February 1, 1992; May 1, 1990; November 1, 1984; July 1, 1978;
Readopted Eff. April 1, 2020.

How the Tool Accounts for 15A NCAC 04B .0109

Outlet Analysis Case	Existing Erosion	Pre vs Post Velocity	Post Velocity vs. Permissible Soil Velocity	Velocity Increase 10% Threshold	Rule 15A NCAC 04B .0109 Satisfied?	Additional Requirements / Description
Case 1	Not Present	Decrease or No Change	V10 Post < Permissible for that Soil	N/A Compliance Already Met	YES	Mark "None" in the "Existing / Potential Erosion?" drop down cell
Case 1A	as Case 1 except with existing erosion present			Same	YES	Even though there is a decresae in velocity and it is not erosive, for unknown reasons there is existing erosion present. Mark "Existing" in the "Existing / Potential Erosion" Cell drop down.
Case 2	Not Present	Decrease or No Change	V10 Post > Permissible for that Soil	N/A Velocity Decreased	YES	Even though there is a decrease in velocity the flows are still erosive, Mark "Potential" in the "Existing / Potential Erosion" Cell drop down
Case 2A						re still erosive and xisting / Potential
Case 3						y it is not erosive. ell drop down
Case 3A						ty is not erosive, eason. Mark "Both" down
Case 4						Post still creates ential Erosion" Cell
Case 4A	as Case 4 except with existing erosion present				YES	ng Erosion and V10 Existing / Potential Erosion" Cell drop down
Case 5	Not Present	Increase	V10 Post > Permissible for that Soil	V increase > 10%	NO	Design receiving channel to withstand Vpost anywhere it exceeds Vpre by 10%. Create another outlet analysis tab at that point downstream to show Vincrease < 10%. Coordination with NCDOT may be needed for potential design solutions or design exceptions in this case due to easement constraints or environmental permitting constraints.
Case 5A	as Case 5 except with existing erosion present			Same	NO	

Existing Erosion / Potential Future Erosion? ⓘ: No

Both

Post Const. D/S Channel liner type ⓘ: Soil

Sandy loam

PRE-CONSTRUCTION OUTLET GEOMETRY

2.5 ft./s

N/A

Case 3A

POST-CONSTRUCTION OUTLET GEOMETRY

← Case Type ⓘ

Note 1 *In the case of a PROPOSED non-soil liner to absolve a Case 5 or 5A, Rule15A NCAC 04B .0109 is considered satisifed at this location. Mark only "Existing" or "None" in the "Existing / Potential Erosion Cell drop down". Other analysis points further downstream for where Vincrease becomes < 10% are still necessary.*

Note 2 *In the case of an EXISTING non-soil liner to remain post-construction, Rule 15A NCAC 04B .0109 does not provide guidance. Therefore, engineering judgement on the existing/potential erosion issues shall be used and discussed in the summary section of the outlet analysis. A combination of the 10% velocity increase threshold, the suggested max velocities, and suggested max shear stresses shall applied to make a design decision in these situations.*

What's Next?

ADDITIONAL INFORMATION - LAND USE BREAKDOWN SUMMARY - PSH 4 OUTLET 1							
PRE-CONSTRUCTION			POST-CONSTRUCTION			CHANGE	
LAND USE	C-VALUE	ACRES	LAND USE	C-VALUE	ACRES	Δ SUB AREA (AC.)	Δ SUB AREA (%)
IMPERVIOUS AREA WITHIN RIGHT OF WAY / EASEMENT / NCDOT CONTRIBUTION	0.9	1.18	IMPERVIOUS AREA WITHIN RIGHT OF WAY / EASEMENT / NCDOT CONTRIBUTION (ACRES)	0.9	2.89	1.71	144.9%
IMPERVIOUS AREA OUTSIDE RIGHT OF WAY / EASEMENT (ACRES)		1.95	IMPERVIOUS AREA OUTSIDE RIGHT OF WAY / EASEMENT (ACRES)		1.95	0.00	0.0%
GRASS AREA WITHIN RIGHT OF WAY / EASEMENT / NCDOT CONTRIBUTION (ACRES)	0.3	-	GRASS AREA WITHIN RIGHT OF WAY / EASEMENT / NCDOT CONTRIBUTION (ACRES)	0.3	-	-	-
GRASS AREA OUTSIDE RIGHT OF WAY / EASEMENT (ACRES)		25.95	GRASS AREA OUTSIDE RIGHT OF WAY / EASEMENT (ACRES)		24.80	-1.15	-4.4%
WOODS AREA WITHIN RIGHT OF WAY / EASEMENT / NCDOT CONTRIBUTION (ACRES)	0.2	-	WOODS AREA WITHIN RIGHT OF WAY / EASEMENT / NCDOT CONTRIBUTION (ACRES)	0.2	-	-	-
WOODS AREA OUTSIDE RIGHT OF WAY / EASEMENT (ACRES)		-	WOODS AREA OUTSIDE RIGHT OF WAY / EASEMENT (ACRES)		-	-	-
OTHER LAND USE #1 WITHIN RIGHT OF WAY / EASEMENT / NCDOT CONTRIBUTION (ACRES)	-	-	OTHER LAND USE #1 WITHIN RIGHT OF WAY / EASEMENT / NCDOT CONTRIBUTION (ACRES)	-	-	-	-
OTHER LAND USE #1 OUTSIDE RIGHT OF WAY / EASEMENT (ACRES)		-	OTHER LAND USE #1 OUTSIDE RIGHT OF WAY / EASEMENT (ACRES)		-	-	-
OTHER LAND USE #2 WITHIN RIGHT OF WAY / EASEMENT / NCDOT CONTRIBUTION (ACRES)	-	-	OTHER LAND USE #1 WITHIN RIGHT OF WAY / EASEMENT / NCDOT CONTRIBUTION (ACRES)	-	-	-	-
OTHER LAND USE #2 OUTSIDE RIGHT OF WAY / EASEMENT (ACRES)		-	OTHER LAND USE #1 OUTSIDE RIGHT OF WAY / EASEMENT (ACRES)		-	-	-
OTHER LAND USE #3 WITHIN RIGHT OF WAY / EASEMENT / NCDOT CONTRIBUTION (ACRES)	-	-	OTHER LAND USE #1 WITHIN RIGHT OF WAY / EASEMENT / NCDOT CONTRIBUTION (ACRES)	-	-	-	-
			OTHER LAND USE #1 OUTSIDE				

Land Use Breakdown

What's Next?

Outlet Analysis Summary

TIP Project: HL-0008F
County:
Version 1.1

SUMMARY TABLE

Date: 2/23/2023
Design Firm: NCDOT

RATIONAL METHOD SUMMARY TABLE

OUTLET INFORMATION		PRE-CONSTRUCTION SUMMARY						POST-CONSTRUCTION SUMMARY						OVERALL SUMMARY						
OUTLET	MAPS LINK	DRAINAGE AREA (AC.)	C VAL.	% I.A. TOTAL	Q10 (CFS)	D10 (FT)	V10 (FT/S)	DRAINAGE AREA (AC.)	C VAL.	% I.A. TOTAL	Q10 (CFS)	D10 (FT)	V10 (FT/S)	Δ Q10	Δ D10	Δ V10	Δ TOTAL AREA (AC.)	Δ IMP AREA (AC.)	Δ I.A.	CASE TYPE
PSH 4 OUTLET 1	Click	29.08	0.36	10.8%	51.8	3.8	2.0	29.64	0.40	16.3%	57.7	4.0	2.1	11.3%	5.3%	2.7%	0.56	1.71	5.6%	Case 3A

NORTH CAROLINA
Department of Transportation

Stormwater Permit Compliance Planning – Attaining the Maximum Extent Practicable Treatment Standard

Andrew McDaniel, PE

NCDOT Preconstruction Workshop
May 17, 2023

Agenda

- Maximum Extent Practicable (MEP) Stormwater Treatment Explained
- Tools For Success

Some Context

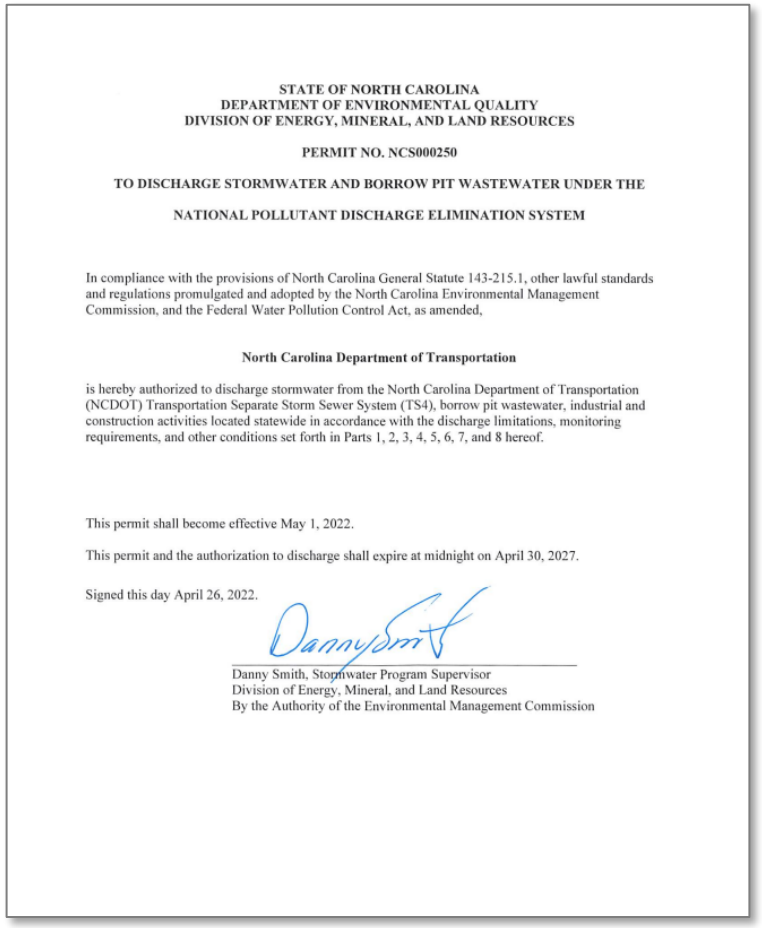
- How many of you do drainage design work for municipal clients?
- Depending on where you are in the state there can be multiple stormwater permits to apply for and obtain
  - Municipal stormwater permit
  - State stormwater permit
- These permits have prescriptive design requirements, which by definition, meet the MEP standard

NCDOT Projects Do Not Apply For Stormwater Permits

- Why?
- Because your project receives automatic coverage under NCDOT's statewide NPDES stormwater permit
- NC General Statutes and NC Administrative Code have consolidated stormwater requirements for NCDOT projects largely under the NPDES permit
  - No municipal stormwater permit required
  - No state stormwater permit required

NPDES Stormwater Permit

- Automatic coverage for:
  - Roadway projects
  - Non-roadway facilities
  - Rail projects
  - Ferry terminal projects
  - NC Global TransPark projects
  - and others



STATE OF NORTH CAROLINA
DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF ENERGY, MINERAL, AND LAND RESOURCES

PERMIT NO. NCS000250

TO DISCHARGE STORMWATER AND BORROW PIT WASTEWATER UNDER THE

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of North Carolina General Statute 143-215.1, other lawful standards and regulations promulgated and adopted by the North Carolina Environmental Management Commission, and the Federal Water Pollution Control Act, as amended,

North Carolina Department of Transportation

is hereby authorized to discharge stormwater from the North Carolina Department of Transportation (NCDOT) Transportation Separate Storm Sewer System (TS4), borrow pit wastewater, industrial and construction activities located statewide in accordance with the discharge limitations, monitoring requirements, and other conditions set forth in Parts 1, 2, 3, 4, 5, 6, 7, and 8 hereof.

This permit shall become effective May 1, 2022.

This permit and the authorization to discharge shall expire at midnight on April 30, 2027.

Signed this day April 26, 2022.

Danny Smith, Stormwater Program Supervisor
Division of Energy, Mineral, and Land Resources
By the Authority of the Environmental Management Commission

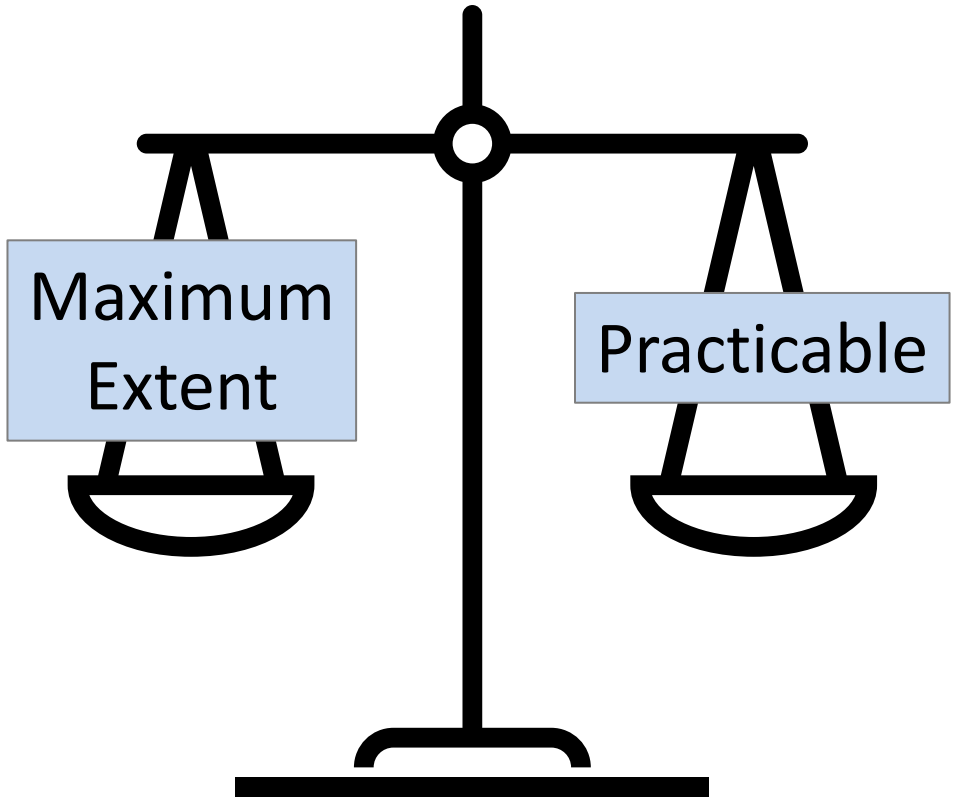
This sounds great!

- No stormwater permit applications can speed up project delivery
- Reduces uncertainty and project risks

Or Does It ?

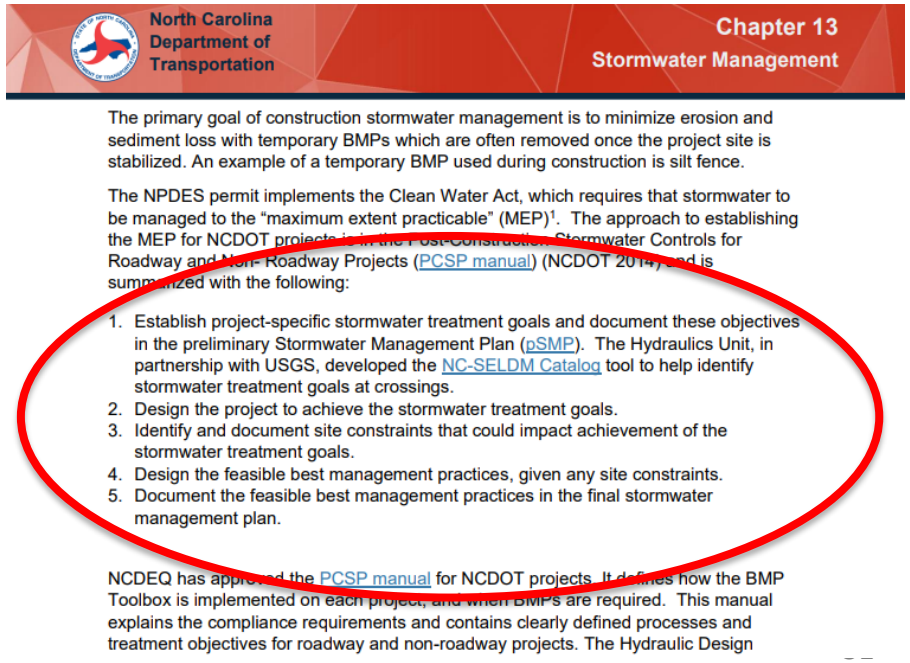
- By design the permit requires NCDOT to develop and implement a Post-Construction Stormwater Program (PCSP)
- Also, by design the permit does not mandate a prescriptive stormwater treatment standard for the PCSP other than the MEP standard
- So, it can be confusing as to what MEP means for NCDOT projects
- Decentralized project delivery complicates the matter further

Finding The Right Balance…



The Good News

- Page 13-6 of the NCDOT Drainage Design Guidelines outlines a straightforward 5 step process to demonstrate attainment of the MEP standard.



North Carolina Department of Transportation

Chapter 13
Stormwater Management

The primary goal of construction stormwater management is to minimize erosion and sediment loss with temporary BMPs which are often removed once the project site is stabilized. An example of a temporary BMP used during construction is silt fence.

The NPDES permit implements the Clean Water Act, which requires that stormwater to be managed to the "maximum extent practicable" (MEP)[1]. The approach to establishing the MEP for NCDOT projects is in the Post-Construction Stormwater Controls for Roadway and Non-Roadway Projects (PCSP manual) (NCDOT 2014) and is summarized with the following:

1. Establish project-specific stormwater treatment goals and document these objectives in the preliminary Stormwater Management Plan (pSMP). The Hydraulics Unit, in partnership with USGS, developed the NC-SELDM Catalog tool to help identify stormwater treatment goals at crossings.
2. Design the project to achieve the stormwater treatment goals.
3. Identify and document site constraints that could impact achievement of the stormwater treatment goals.
4. Design the feasible best management practices, given any site constraints.
5. Document the feasible best management practices in the final stormwater management plan.

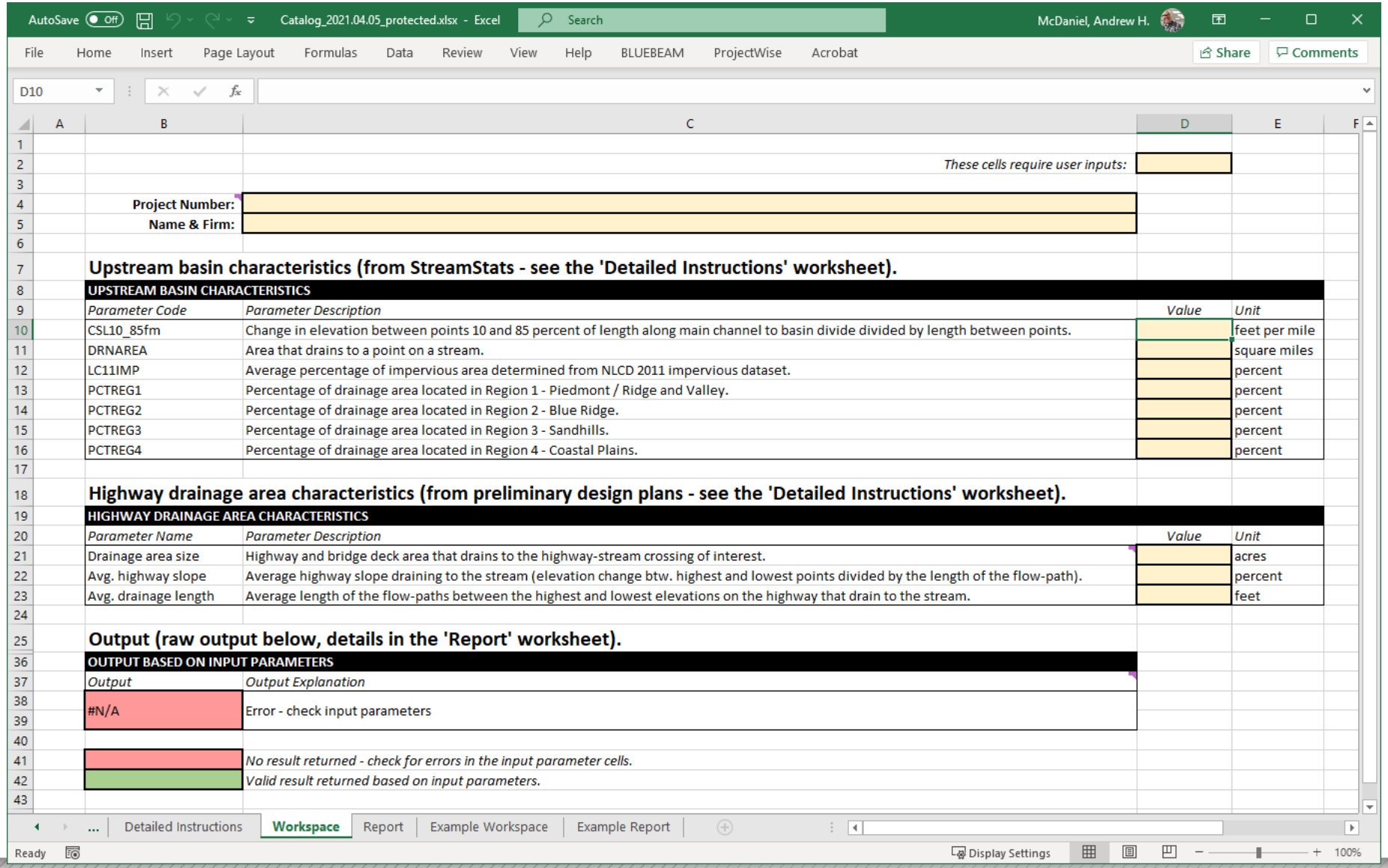
NCDEQ has approved the PCSP manual for NCDOT projects. It defines how the BMP Toolbox is implemented on each project, and when BMPs are required. This manual explains the compliance requirements and contains clearly defined processes and treatment objectives for roadway and non-roadway projects. The Hydraulic Design

Step 1

- Establish project-specific stormwater treatment goals at each crossing and document them in the preliminary Stormwater Management Plan (pSMP).

- A goal is one of the following:
  - Use of a BMP Toolbox structural practice
  - Use of non-structural Minimum Measure practices
  - Direct discharge

NC-SELDM Catalog Tool



Catalog_2021.04.05_protected.xlsx - Excel

			These cells require user inputs:	
	Project Number:			
	Name & Firm:			

Upstream basin characteristics (from StreamStats - see the 'Detailed Instructions' worksheet).

UPSTREAM BASIN CHARACTERISTICS			
Parameter Code	*Parameter Description*	*Value*	*Unit*
CSL10_85fm	Change in elevation between points 10 and 85 percent of length along main channel to basin divide divided by length between points.		feet per mile
DRNAREA	Area that drains to a point on a stream.		square miles
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset.		percent
PCTREG1	Percentage of drainage area located in Region 1 - Piedmont / Ridge and Valley.		percent
PCTREG2	Percentage of drainage area located in Region 2 - Blue Ridge.		percent
PCTREG3	Percentage of drainage area located in Region 3 - Sandhills.		percent
PCTREG4	Percentage of drainage area located in Region 4 - Coastal Plains.		percent

Highway drainage area characteristics (from preliminary design plans - see the 'Detailed Instructions' worksheet).

HIGHWAY DRAINAGE AREA CHARACTERISTICS			
Parameter Name	*Parameter Description*	*Value*	*Unit*
Drainage area size	Highway and bridge deck area that drains to the highway-stream crossing of interest.		acres
Avg. highway slope	Average highway slope draining to the stream (elevation change btw. highest and lowest points divided by the length of the flow-path).		percent
Avg. drainage length	Average length of the flow-paths between the highest and lowest elevations on the highway that drain to the stream.		feet

Output (raw output below, details in the 'Report' worksheet).

OUTPUT BASED ON INPUT PARAMETERS	
Output	*Output Explanation*
#N/A	Error - check input parameters

No result returned - check for errors in the input parameter cells.

Valid result returned based on input parameters.

Detailed Instructions | Workspace | Report | Example Workspace | Example Report

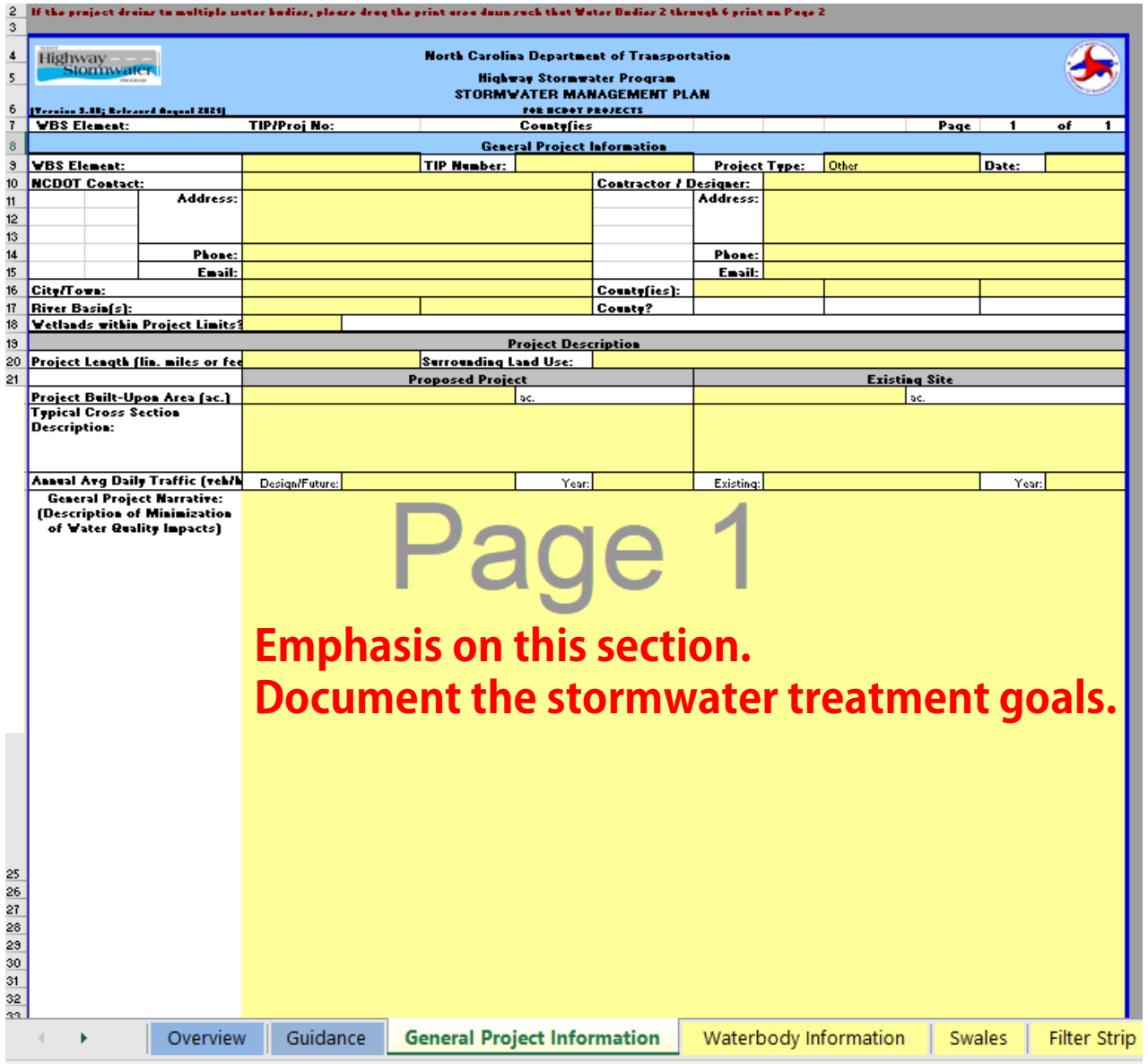
Training: NC-SELDM Catalog

Preliminary Stormwater Management Plan (pSMP)

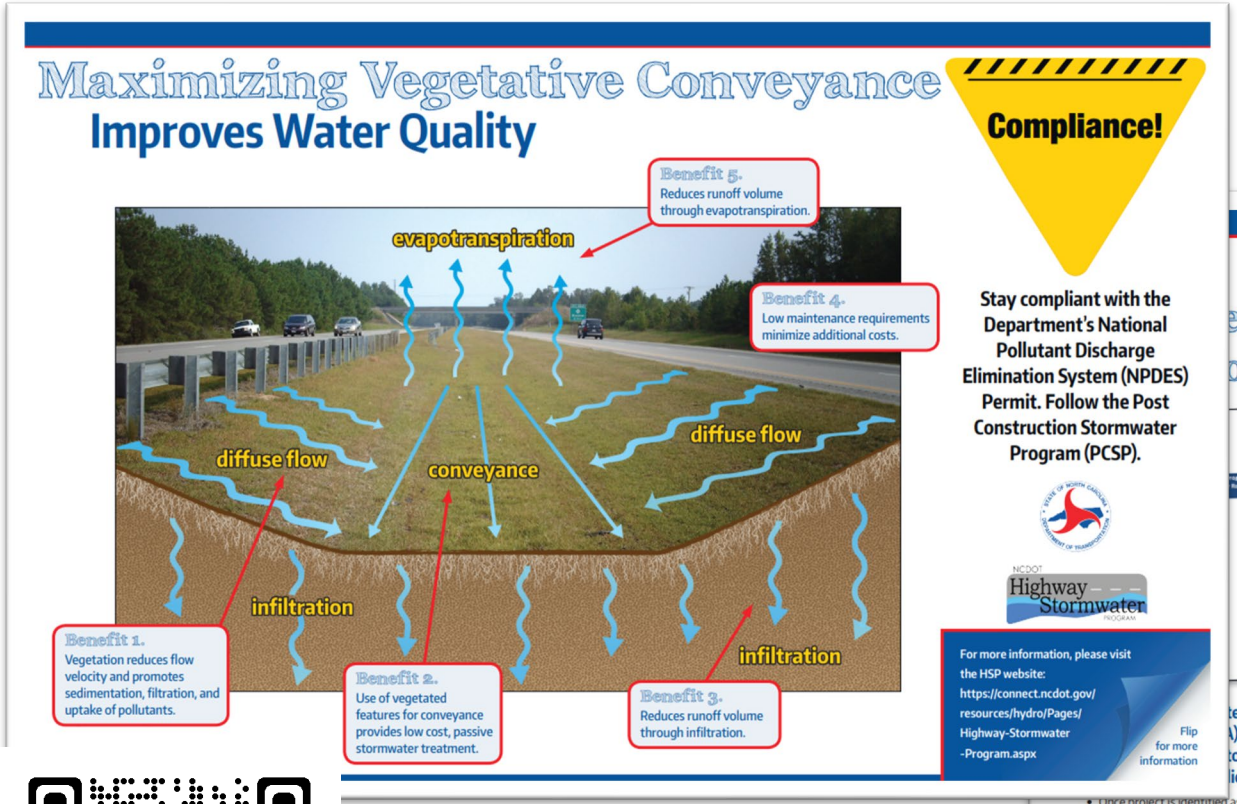
- Document Stormwater Treatment Goals in the pSMP
  - Excel form (SMPv3.01) – Dec. 2021
    - General Project Information
    - Waterbody Information

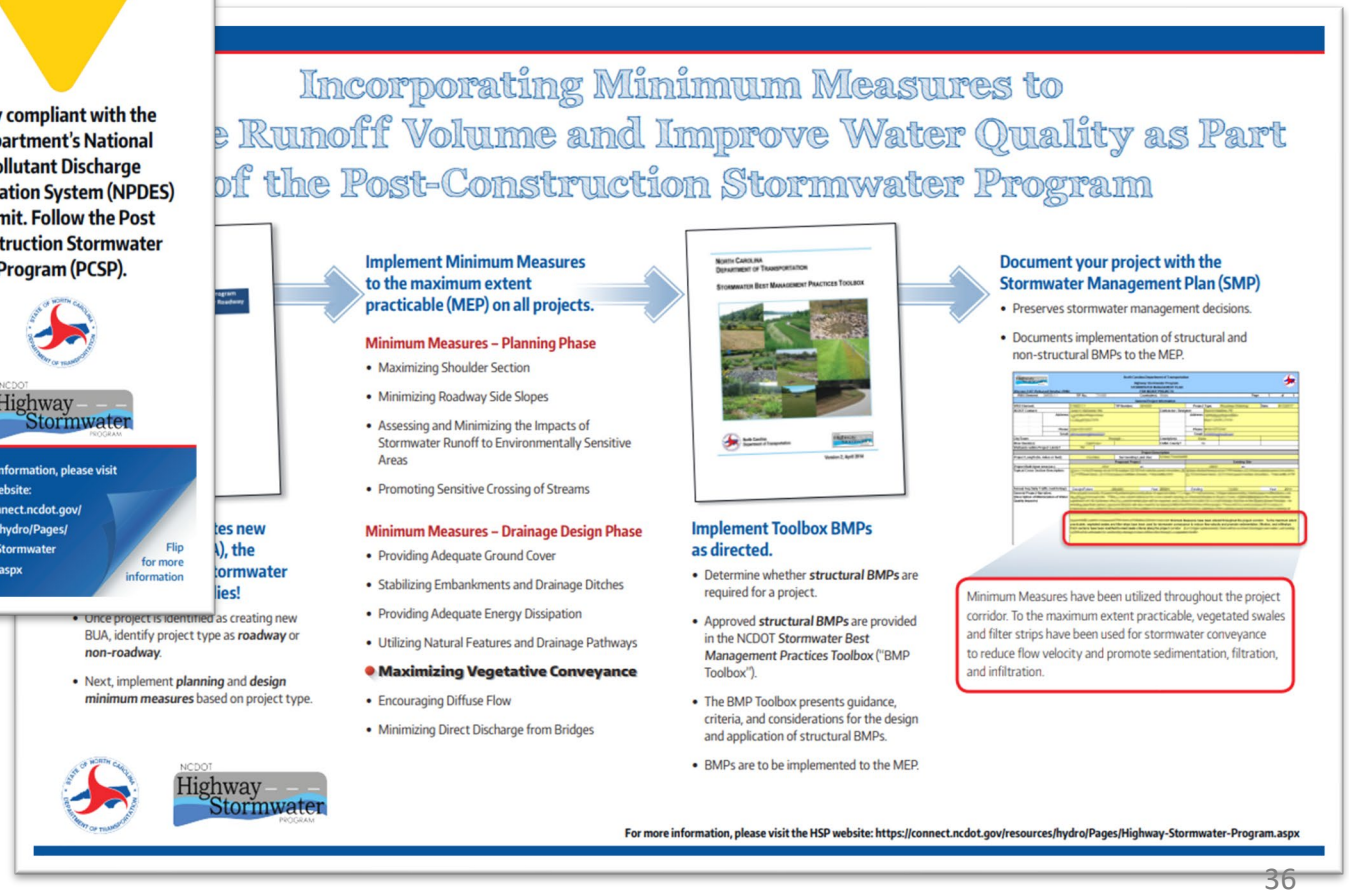
https://connect.ncdot.gov/resources/hydro/Pages/HSPProductPages.aspx?PROD=SMP

  - Save a pdf to the Preconstruction site.
    - For projects not on the Preconstruction Site submit via email to NCDOT_Hydraulics_SMP@ncdot.gov



Minimum Measures Infographic





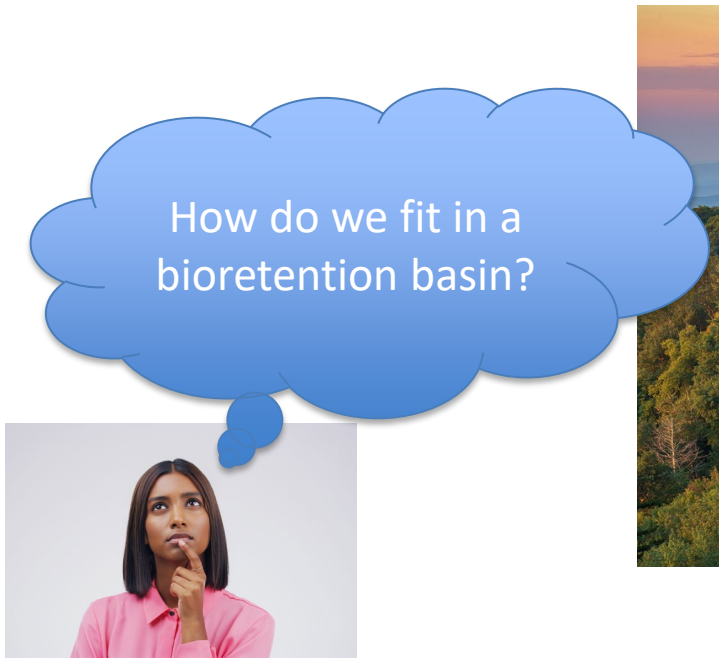
Example language on PCSP Connect Site

Step 2

- Attempt to design the project to achieve the stormwater treatment goals.

Step 3

- If necessary, identify and document site constraints that impact achievement of the stormwater treatment goals.



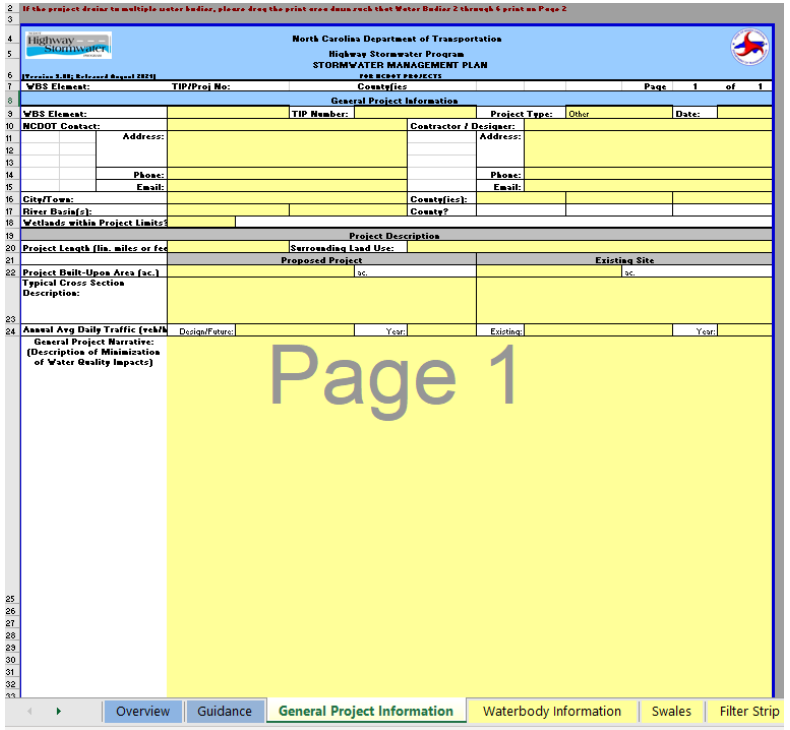
Step 4

- Design the feasible BMP, given the site constraints.

- Keep in mind that the stormwater treatment goal provided by the NC-SELDM Catalog is for water quality treatment.
- Your feasible BMP choice should also factor in water quantity management (outlet analysis).

Step 5

- Document the feasible stormwater control measures in the final stormwater management plan.



To Demonstrate Attainment of the MEP Stormwater Treatment Standard

- ***Step 1*** – Establish treatment goals and document in the preliminary stormwater management plan
- ***Step 2-*** Attempt to design the project to achieve the goals
- ***Step 3*** – If necessary, identify and document site constraints impacting goal attainment
- ***Step 4*** – Design feasible BMPs
- ***Step 5*** – Document your design in the final SMP

In Conclusion

- NCDOT's statewide NPDES permit gives the Department a lot of flexibility and helps speed project delivery.
- But there's no guarantee that the flexibility NCDOT enjoys now will last. Our permit is renewed every 5 years following a detailed audit conducted by DEQ.
- So, it is incumbent upon all of us to make sure we are following these 5 steps to demonstrate MEP and ensure permit compliance.

NCDOT Highway Stormwater PROGRAM

Google: *"ncdot stormwater"*

NORTH CAROLINA
Department of Transportation

NCDOT Hydroplaning Policy, Assessment Tool, and Mitigation Strategies

Matthew York, PE

May 17, 2023

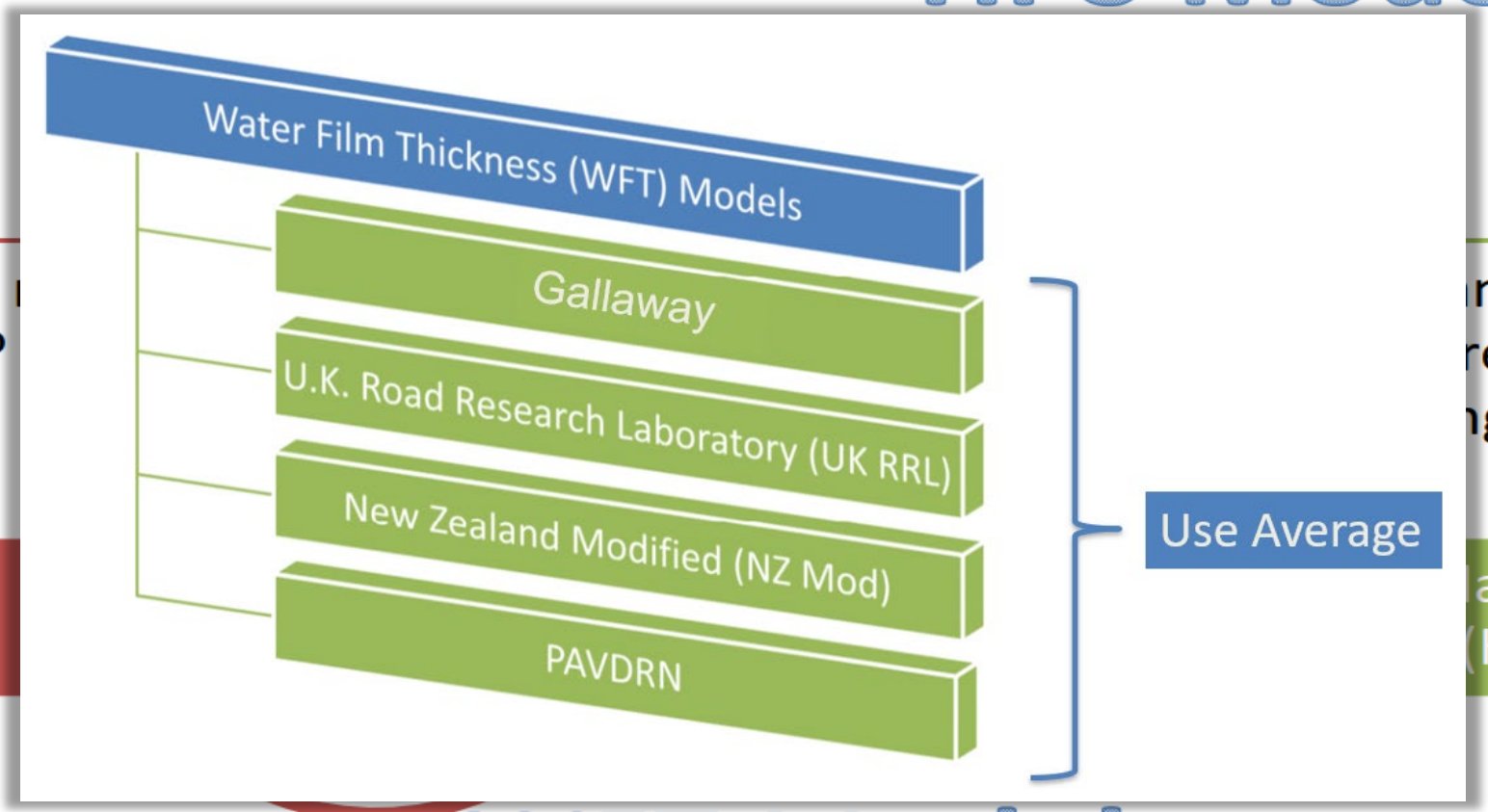
What Do We Mean by Hydroplaning?

Sheet Flow

Ponded Water

Hydroplaning Prediction

HPS Models



- How
  rain?

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re
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aning
(HPS)

WFT Models

(Slide Courtesy of FDOT) 46

Factors that Influence Hydroplaning

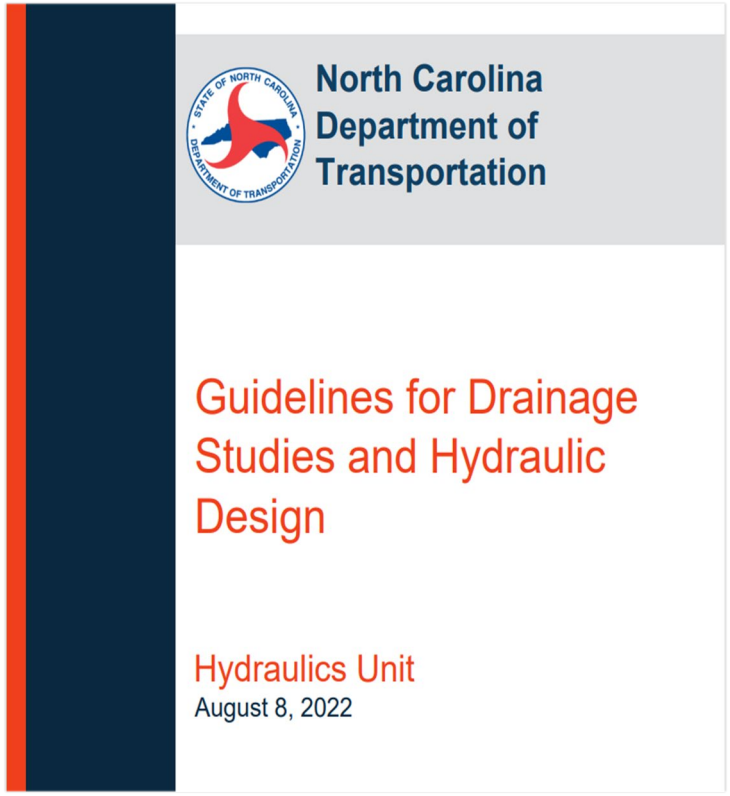
Roadway and Pavement Parameters	Environmental Factors	Driver Factors	Vehicle Factors
• Surface type • Rut depth • Permeability of pavement surface • Pavement micro- and macro-textures • Cross-slope (to include locations of superelevation) • Longitudinal grade (to include sag vertical curves) • Pavement width • Roadway curvature • Depressions	• Rainfall intensity • Rainfall duration • Temperature	• Speed • Accelerating or braking • Steering maneuvers	• Tire tread design • Tire tread wear (tread depth) • Tire pressure • Vehicle type • Vehicle (or axle) weight

What can we control?

Lack of Data

2022 Hydraulics Guidelines

- *Preliminary* Assessment of Typical Sections
- *Final* Assessment Includes…
  - Superelevation
  - Ramps, gore areas, auxiliary lanes
- Updated Pavement Characteristics
- Modern Tire Treads and Inflation
- Mitigation Strategies

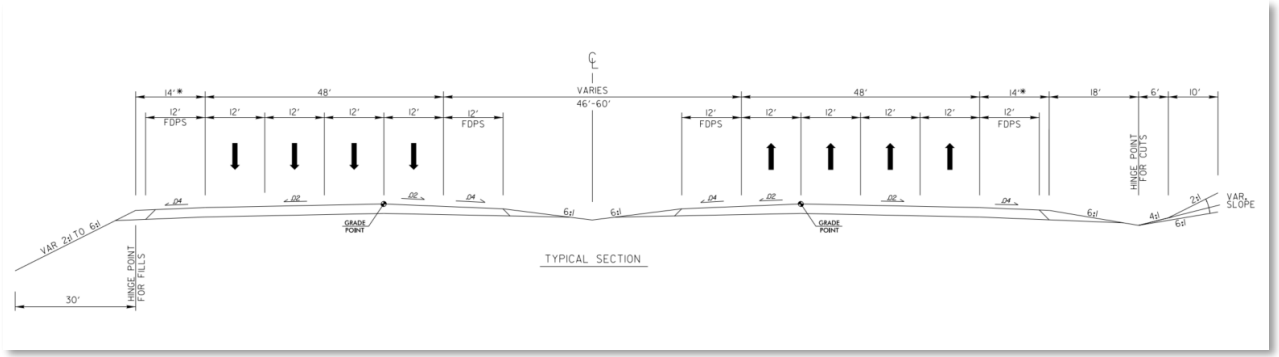


Hydroplaning Policy - Section 4.3.2

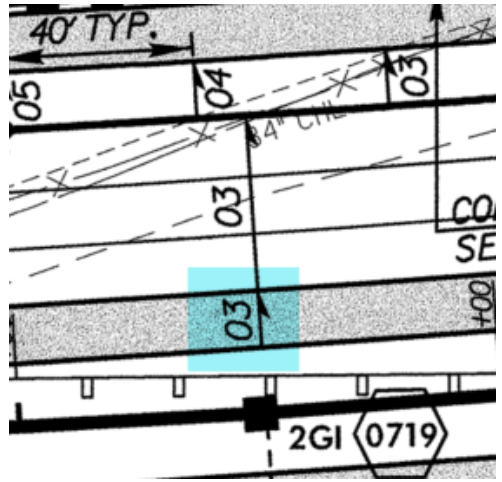
- Required for highways with a **design speed of ~~60~~ 65 mph** or greater and when one or both conditions occur at any point along the project:
- Tangent section with **36 ft or greater** sloped in one direction.
- Superelevated sections of 36 ft or greater, accounting for contributing directly connected impervious areas such as shoulders and gore areas.

Areas of Concern

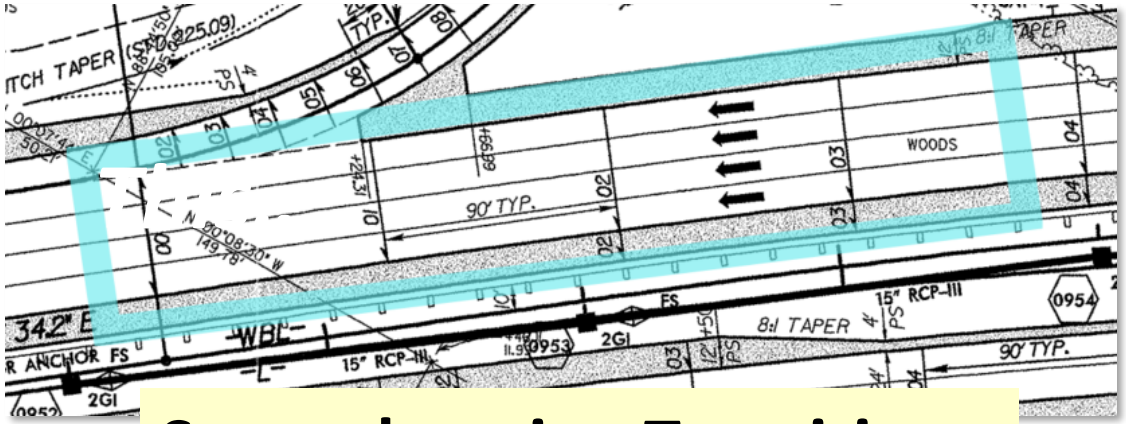
Typical Sections



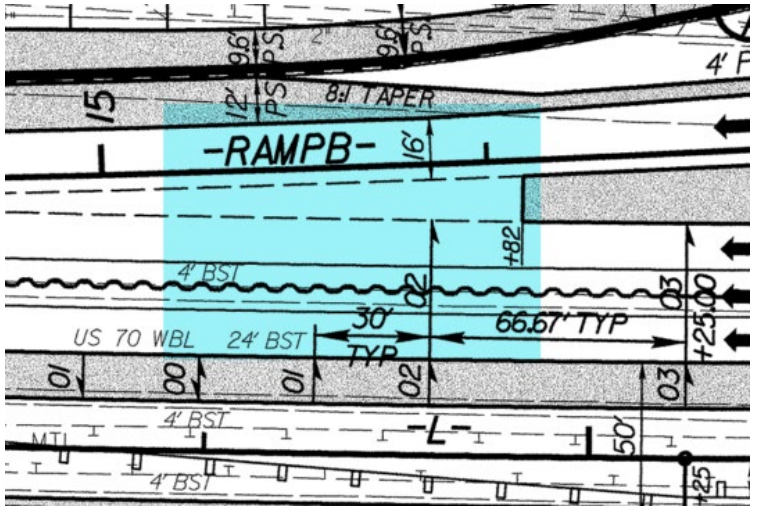
Contributing Shoulders



Superelevation Transitions



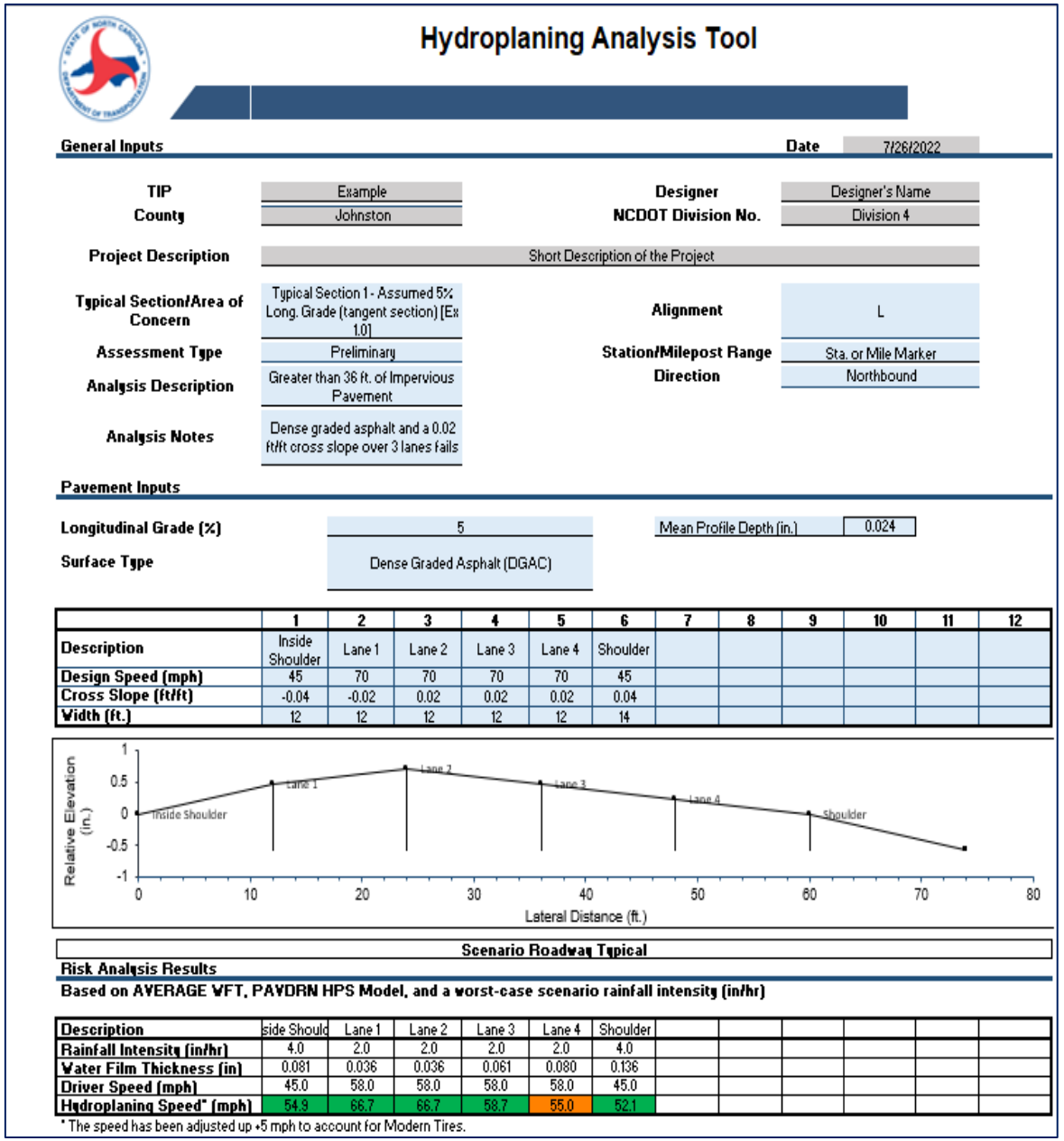
Ramps & Gores



NEW

Hydroplaning Assessment Tool

https://connect.ncdot.gov/resources/hydro/DrainageStudiesGuidelines/NCDOTHydroplaningAssessmentTool.xlsm



Hydroplaning Analysis Tool

General Inputs — **Date** 7/26/2022

TIP	Example	**Designer**	Designer's Name
County	Johnston	**NCDOT Division No.**	Division 4
Project Description	Short Description of the Project		
Typical Section/Area of Concern	Typical Section 1 - Assumed 5% Long. Grade (tangent section) [Ex 1.0]	**Alignment**	L
Assessment Type	Preliminary	**Station/Milepost Range**	Sta. or Mile Marker
Analysis Description	Greater than 36 ft. of Impervious Pavement	**Direction**	Northbound
Analysis Notes	Dense graded asphalt and a 0.02 ft/ft cross slope over 3 lanes fails		

Pavement Inputs

Longitudinal Grade (%)	5	Mean Profile Depth (in.)	0.024
Surface Type	Dense Graded Asphalt (DGAC)		

	1	2	3	4	5	6	7	8	9	10	11	12
Description	Inside Shoulder	Lane 1	Lane 2	Lane 3	Lane 4	Shoulder						
Design Speed (mph)	45	70	70	70	70	45						
Cross Slope (ft/ft)	-0.04	-0.02	0.02	0.02	0.02	0.04						
Width (ft.)	12	12	12	12	12	14						

Scenario Roadway Typical

Risk Analysis Results

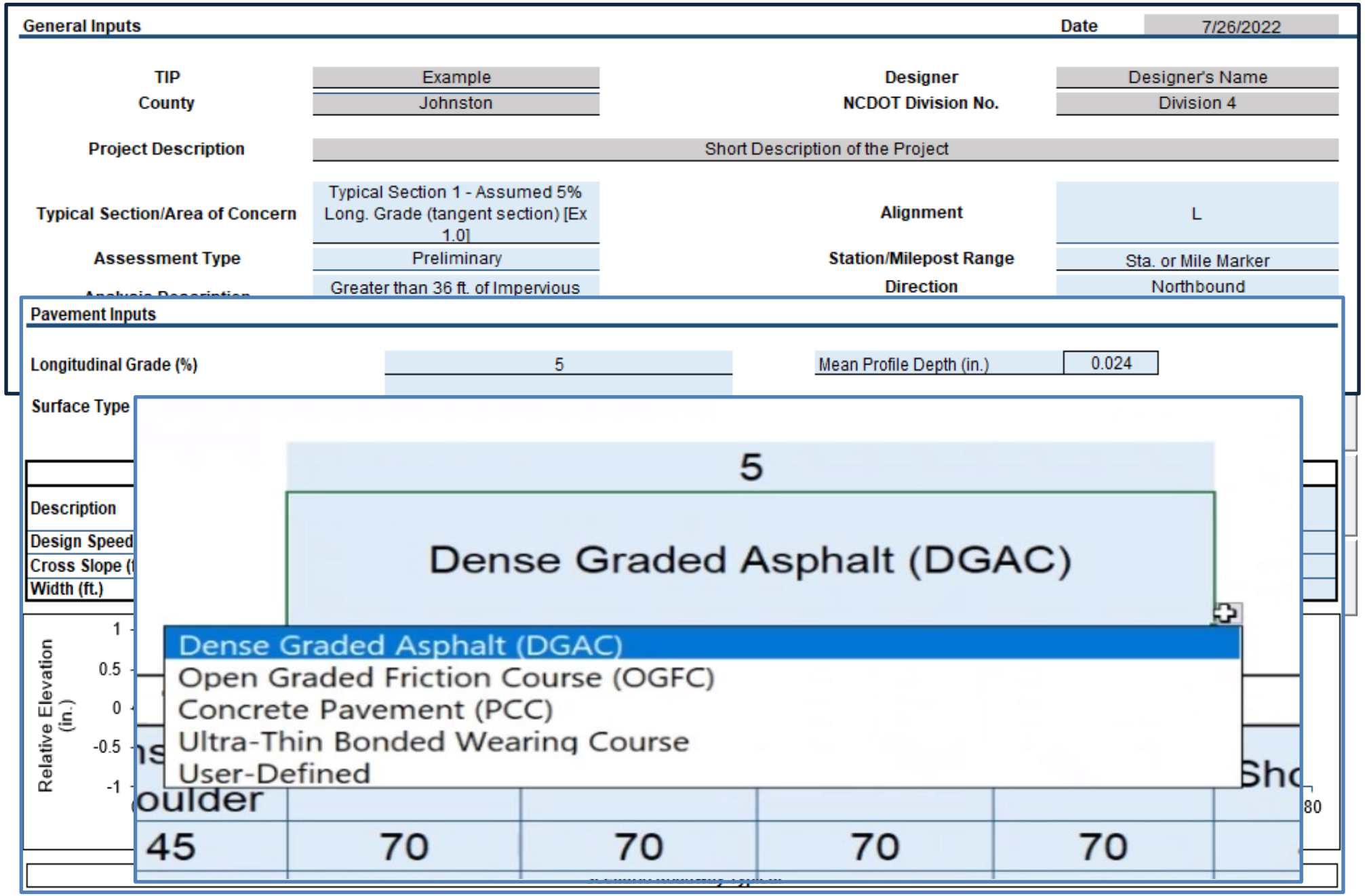
Based on AVERAGE WFT, PAVDRN HPS Model, and a worst-case scenario rainfall intensity (in/hr)

	side Should	Lane 1	Lane 2	Lane 3	Lane 4	Shoulder						
Rainfall Intensity (in/hr)	4.0	2.0	2.0	2.0	2.0	4.0						
Water Film Thickness (in)	0.081	0.036	0.036	0.061	0.080	0.136						
Driver Speed (mph)	45.0	58.0	58.0	58.0	58.0	45.0						
Hydroplaning Speed* (mph)	54.9	66.7	66.7	58.7	55.0	52.1						

* The speed has been adjusted up +5 mph to account for Modern Tires.

Inputs

- General
- Pavement
- Roadway



Scenario Results

Risk Analysis Results

Based on AVERAGE WFT, PAVDRN H

Description	Sic
Rainfall Intensity (in/hr)	
Water Film Thickness (in)	
Driver Speed (mph)	
Hydroplaning Speed* (mph)	

* The speed has been adjusted up +5 m

Possible Hydroplane Conditions

High

High : *HPS is ≥ 4 mph Below the Pre*

Low: *HPS is ≥ 2 mph Below The Pr*
Mitigation methods needed and pro
driver responsibility.

None: *HPS is greater than Predicte*

Risk Analysis Results

(Based on AVERAGE WFT and PAVDRN HPS Models)

Predicted Water Film Thickness (in.)

Plane Number	1	2	3	4	5	6	7	8	9	10	11	12
Intensity (in/hr)	side Shoulde	Lane 1	Lane 2	Lane 3	Lane 4	Shoulder						
0.1	-0.012	-0.014	-0.014	-0.009	-0.005	-0.004						
0.25	-0.002	-0.006	-0.006	0.002	0.009	0.010						
0.5	0.009	0.003	0.003	0.015	0.024	0.027						
1	0.025	0.016	0.016	0.034	0.047	0.051						
2	0.048	0.036	0.036	0.061	0.080	0.086						
3	0.066	0.051	0.051	0.082	0.106	0.113						
4	0.081	0.064	0.064	0.100	0.128	0.136						

Predicted Driver Speed (mph)

Plane Number	1	2	3	4	5	6	7	8	9	10	11	12
Intensity (in/hr)	side Shoulde	Lane 1	Lane 2	Lane 3	Lane 4	Shoulder						
0.1	45.0	70.0	70.0	70.0	70.0	45.0						
0.25	45.0	70.0	70.0	70.0	70.0	45.0						
0.5	45.0	64.0	64.0	64.0	64.0	45.0						
1	45.0	62.0	62.0	62.0	62.0	45.0						
2	45.0	58.0	58.0	58.0	58.0	45.0						
3	45.0	45.0	45.0	45.0	45.0	45.0						
4	45.0	45.0	45.0	45.0	45.0	45.0						

Predicted Hydroplaning Speed (mph)

"These speeds are increased by 5MPH to account for Gunaratne research."

Plane Number	1	2	3	4	5	6	7	8	9	10	11	12
Intensity (in/hr)	side Shoulde	Lane 1	Lane 2	Lane 3	Lane 4	Shoulder						
0.1	999.0	999.0	999.0	999.0	999.0	999.0						
0.25	999.0	999.0	999.0	132.5	94.2	89.9						
0.5	93.9	122.5	122.5	82.1	73.1	71.3						
1	72.9	80.6	80.6	67.6	62.4	61.3						
2	62.3	66.7	66.7	58.7	55.0	54.2						
3	57.7	61.3	61.3	54.7	52.6	52.5						
4	54.9	58.1	58.1	52.8	52.2	52.1						

Superelevation Transitions

Typical Section/Area of Concern	Rollover Transition [Ex 3.0]			
Assessment Type	Final			
Analysis Description	Superelevation Transition			
Superelevation Transition	# of lanes	3	Factor	1.5

Fails with Dense Graded Asphalt

Risk Analysis Results

Based on AVERAGE WFT, PAVDRN HPS Model, and a worst-case scenario rainfall intensity (in/hr)

Max WFT Condition within the SE Rollover	
Rainfall Intensity (in/hr)	2.0
Water Film Thickness (in)	0.106
Driver Speed (mph)	58.0
Hydroplaning Speed* (mph)	52.6

* The speed has been adjusted up +5 mph to account for Modern Tires.

Pavem

Longitu

Surface

Descrip

Design Speed (mph)	45	70	70	70	70	45						
Cross Slope (ft/ft)	-0.04	-0.02	0.02	0.02	0.02	0.04						
Width (ft.)	12	12	12	12	12	14						

Hydraulics Designer: Designer's Name
Reviewer:
Date: 7/26/2022
Project TIP #: Example

Final Hydroplaning Assessment

Area of Concern	Analysis Description	Alignment	Station	Direction	Lane	Design Speed (mph)	Rainfall Intensity (I, in/hr)	Long. Slope (%)	Cross Slope (ft/ft)	Pavement Width (ft)	Pavement Surface Material	Hydroplaning Average WFT (in)	PAVDRN Hydroplaning Speed (mph)	Predicted Driver Speed (mph)	Analysis Notes	User-Defined Pavement Notes
Typical Section 1 - Max. Long Grade (tangent section) [Ex 2.0]	Greater than 36 ft. of Impervious Pavement	L	Sta. or Mile Marker	Northbound	Lane 4	70.0	2.0	3.3	0.02	36.0	DGAC	0.07	56.1	58.0	0.02 ft/ft cross slope on the exterior produces more potential for hydroplaning	
Typical Section 1 - Max. Long Grade (tangent section) [Ex 2.1]	Mitigation	L	Sta. or Mile Marker	Northbound	Lane 4	70.0	2.0	3.3	0.03	36.0	DGAC	0.07	57.6	58.0	No Hydroplaning potential w/ 0.03 ft/ft Exterior Lane cross slope	
Typical Section 1 - Max. Long Grade (tangent section) [Ex 2.2]	Mitigation	L	Sta. or Mile Marker	Northbound	Lane 4	70.0	2.0	3.3	0.03	36.0	PCC	0.06	60.1	58.0	Concrete Pavement (PCC) shows no potential for Hydroplaning	
Typical Section 1 - Max. Long Grade (tangent section) [Ex 2.3]	Mitigation	L	Sta. or Mile Marker	Northbound	Lane 4	70.0	2.0	3.3	0.03	36.0	UTBWC	0.05	60.9	58.0	Ultra-Thin Bonded Wearing Course Surface shows no potential for Hydroplaning	
Typical Section 1 - Max. Long Grade (tangent section) [Ex 2.4]	Mitigation	L	Sta. or Mile Marker	Northbound	Lane 4	70.0	2.0	3.3	0.03	36.0	OGFC	0.04	63.8	58.0	Open Graded Friction Course Surface shows no potential for Hydroplaning	
Rollover Transition [Ex 3.0]	Superelevation Transition	L	Sta. or Mile Marker	Northbound	Lane 4	70.0	2.0	2.5	0.02	36.0	DGAC	0.11	52.6	58.0	Fails with Dense Graded Asphalt (DGAC)	
Rollover Transition [Ex 3.1]	Superelevation Mitigation	L	Sta. or Mile Marker	Northbound	Lane 4	70.0	2.0	2.5	0.02	36.0	PCC	0.09	54.6	58.0	Fails with Concrete Pavement (PCC)	
Rollover Transition [Ex 3.2]	Superelevation Mitigation	L	Sta. or Mile Marker	Northbound	Lane 4	70.0	2.0	2.5	0.02	36.0	UTBWC	0.09	55.5	58.0	Shows a high potential for hydroplaning conditions	
Rollover Transition [Ex 3.3]	Superelevation Mitigation	L	Sta. or Mile Marker	Northbound	Lane 4	70.0	2.0	2.5	0.02	36.0	OGFC	0.07	60.3	58.0	Open Graded Friction Course Surface Passes	
Initial Uniform Cross-slope After Rollover Transition [Ex 4.0]	Greater than 36 ft. of Impervious Pavement	L	Sta. or Mile Marker	Northbound	Lane 1	70.0	2.0	2.5	-0.02	24.0	DGAC	0.09	54.2	58.0	Fails when using Dense Graded Asphalt (DGAC)	
Initial Uniform Cross-slope After Rollover Transition [Ex 4.1]	Mitigation	L	Sta. or Mile Marker	Northbound	Lane 1	70.0	2.0	2.5	-0.02	24.0	PCC	0.07	56.1	58.0	Concrete Pavement (PCC) Shows more potential for hydroplaning conditions	
Initial Uniform Cross-slope After Rollover Transition [Ex 4.2]	Mitigation	L	Sta. or Mile Marker	Northbound	Lane 1	70.0	2.0	2.5	-0.02	24.0	UTBWC	0.07	56.7	58.0	Ultra-Thin Bonded Wearing Course Shows low potential for hydroplaning conditions	
Initial Uniform Cross-slope After Rollover Transition [Ex 4.3]	Mitigation	L	Sta. or Mile Marker	Northbound	Lane 1	70.0	2.0	2.5	-0.02	24.0	OGFC	0.06	60.8	58.0	Open Graded Friction Course Surface shows no potential for Hydroplaning	

Mitigation Selection Guide

Hydroplaning Mitigation Selection Guide

NEW

Select mitigation topic for more information -->

	PAVEMENT MITIGATION						GEOMETRIC CHANGES							SIGNAGE		
	Pavement Overlays			Surface Treatments			Modifying Roadway Typical		Intercepting Pavement Runoff		Managing Roadway Geometry			Signage Strategies		
	Open Graded Friction Course[1]	Ultra Thin Bonded Wearing Course	High Surface Friction Treatment[3]	Diamond Grooving[4]	Diamond Grinding	Shotblasting	Slope Shoulder Away	Moving the Crown Point	Gore Valley Gutters	Slotted or Trench Drain	Flatten Longitudinal Slope	Increase Cross Slopes	Adjust SE Transitions	Static Signs	Static Signs with Emphasis	Dynamic Signs
Applicable Project Type (New Pavement[2], Widening, Maintenance)	All	All	Widening or Maintenance	Widening or Maintenance	All	Maintenance	All	All	Widening or Maintenance	Widening or Maintenance	New Pavement	All	All	All	All	New Pavement or Widenings
Spatial Exent[5]	Global	Global	Local	Both	Both	Both	Global	Global	Local	Local	Global	Global	Both	Both	Both	Both
Construction Costs	$$	$$	$$$	$$$	$$$	$$	$	$	$	$$	$	$	$$	$	$	$$
Maintenance Effort	medium	medium	high	medium	medium	high	low	low	low	medium	low	low	low	low	low	medium
Service Life	8-10 years	9-11 years	8-12 years	15 years	15 years	2-5 years	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10 years	10 years	15-20 years
Suitable for the Following Existing Pavement Surfaces[6]	DGAC Concrete UTBWC	DGAC Concrete	DGAC Concrete	Concrete DGAC[4]	Concrete	DGAC Concrete OGFC	All Pavement Surfaces	All Pavement Surfaces	All Pavement Surfaces	All Pavement Surfaces	All Pavement Surfaces	All Pavement Surfaces	All Pavement Surfaces	Applicable for all pavement surfaces including temporary construction conditions.[7]		
Hydroplaning Benefit ★ to ★★★	★★★	★★½	★★★	★★★ *(transverse grooving)*	★½	★★	★	★★½	★★★	★★★	★	★½	★★★	Effectiveness is unknown at this time. Further research is needed.		

Notes:

General Note: Mitigation strategies can be combined for greater hydroplaning potential reduction. Example: geometry, pavement type, or surface treatment.

(1) Open Graded Friction Course is not recommended for regions prone to frequent ice/snow events or longitudinal slopes steeper than 5%. (Divisions 11, 13 and 14)

(2) New pavement consists of new and/or reconstructed pavement.

(3) High Friction Surface Treatment is only applicable for DGAC or Concrete pavement and treatment is vulnerable to maintenance issues in Divisions where sand is used in ice/snow conditions.

(4) Diamond grooving is typically reserved for bridge decks (see NCDOT Specification 420). DGAC grooving can be used for short segments, typically curves, as a spot treatment.

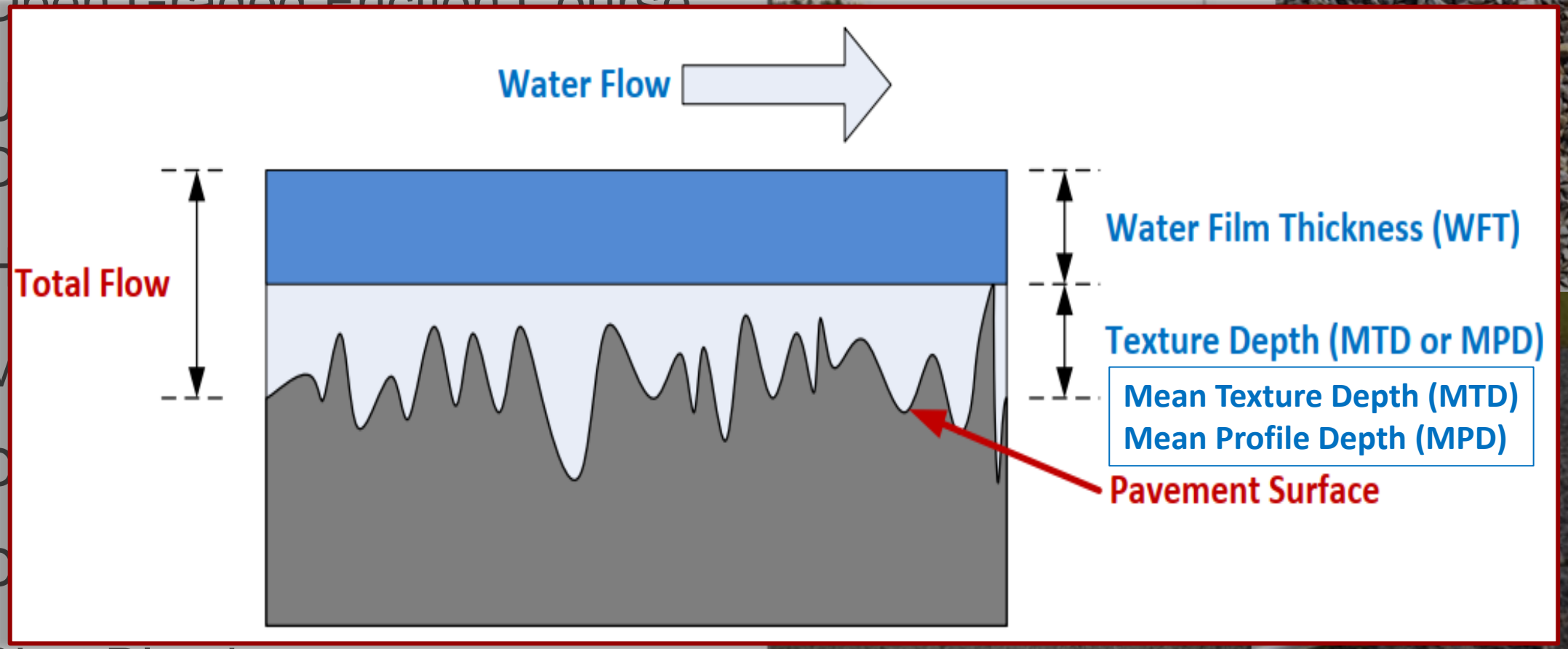
(5) Global treatments are applicable to the entire project limits; Local treatments are considered 'spot treatments' and used in smaller applications.

(6) If hydroplaning potential occurs in OGFC areas, consider geometric solutions.

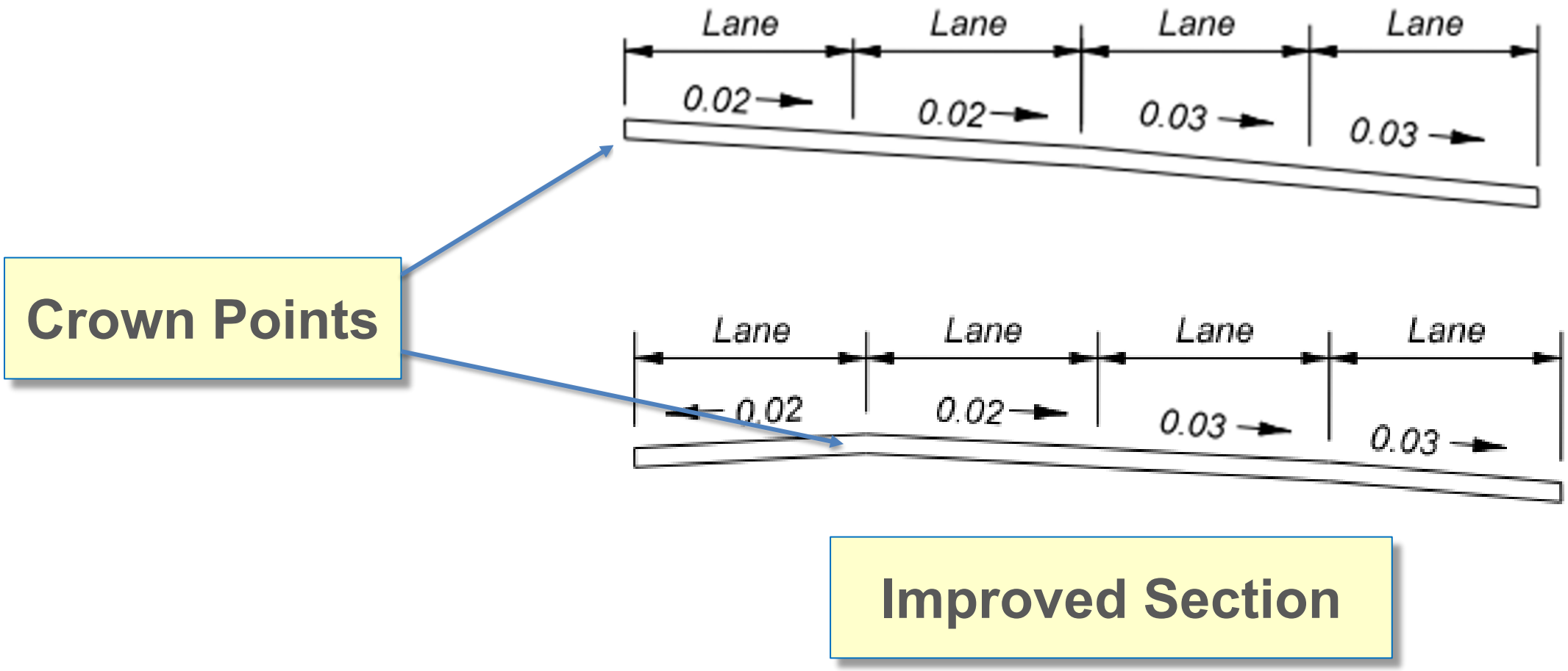
(7) Variable message boards can be used during construction to warn of temporary hydroplaning concerns.

Pavement Surface Improvements

- Open Graded Friction Course
- U
  C
- T
- M
- D
- D
- Shot Blasting

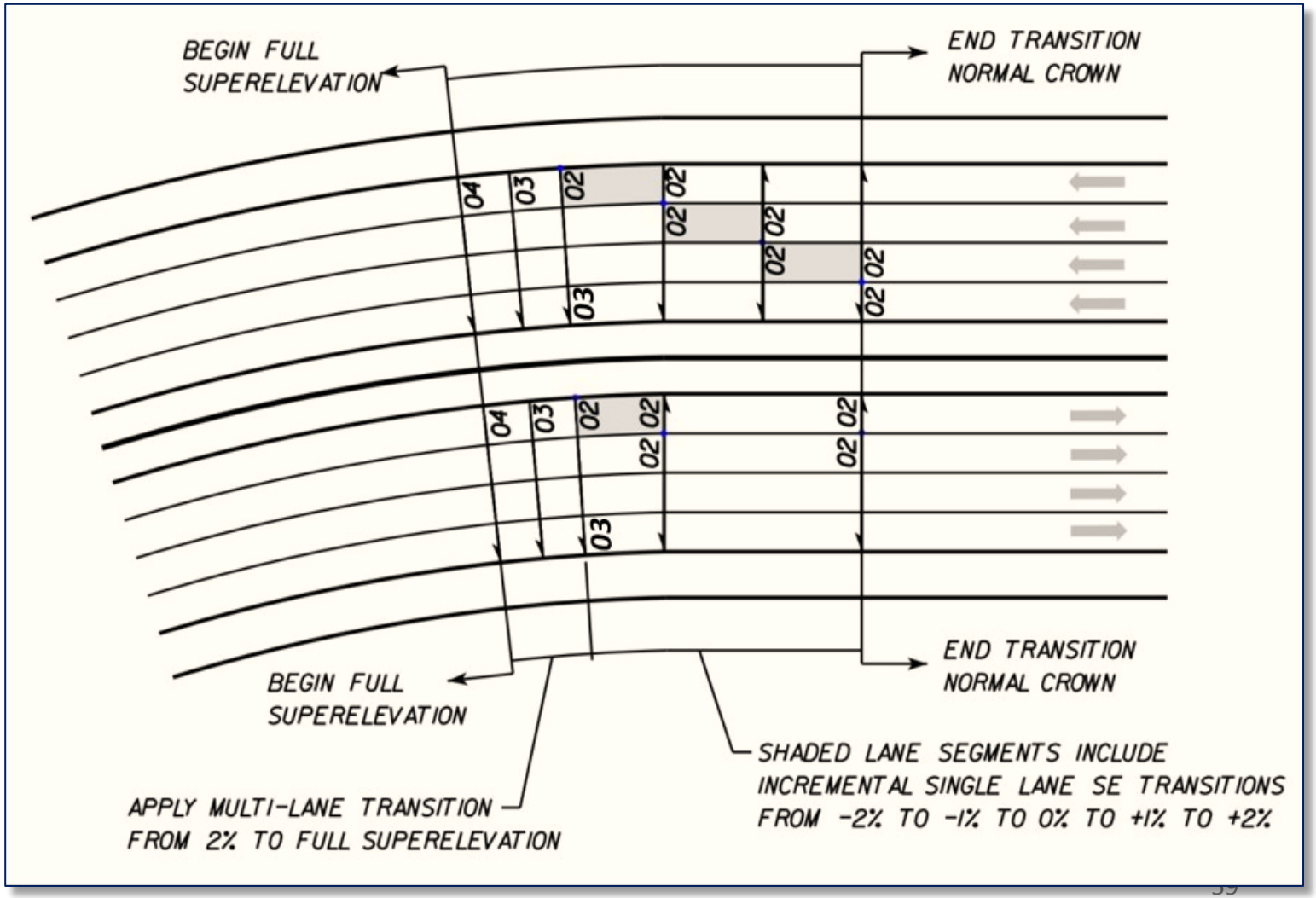


Moving the Crown Point



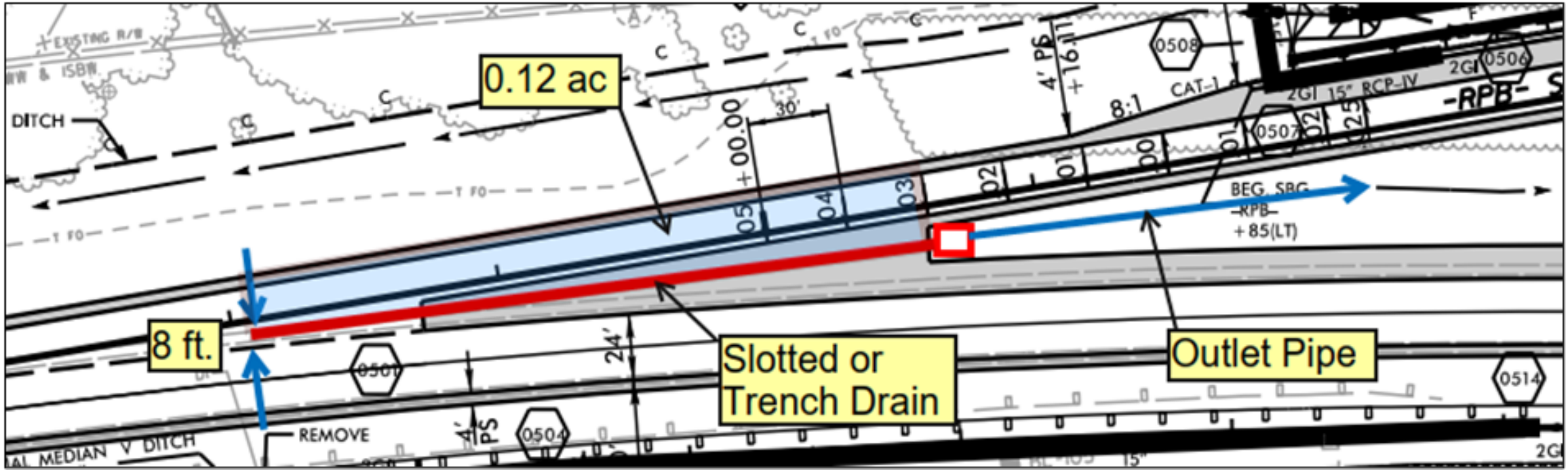
Adjusting Superelevation Transitions

- Transition One Lane at a Time
- Results in Longer Transitions
- Not always feasible



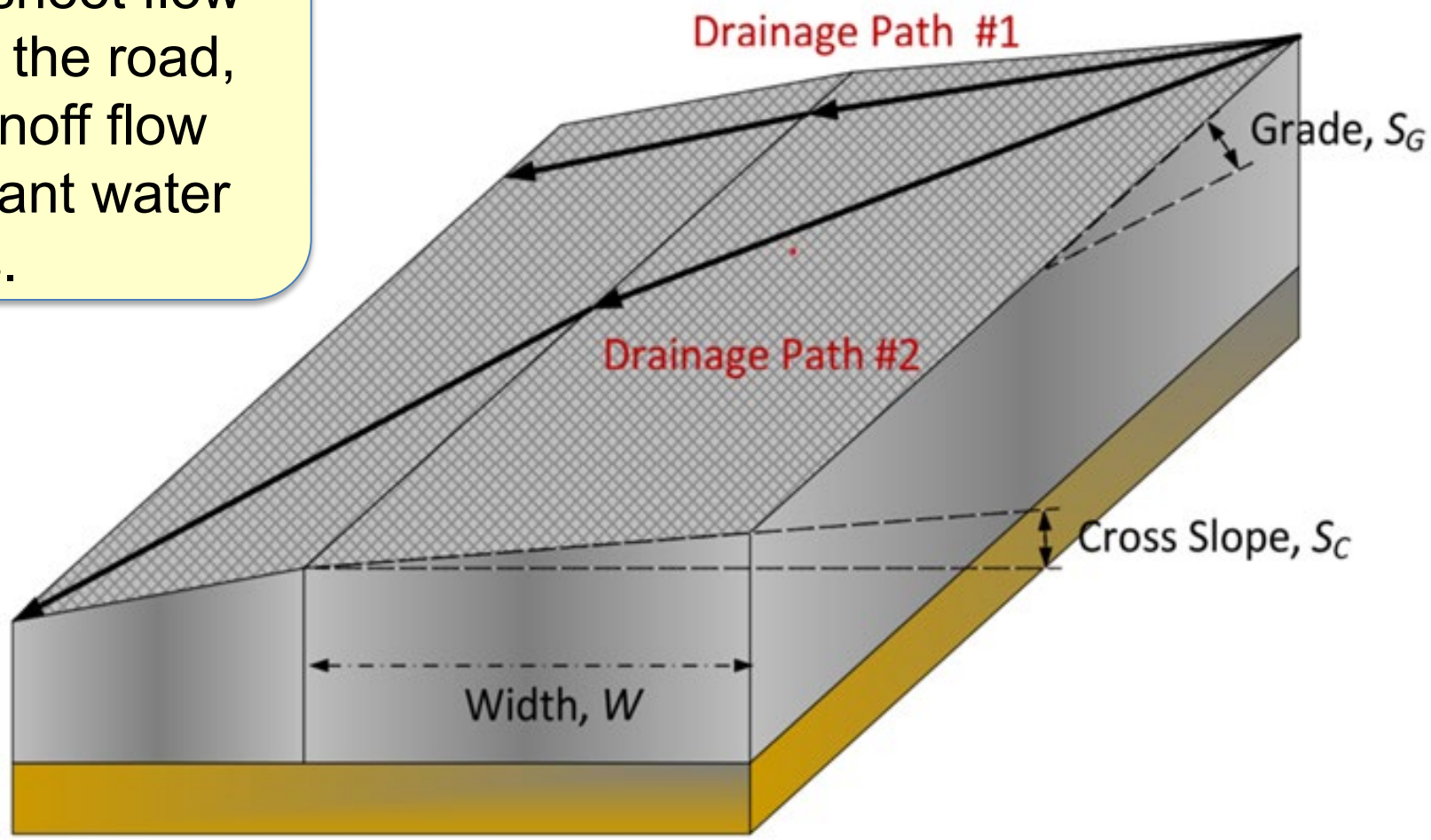
Intercepting Pavement Runoff

- Paved gore gutters - where gore slope is favorable
- Slotted Drains / Trench Drains - up to about 0.3% adverse gore slope



Flatter Longitudinal Slopes

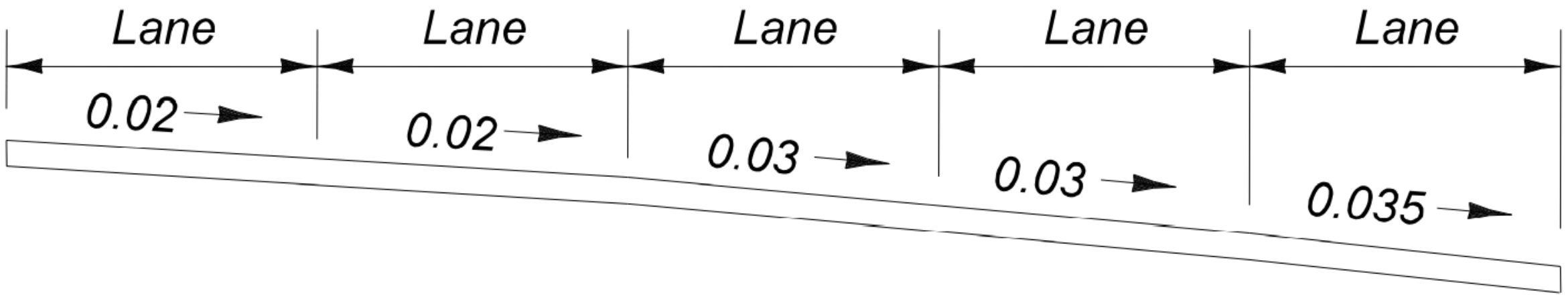
Flatter grades makes sheet flow more perpendicular to the road, which reduces the runoff flow path length and resultant water film thickness.



Increase Cross Slopes

Increase the cross-slope steepness to provide faster and more efficient removal of water from the pavement.

AASHTO recommends breaking the cross slope every two lanes and prohibits cross slopes greater than 3.5% on high-speed facilities.



Static and Active Warning Signs

- Static Signs
- Static Signs with Emphasis
- Dynamic Signs

What's Next for Hydroplaning?

Hydroplaning Tool 2.0

- Improved automation
- Designer flexibility

Future Research

- NC Driver Behavior Study
- MPD Data from Pavement Studies

LUNCH & LEARN COMING SOON!


Thank You

ANY QUESTIONS?