American Association of State Highway and Transportation Officials

AASHTO

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Center for Environmental Excellence

U.S. Department of Transportation

Federal Highway Administration

Water Quality Post-Construction BMPs and Project Delivery Web Forum

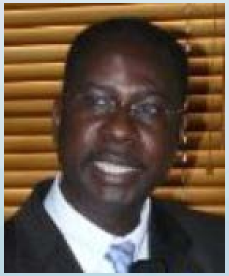
CEE by AASHTO Stormwater Community of Practice

December 8, 2015

AASHTO and FHWA

- **GABRIEL WEIL**, American Association of State Highway and Transportation Officials

- **SUSAN JONES**, P.E., Federal Highway Administration



- **MARCEL TCHAOU**, P.E., Federal Highway Administration

Web Forum Topics

- Web Forum 1: Water Quality affecting the project delivery process - post-construction treatment BMPs, Low Impact Development. *Presenting Now.*

- Web Forum 2: Water Quality affecting DOT construction projects - lessons learned and process improvements on temporary construction BMP practices and administrative processes. *Tentative January 28, 2016, 11:00 a.m. Eastern*

- Web Forum 3: DOT Stormwater Program Organizational Structure - how best to manage Stormwater Requirements. *Tentative March 17, 2016, 11:00 a.m. Eastern*

Community of Practice Presenters

- **ANDREW MCDANIEL**, P.E.,
  Highway Stormwater Program Manager
  North Carolina Department of Transportation

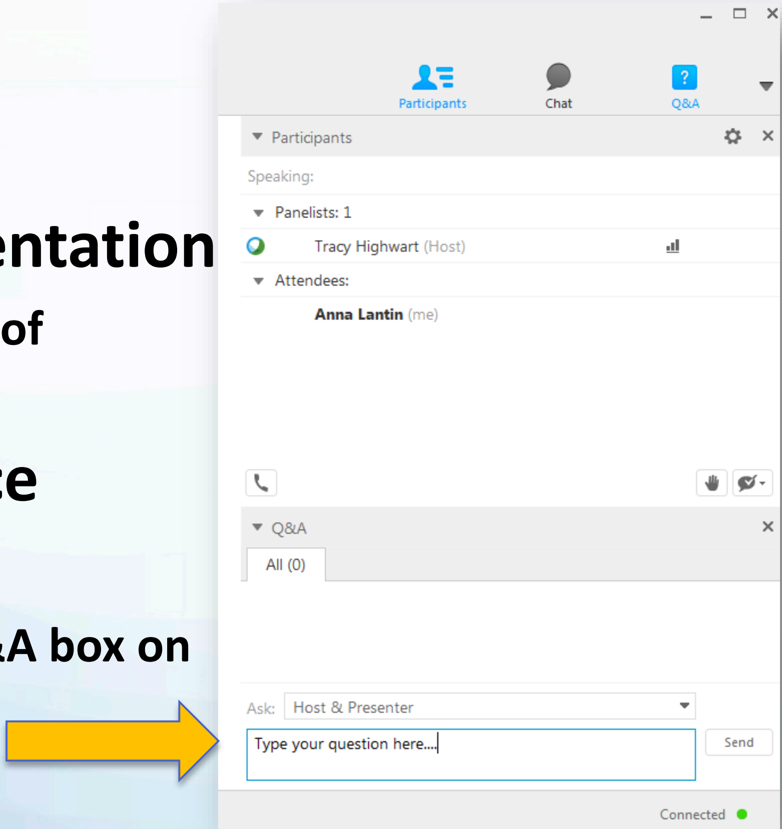
- **KENNETH STONE**
  Environmental Manager
  Washington State Department of Transportation

- **SCOTT MCGOWEN**, P.E.
  Chief Environmental Engineer, Caltrans
  Chair AASHTO Stormwater Work Group

- **ANNA LANTIN, P.E.**
  Facilitator, AASHTO Stormwater Community of Practice
  Michael Baker International

Community of Practice Forum Overview

- **Post-Construction BMPs and the Project Delivery Process**
  - **Andrew McDaniel, North Carolina Department of Transportation**
- **Emerging BMPs and Issues**
  - **Scott McGowen, California Department of Transportation**
- **Green Infrastructure/LID Implementation**
  - **Ken Stone, Washington State Department of Transportation**
- **Stormwater Community of Practice Forum Collaboration**
  - **Submit your questions by typing in the Q&A box on the webex panel on your screen.**



- **Closing**

Post-Construction BMPs and the Project Delivery Process

ANDREW MCDANIEL, P.E.,

Highway Stormwater Program Manager

North Carolina Department of Transportation

December 8, 2015

Post-Construction BMPs vs. Construction BMPs

Post-construction BMPs:

Construction BMPs:

Post-Construction BMPs

Structural

Non-structural

(minimum measures)

BMP Decision Drivers

- NPDES post-construction requirements
- TMDLs
- Impaired waters/pollutant of concern
- 404/401 certifications
- Local government requirements
- Endangered species
- Coastal zone management act
- Sensitive waters requirements
- NEPA negotiations

BMP Decision Process

BMP Drivers

- NPDES post-construction requirements
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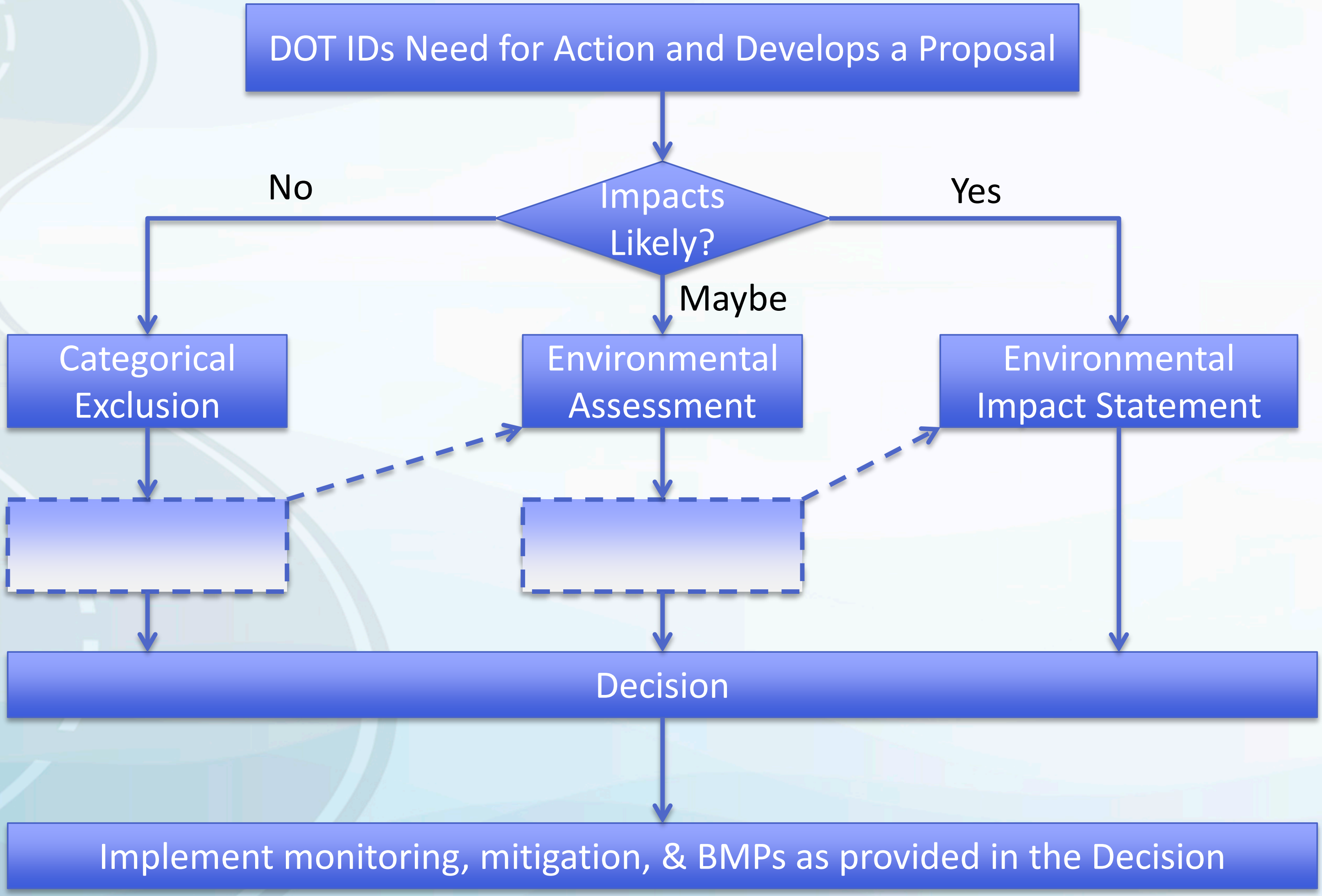
Decision Framework

- NEPA process
- NPDES

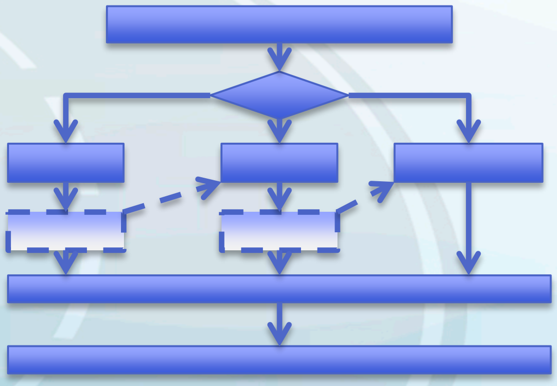
NEPA Refresher

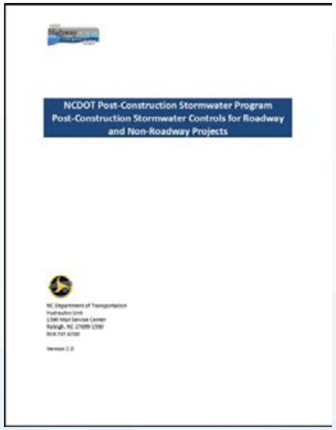


NCDOT's Project Delivery / BMP Decision-Making Process

Integrates:

- NEPA process (BMP drivers) with
- NPDES Post-Construction Stormwater Program





NCDOT Post-Construction Stormwater Program
Post-Construction Stormwater Controls for Roadway and Non-Roadway Projects

Two Models for Post-Construction Stormwater Management

1. Processes with prescriptive stormwater management criteria:
   - treat first 1” of runoff
   - pre/post peak flow or volume matching

2. Processes without prescriptive criteria

NCDOT's Project Delivery Process: Model #2 – No Prescribed Treatment Criteria

Keys To Success:

- Robust BMP decision framework
- Involve regulatory agencies in this framework

NCDOT's NEPA/404 Merger Process

- Signatories: NCDOT, USCOE, FHWA, NCDEQ
- **Concurrence Point #1** – Purpose and Need
- **Concurrence Point #2** – Detailed Study Alternatives
  - #2a – Bridging Decisions
- **Concurrence Point #3** – LEDPA
- **Concurrence Point #4** – Hydraulic Design/Permit Drawings
  - #4a – Avoidance & Minimization
  - #4b – 30% Hydraulic Design
  - #4c – Permit Drawings

Post-construction BMP Decisions

NCDOT's Post-Construction Stormwater Program

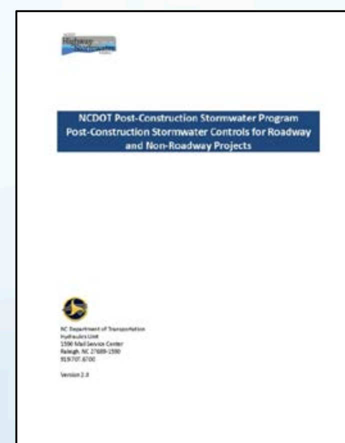
1.0 Introduction – PCSP applies to most all projects

2.0 Stormwater Quality Management for Roadway Projects

3.0 Stormwater Quality Management for Non-roadway Projects

4.0 Documenting Compliance with the PCSP

5.0 Sustaining the PCSP Outcome


NCDOT Post-Construction Stormwater Program
Post-Construction Stormwater Controls for Roadway and Non-Roadway Projects

Lessons Learned

- Positive working relationship with regulatory agencies is a foundational component to success
- Regulatory agencies must trust the BMP decision framework

Lessons Learned Cont'

- BMP decision frameworks without prescriptive criteria can add both flexibility AND complexity to the process
- NCDOT investing in the FHWA SELDM model
  - fills criteria void
  - furthers trust in the process

Lessons Learned Cont’

- TRAINING becomes especially important to successfully implementing a BMP decision process without prescriptive criteria

Thank you!

https://connect.ncdot.gov/resources/hydro

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Emerging BMPs and Issues

What's in the tool box and what's emerging?

SCOTT MCGOWEN, P.E.

Chief Environmental Engineer

California Department of Transportation

December 8, 2015

Emerging Technology For Stormwater (appropriate for Highways)

- Conventional BMPs
  - Detention Devices
  - Infiltration Devices
  - Vegetated Strips and Swales
  - Media Filters
  - Wet Ponds
  - Others
- **Emerging BMPs**
  - **Permeable Friction Course (PFC) Overlay**
  - **Infiltration Modular Systems**
  - **Media Filter Drain**
  - **Compost Amended Slopes**
  - **Enhanced Sweeping**

Treatment BMPs appropriate for Highways

Detention basins or Infiltration basins

Media Filter

Biofilter Strip/Infiltration Trench

Media Filter - Earthen

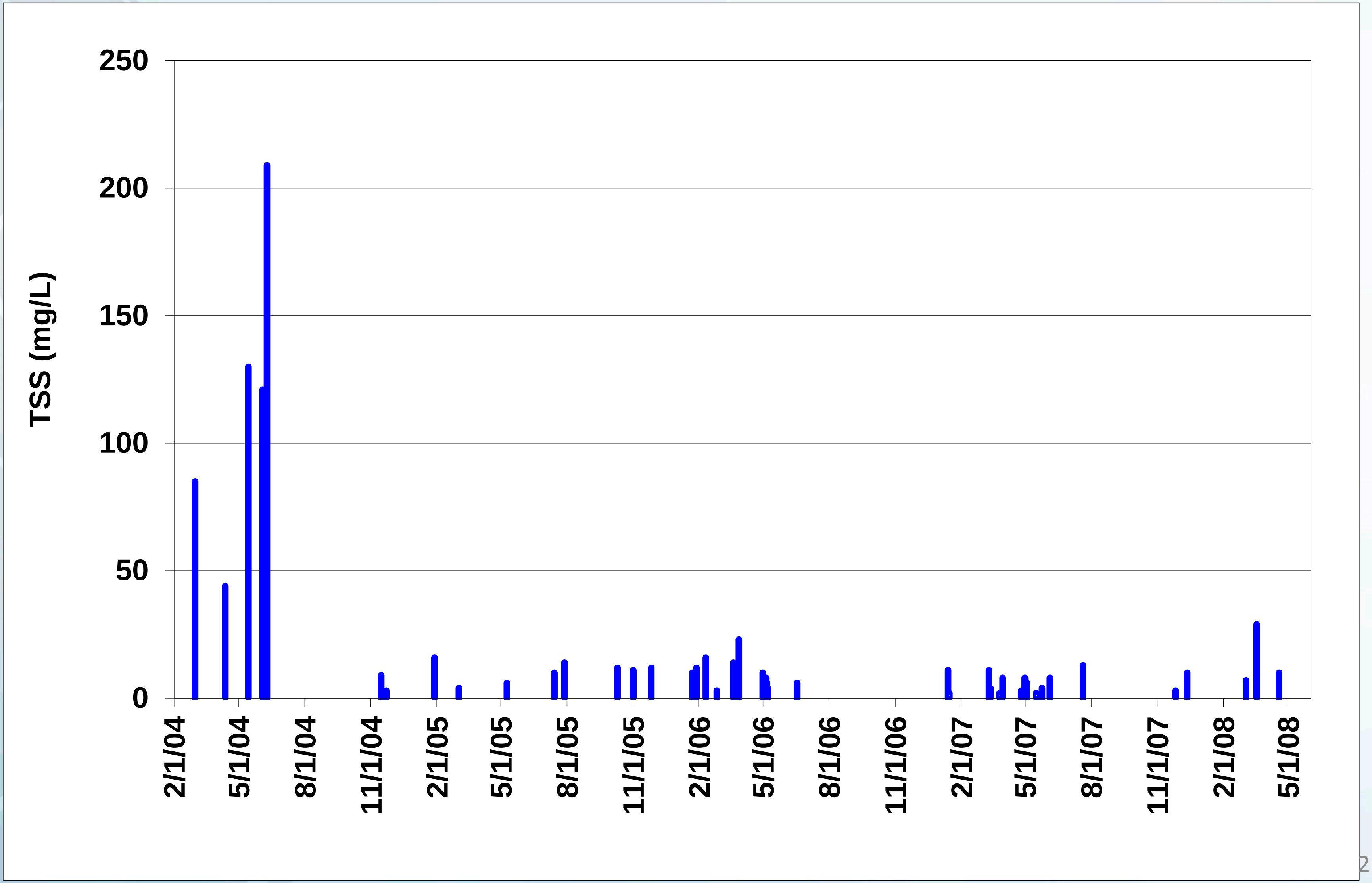
Emerging Technology For Stormwater

- Permeable Friction Course (PFC) Overlay
- Infiltration Modular Systems
- Media Filter Drain
- Compost Amended Slopes
- Enhanced Sweeping
- …others

Permeable Friction Course (PFC)

- Permeable Friction course is a layer of permeable asphalt placed over a conventional roadway section.
- Known Benefits of PFC
  - Hydroplaning resistance
  - Spray reduction
  - Increased visibility
  - Smoother riding surface
  - Noise reduction

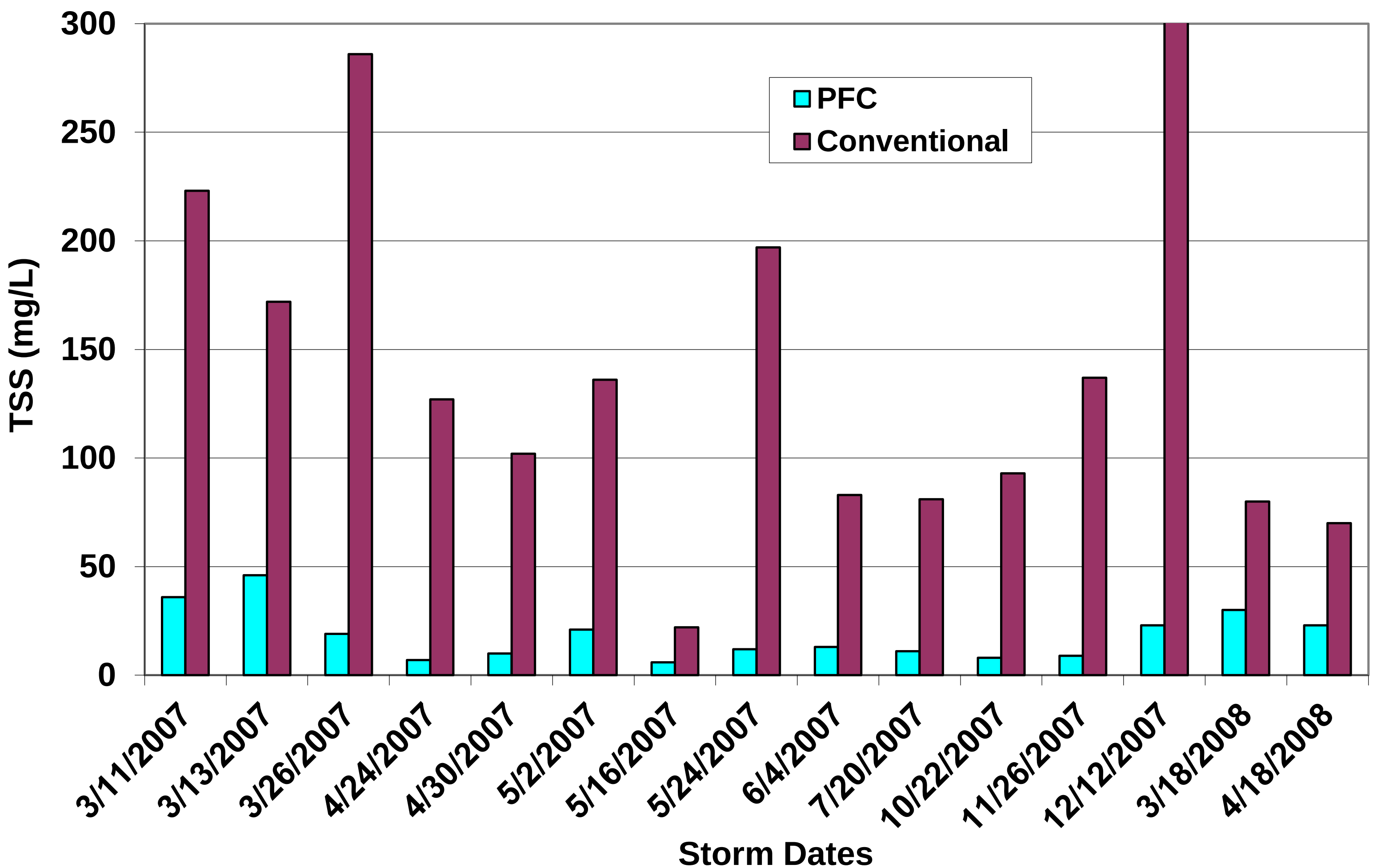
TSS Concentrations vs. Time



Pollutant	HMA 6 storms	PFC 36 storms
Suspended Solids	118	8.4
Copper	26.8	12.8
Lead	12.6	1.5
Zinc	167	32
Total P	0.13	0.08


LAKEWOOD
Samplers

Paired Samples



Infiltration Modular Systems

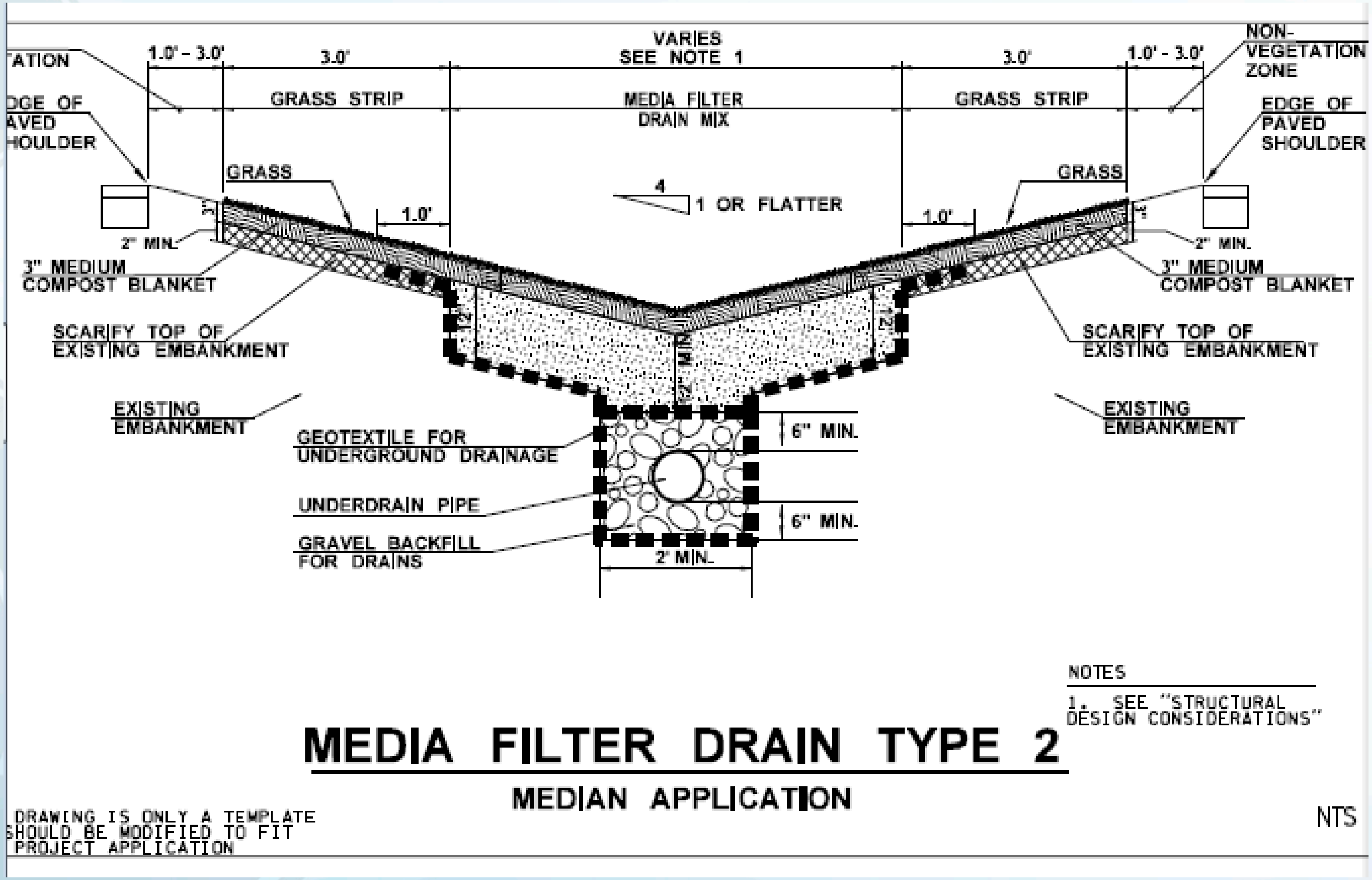
- High void ratio = 97% Void Ratio (Compared to 30% Porous Rock)
- Ease of construction (HDPE)
- Traffic Rated up to HS-25 AASHTO vehicle
- 50 Year Design Life with proper maintenance
- Applications under Landscaped areas or parking lots

Media Filter Drain

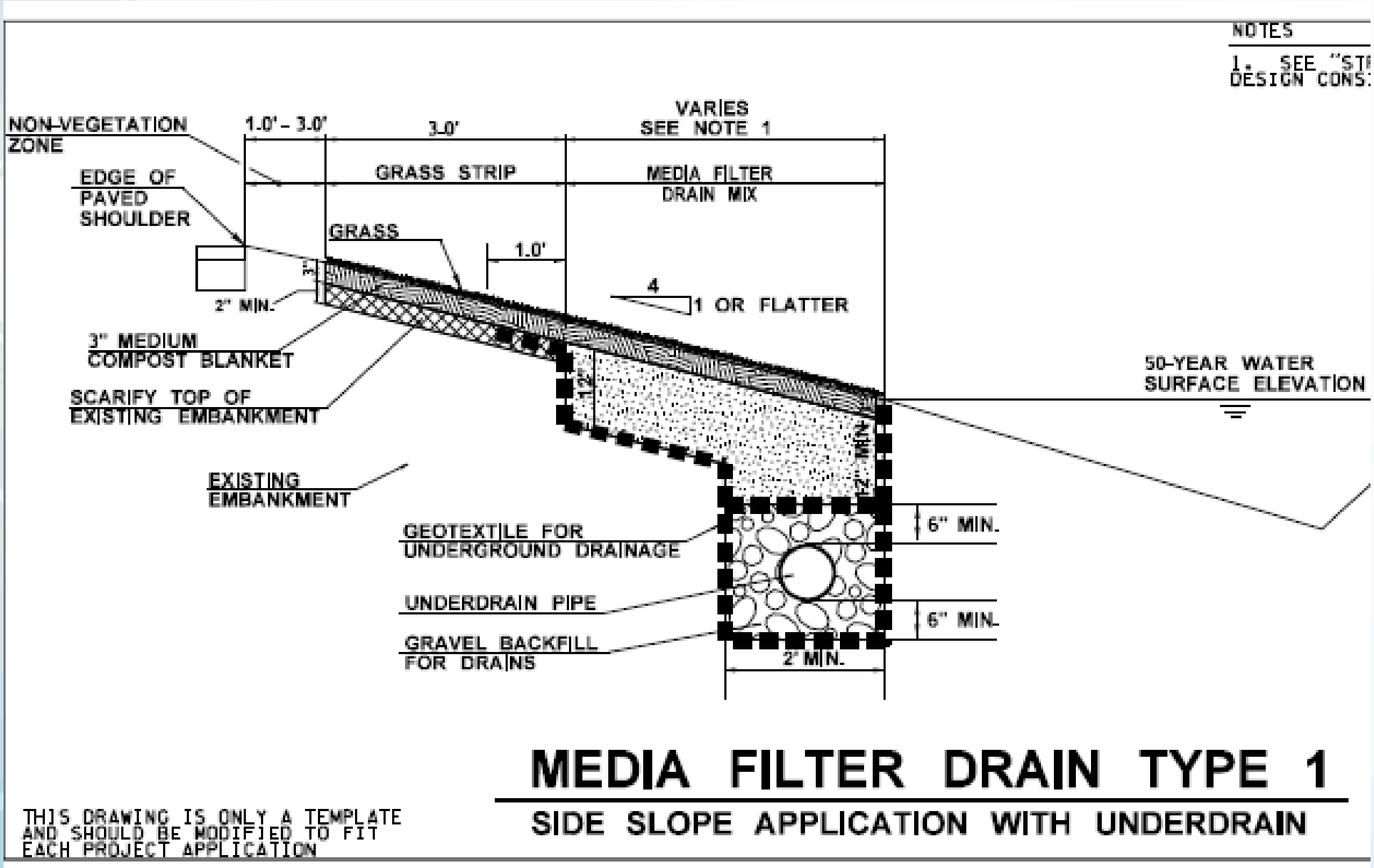
- Developed by Washington DOT
- Field Tested
- Broad Range of Application
- Non-proprietary
- Nearly 10 years of experience

Photos: WSDOT

Media Filter Drain (Cross-Section)



Media Filter Drain



Media Filter Drain Ecology Media Mix

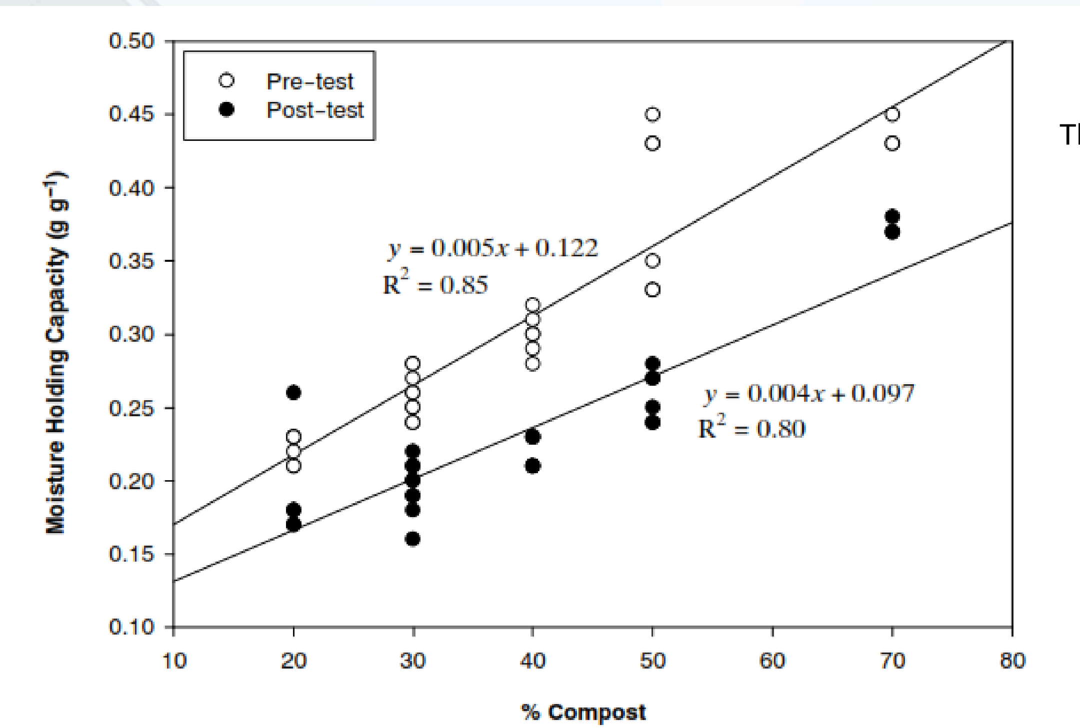
- Composed of:
  - Crushed Rock
  - Dolomite
  - Gypsum
  - Perlite
- Removal Mechanisms
  - Straining
  - Ion exchange
  - Carbonate Precipitation
  - Biofiltration

Performance of Media Filter Drain

Constituent	Influent (median)	Effluent (median)
TSS	100 mg/l	5 mg/l
Dissolved Zinc	120 µg/l	25 µg/l
Dissolved Copper	16 µg/l	7.1 µg/l
Turbidity	78.5 NTU	25 NTU

Compost Amended Slopes

- Increases soil runoff holding capacity and permeability
- Amend 30% compost into 12 inches of soil



Thompson, et al. ASABE 2008

Performance – Compost Slope

Parameter	Untreated Runoff	Compost filter strip treated	% Concentration Reduction	% Load Reduction
	mg/l			
TDS	52.7	55.5	-5	63
T. Phosphorus	0.089	0.26	-192	-2
COD	73.5	49.6	33	76
TSS	81	23	72	90
	ug/l			
Total Copper	28.18	9.14	68	89
Dissolved Copper	7.85	5.77	26	74
Total Lead	12.62	3.54	72	90
Dissolved Lead	0.5	0.05	90	97
Total Zinc	129.70	31.57	76	91
Dissolved Zinc	64.22	20.71	68	89

TDS=Total Dissolved Solids, COD=Chemical Oxygen Demand, TSS=Total Suspended Solids

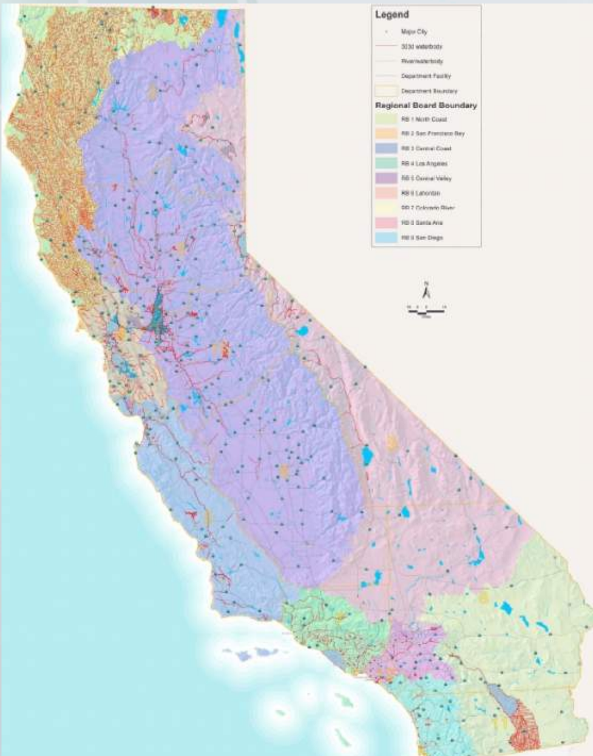
Enhanced Sweeping

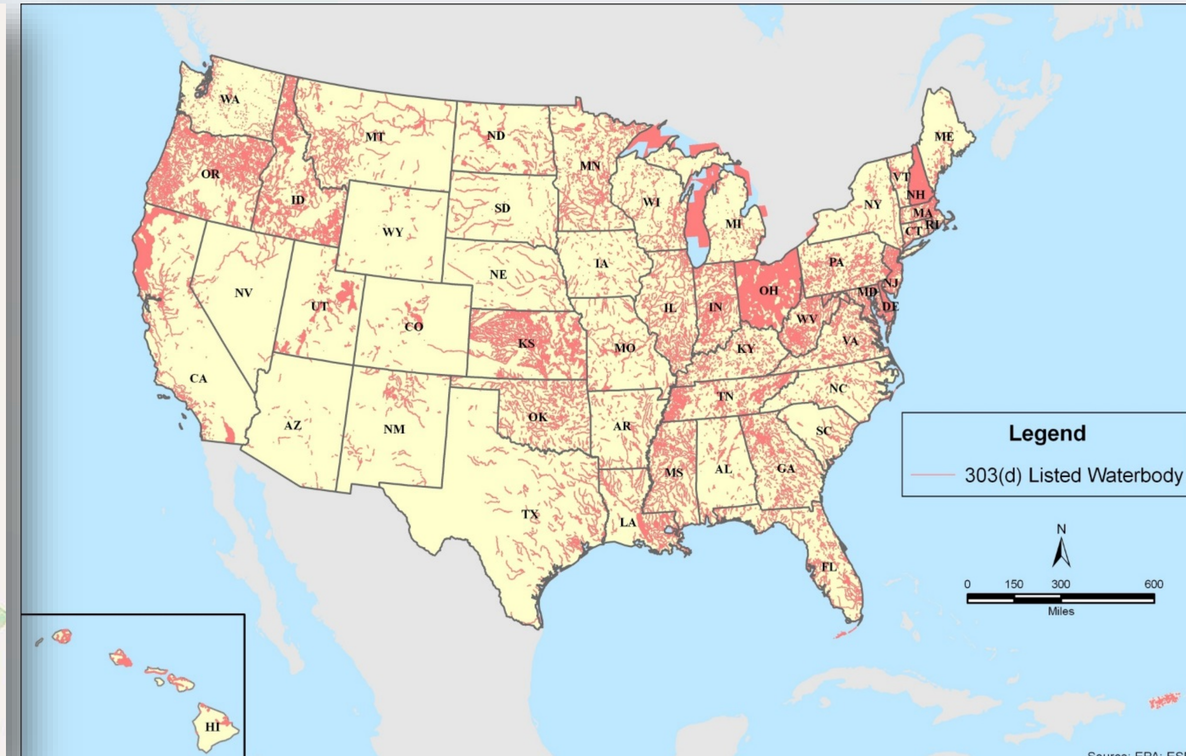
- Originally designed for the Airport Market – remove rubber from runways
- Pressure washer, reclaims rinsate
- Hydrostatically controlled working speeds 0.5 – 6 mph; 11 mph in some instances
- Pressures from 1450 – 29,000 psi @ 37 – 7.5 gpm, respectively
- Leaving pavement matrix & surface extremely clean & virtually dry in a single pass

Advance Storm Cleaning

- What is removed from the highway

Impaired Waters Program
CWA Section 303(d)





- Nationwide Impaired waters is growing
- California currently 1,780 pollutant / waterbody combinations listed
- Emerging BMPs will be needed

Thank You!

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Green Infrastructure/Low Impact Development Implementation

KENNETH STONE

Environmental Manager

Washington State Department of Transportation

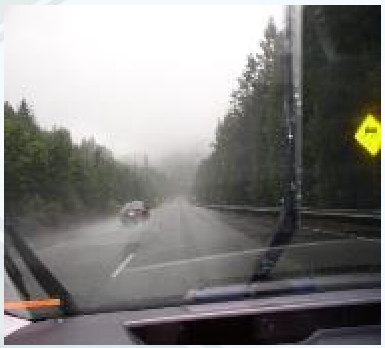
December 8, 2015

Low Impact Development BMPs

In the Highway Environment

Kenneth M. Stone
Environmental Services Office
WA State Department of Transportation

AASHTO Stormwater Community of Practice
Web Forum
December 8, 2015

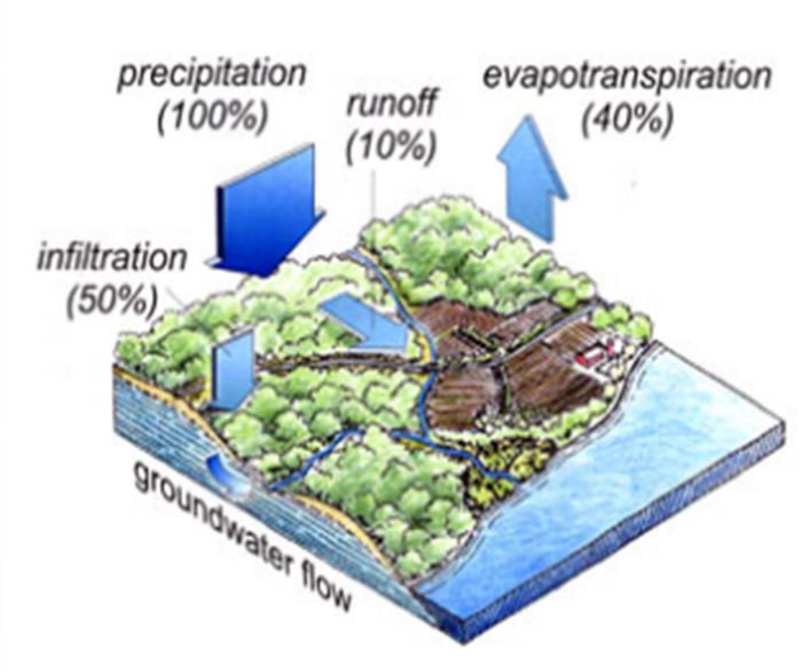







LID as a Concept

"Low Impact Development Best Management Practices (LID BMPs)" means distributed stormwater management practices, integrated into a project design, that emphasize pre-disturbance hydrologic processes of infiltration, filtration, storage, evaporation, and transpiration.



LID Techniques

- Reduce impervious area
- Treat/manage runoff near the source
- Disperse, route through vegetation, infiltrate
- Use pervious pavement

LID

Not LID

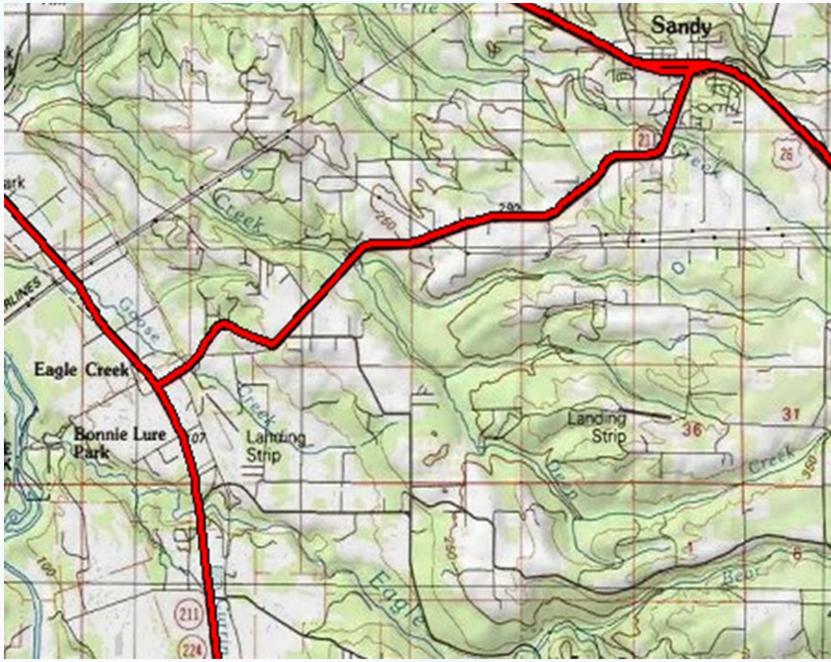
LID in Various Situations

- New Developments: Start fresh, and can incorporate LID into the entire site design

- Existing Development: Already built out, traffic speeds low, LID gets shoehorned in
  - But can reduces stress on existing storm sewers
  - Infiltration can damage properties

The Linear Nature of Highways

- Cross multiple watersheds and jurisdictions
- Most already in place
- Safety dictates design standards, geometrics
- Limited right-of-way with constraining adjacent land uses/features
- High traffic speeds, heavy wear of pavement
- Need to keep water away from road and roadbed



LID vs Highways

Practice	Concerns/Constraints
Minimize impervious surface and runoff	Safety design standards dictate minimum road widths
Treat near the source	Constrained by adjacent land use/features
Promote dispersion, infiltration, vegetation	Roadside areas may not be suitable Roadbed stability issues
Pervious/permeable pavement	Durability concerns (especially with studded tires)
Rain Gardens	Safety hazard on high speed highways; Cumulative high maintenance costs

Appropriate LID Techniques for Highway Stormwater BMPs

Emphasis on pollutant removal processes that involve filtration, biological uptake, and chemical adsorption:

- Infiltration BMPs
  - Infiltration basins and trenches
  - Bioinfiltration swales
- Dispersion BMPs
  - Natural and engineered dispersion areas
- Longitudinal/Media Filtration
  - Vegetated filter strips: as is, compost amended or blanketed
  - Enhanced roadside biofiltration swales
  - Media filter drains
- Permeable pavements

Pros and Cons of LID BMPs

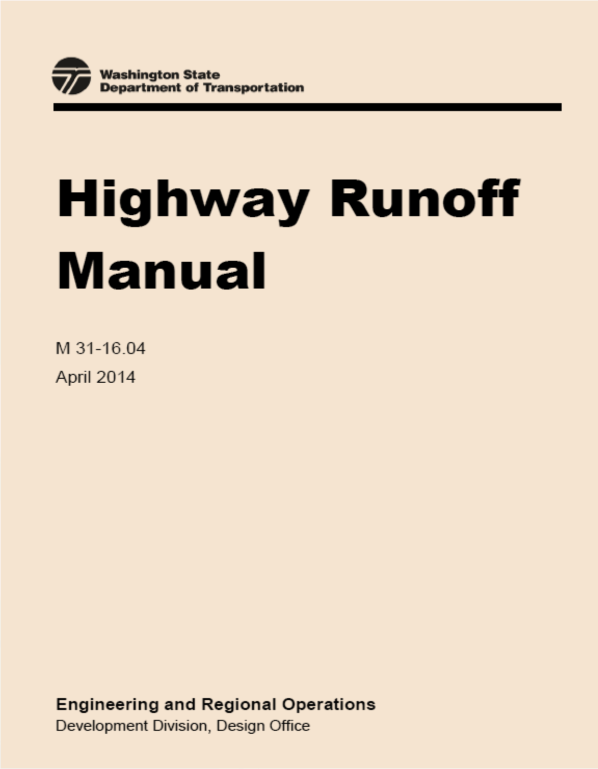
Potential Advantages	Potential Disadvantages
Lower maintenance costs	Uncertain life cycle and long-term maintenance costs
Less or smaller hard drainage infrastructure	ROW space constraints in developed and developing areas
Precludes stormwater discharges to surface water bodies and their impacts	May require more ROW–or purchase of ROW–compared to conventional BMPs
Favored/promoted by regulatory agencies and permitting processes	Requires soils and geology that provides appropriate infiltration rates

LID Feasibility and Design Criteria

General Approach WSDOT uses (per the WSDOT *Highway Runoff Manual*)

- Site Suitability Criteria
- LID Feasibility
  - Scoping-Level Feasibility
  - Project-Level Feasibility
- Saturated Hydraulic Conductivity of the Underlying Soil
- Determination of Infiltration Rate
- Underground Injection Facility (UIC) Consideration

(HRM Section 4-5, pp. 4-28 to 4-45)


Washington State
Department of Transportation

Highway Runoff Manual

M 31-16.04
April 2014

Engineering and Regional Operations
Development Division, Design Office

http://www.wsdot.wa.gov/Environment/WaterQuality/Runoff/HighwayRunoffManual.htm

Site Suitability

- Infiltration BMPs can provide runoff (water quality) treatment and flow (quantity) control, but to do so requires certain site and soil characteristics.
- In most cases a geotechnical and hydrogeologic report, prepared by a qualified engineer with geotechnical and hydrogeologic experience, is needed.
- The design engineer could use a team of certified or registered professionals in soil science, hydrogeology, geology, and other related fields.

Site Suitability Criteria (SSC)

SSC 1 – Setback Requirements

- Setback requirements are usually provided in local regulations, Uniform Building Codes or state regulations.
- Generally, setbacks are required from building foundations, top of slopes, drinking water wells, septic tanks and drainfields, springs, and property lines

SSC 2 – Seepage Analysis and Control

- Assess for adverse effects caused by seepage zones near building foundations, roads, parking lots, or sloping sites
- Infiltration not allowed upgradient of contaminated sites (can cause contaminants to mobilize)
- Sidewall seepage: usually not a concern if seepage occurs through same soil stratum as the bottom of the BMP (potential concern is bypassing the treatment through the sidewalls of the BMP)

SSC 3 – Groundwater Protection Areas

- Site is not suitable if infiltrated stormwater will cause adverse effect on groundwater quality.
- Consult local and state agencies with groundwater/drinking water responsibility to determine if site is within a sole source aquifer, critical recharge area, wellhead protection zone, or other aquifer-sensitive area.
- Pretreatment prior to infiltration may be required

SSC 4 – Depth to Bedrock, Water Table or Impermeable Layer

- The base of infiltration BMPs should be roughly 3 to 5 feet above seasonal high water table, bedrock or hardpan, or other low-permeable layer.
- Amount of separation may be dictated by regulatory agency
- Amount of separation may be reduced if overflow/bypass structure (if any) is adequate to prevent overtopping (for flow control).

SSC 5 – Soil Infiltration Rates

- For runoff treatment infiltration BMPs, maximum soil infiltration rate is 9 inches/hour
- HRM also requires calculation of a long-term infiltration rate, using a "Detailed" or "Simplified" approach.
- Soil texture is key for optimum infiltration rates, and to have sufficient physical and chemical properties for adequate treatment, particularly for soluble pollutant removal (also see SSC 7)

SSC 6 – Drawdown Time

- Importance of determining drawdown time depends on type of infiltration BMP being designed, and whether for runoff treatment and/or flow control.
- Need to match a design storm, determine storage capacity
- Single event hydrograph vs. continuous simulation hydrologic model

SSC 7 – Soil Physical and Chemical Suitability for Treatment

- To determine if soil is adequate to remove target pollutants, consider soil texture and design infiltration rates along with the following physical and chemical characteristics:
- Cation exchange capacity
- Sodium adsorption ratio
- Depth of soil for infiltration treatment (HRM: minimum of 18 inches, except for vegetated infiltration facilities with an active root zone, e.g., bioinfiltration swale)
- Organic matter content – can increase the sorptive capacity of the soil for some pollutants
- Engineered soils (i.e., use of soil amendments) can be used to achieve soil suitability

SSC 8 – Cold Climate and Impacts of Roadway Deicers

- For cold climate design criteria (snowmelt/ice impacts), refer to the D. Caraco and R. Claytor document, *Stormwater BMP Design Supplement for Cold Climates*, U.S. EPA, December 1997.
- Consider the potential impact of roadway deicers on drinking water wells in the siting determination
- Mitigation measures may be necessary if infiltration of deicers could cause a violation of groundwater quality standards.

LID Feasibility

- There are many types of LID and infiltration BMPs
- Each BMP has its own distinct set of LID infeasibility criteria listed in the BMP descriptions
- There are some infeasibility criteria that are shared among all LID/infiltration BMPs, listed on following slides
- Infeasibility may be overcome by site-specific conditions and/or design
- Utilize licensed engineers, geologists, hydrogeologists as necessary

Scoping-Level Feasibility Considerations

- Proximity to erosion or landslide hazard areas
- Proximity to underground utilities or storage tanks
- Proximity to houses or buildings with basements, that might be damaged by infiltrating stormwater
- Encroachment on structure setbacks
- Property with known soil or groundwater contamination
- Proximity to closed or active landfills
- Within 100 feet of a drinking water well or spring
- Within 10 feet of a onsite sewage disposal drain field

Project-Level Feasibility Considerations

- Adequate space in the right of way to site the BMP
- Safe overflow pathway to surface drainage system
- Proximity to shoreline structures (e.g., bulkheads) that might be damaged by infiltrating stormwater
- Field testing indicates initial native soil saturated hydraulic conductivity less that 0.30 inches/hour
- Inadequate minimum vertical separation between bottom of the BMP and seasonal high water table, bedrock, or other impervious layer

Saturated Hydraulic Conductivity (K_{sat})

- Once a site is determined suitable for infiltration, design can begin
- Sizing of an infiltration BMP is dependent on infiltration rate of soils over which the BMP is located
- Infiltration rates are based on two components:
  - Saturated hydraulic conductivity (porosity of the soil when saturated)
  - Hydraulic gradient
- Two methods to determine K_{sat}
  - Detailed Approach (*after Massmann, 2003*)
  - Use of the Guelph Permeameter

Underground Injection Facility (UIC) Consideration

- Pertains to *subsurface* infiltration BMPs – a facility with a constructed subsurface water distribution system or excavated hole that is deeper than the largest surface dimension.
- Per WA State regulations, varies by state
- Infiltration BMPs that are also considered UIC facilities include Dry Wells, and Infiltration Trenches with perforated underdrain pipes
- *Vadose Zones* vary widely in their ability to remove pollutants, based on thickness and soil texture

Bioinfiltration Swale (Interstate 5 - Seattle metro area)

Swale leads to pond – “treatment train”

Media Filter Drain

under construction

Media Filter Drain

Completed BMP

Engineered Dispersion Area (Interstate 5)

“Engineered” = soils amended to facilitate infiltration

Infiltration Trench with Filter Strip (SR 539)

Infiltration Pond (SR 18)

Note gravel access road in background

Infiltration Swale in urban location (SR 507)

Note inlet at curb cut

Thank You!

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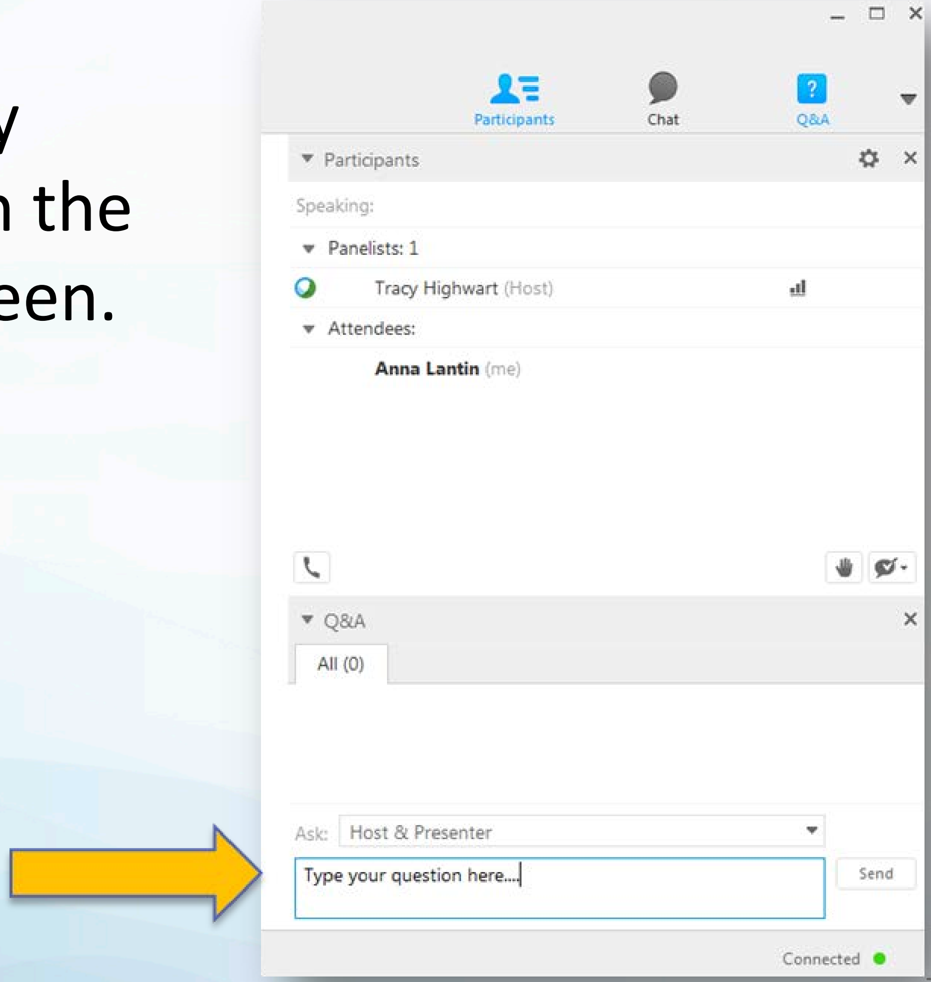
Stormwater Community of Practice Forum Collaboration

- Submit your questions by typing in the Q&A box on the webex panel on your screen.



CoP Questions/Discussions

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CLOSING

Reminder….Future Web Forum Topics

- Web Forum 2: Water Quality affecting DOT construction projects - lessons learned and process improvements on temporary construction BMP practices and administrative processes. *Tentative January 28, 2016, 11:00 a.m. Eastern*
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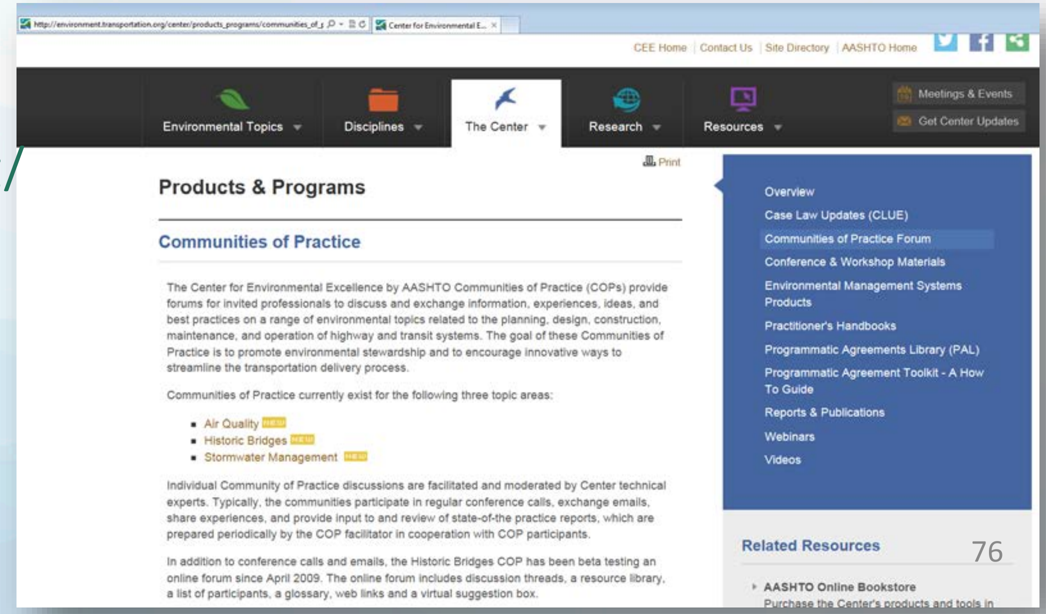

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THANK YOU FOR ATTENDING

CEE by AASHTO Stormwater Community of Practice

December 8, 2015