Subsurface Gravel Wetlands

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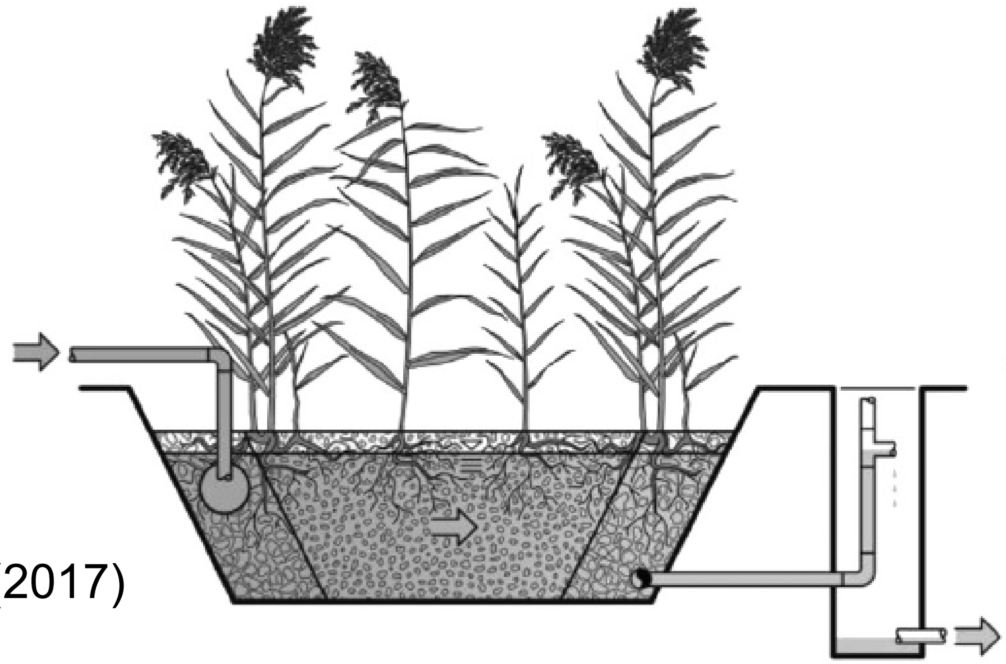
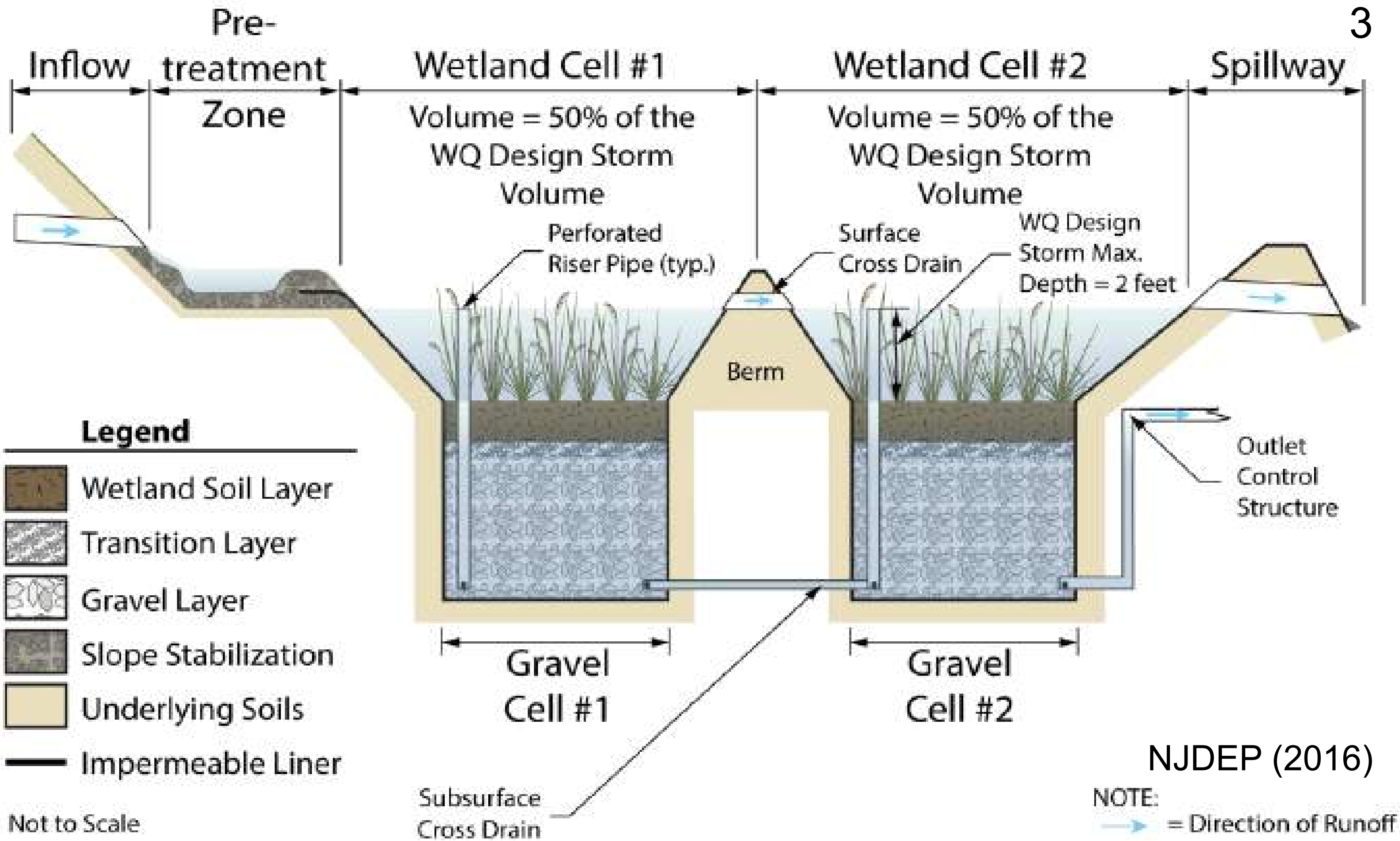
What are Subsurface Gravel Wetlands?

- Structural option for wastewater or stormwater treatment
- Treatment provided using horizontal flow through saturated gravel bed



Dotro et al. (2017)



NJDEP (2016)

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Stormwater Wetlands vs. Gravel Wetlands

- Stormwater wetlands:
  - Constantly ponded water
  - Varying topography
  - Plant specific zones
- Gravel wetlands:
  - Temporarily pond water
  - Saturated gravel layer
  - Little variation in topography

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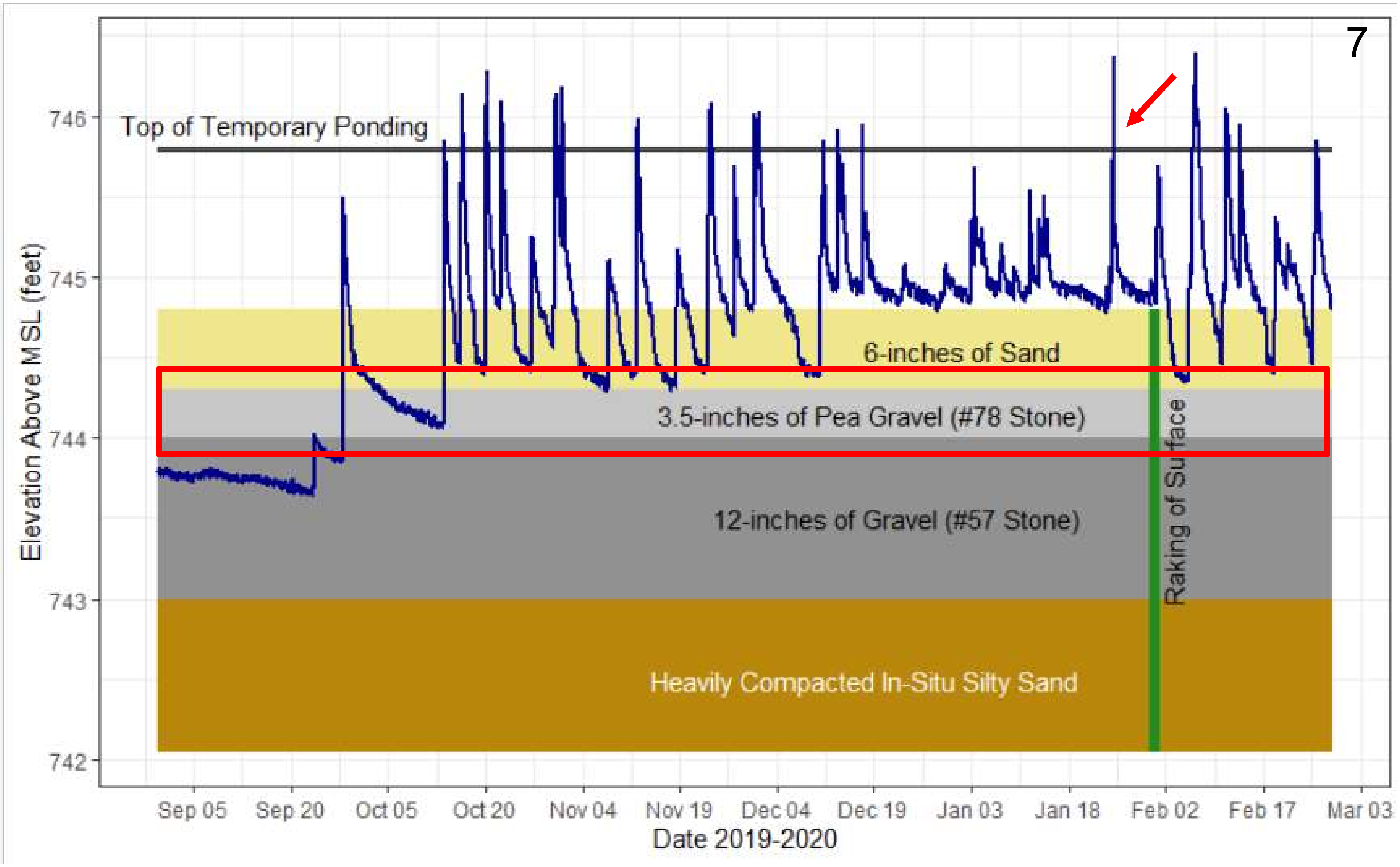

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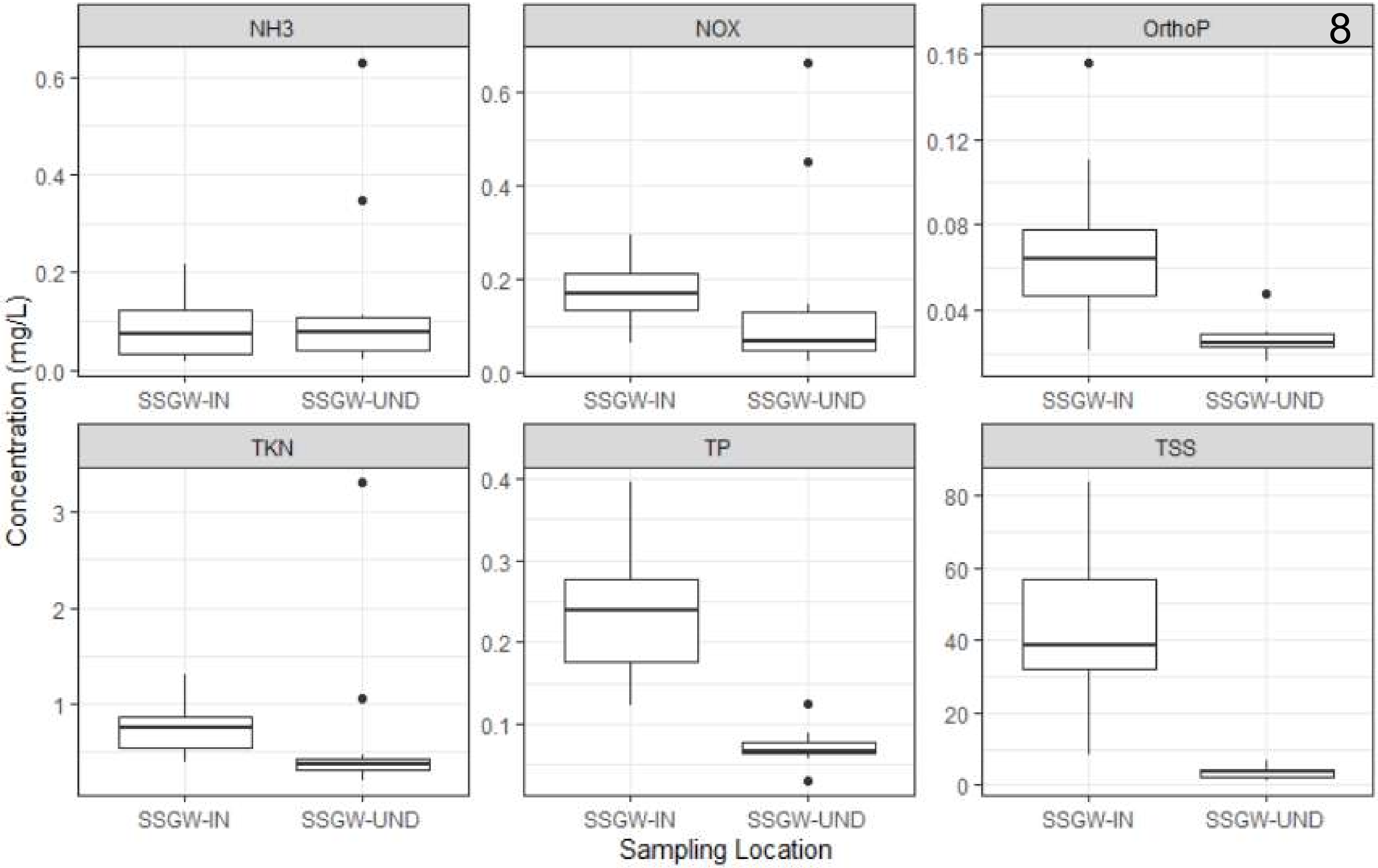

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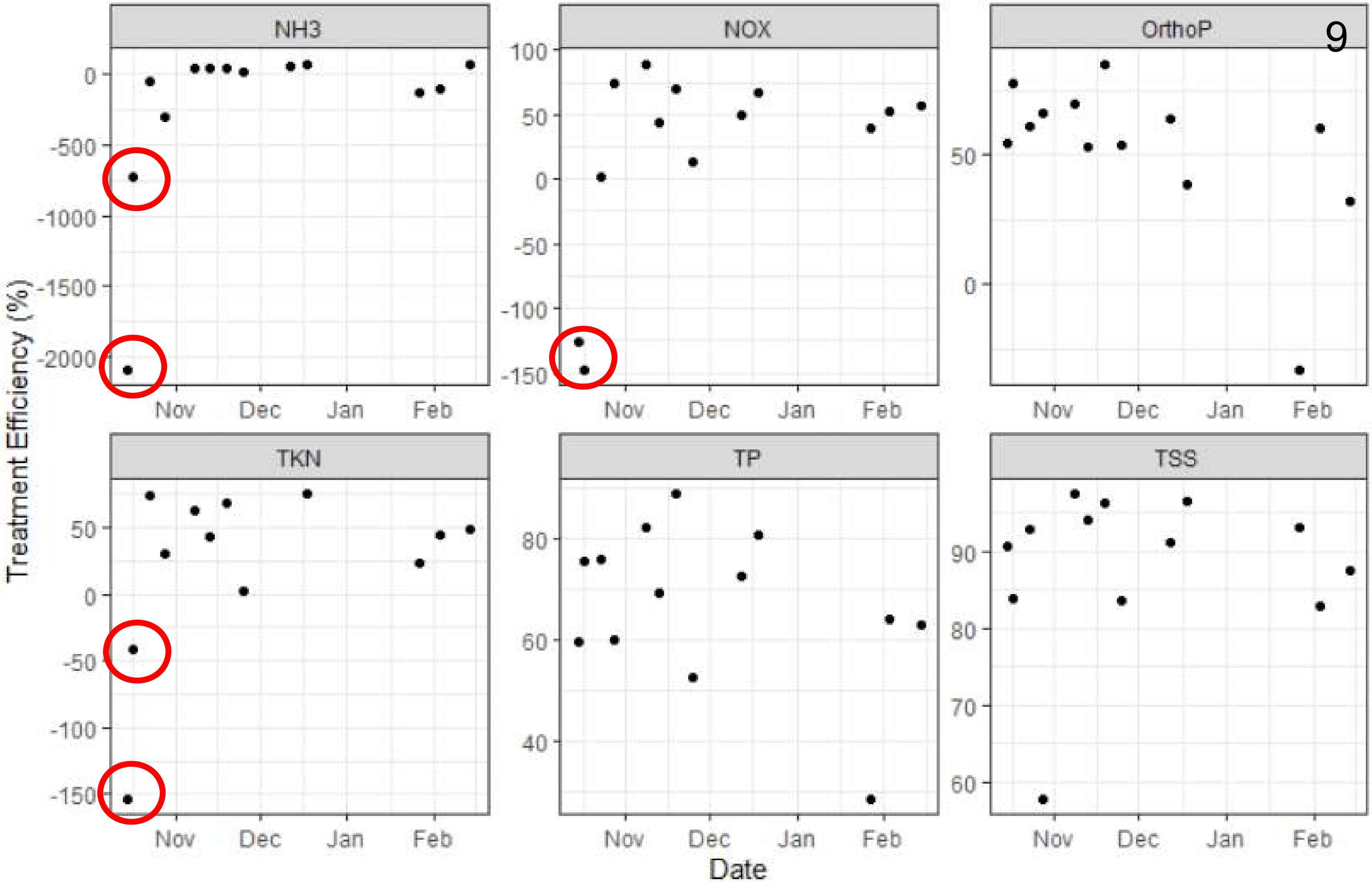

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NC DEQ NEST Program and SCM EMCs

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Current NC DEQ NEST Program

- Program established to evaluate proprietary systems for stormwater management
- Minimum of two systems must be monitored
  - At least one system must be monitored in NC

Table 1: TSS Removal Standards for Primary SCMs

Median Influent EMC	Applicable Performance Standard[1,2]
< 20 mg/L	Invalid test
20 – 35 mg/L	$\geq$ 29% removal
35 – 100 mg/L	$\leq$ 25 mg/L
100 mg/L	$\geq$ 75% removal

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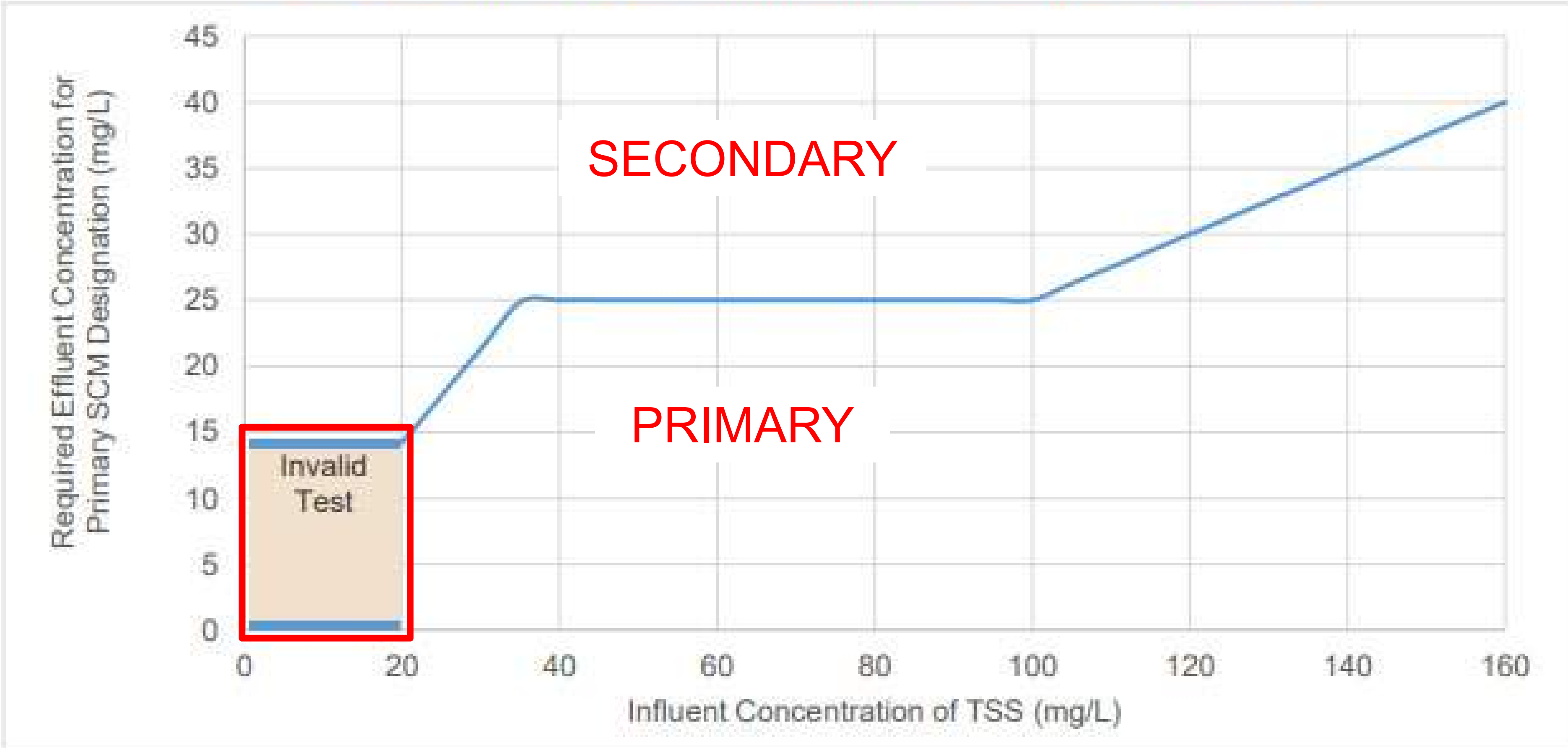
Figure 2: Required Performance Standard for Primary SCMs



Current NC DEQ NEST Program

- Effluent TN and TP EMCs for systems are based on monitoring data
- But research has shown influent concentrations impact effluent concentrations…

Is the system's water quality performance a result of low or "clean" influent concentrations or the system's treatment mechanisms?

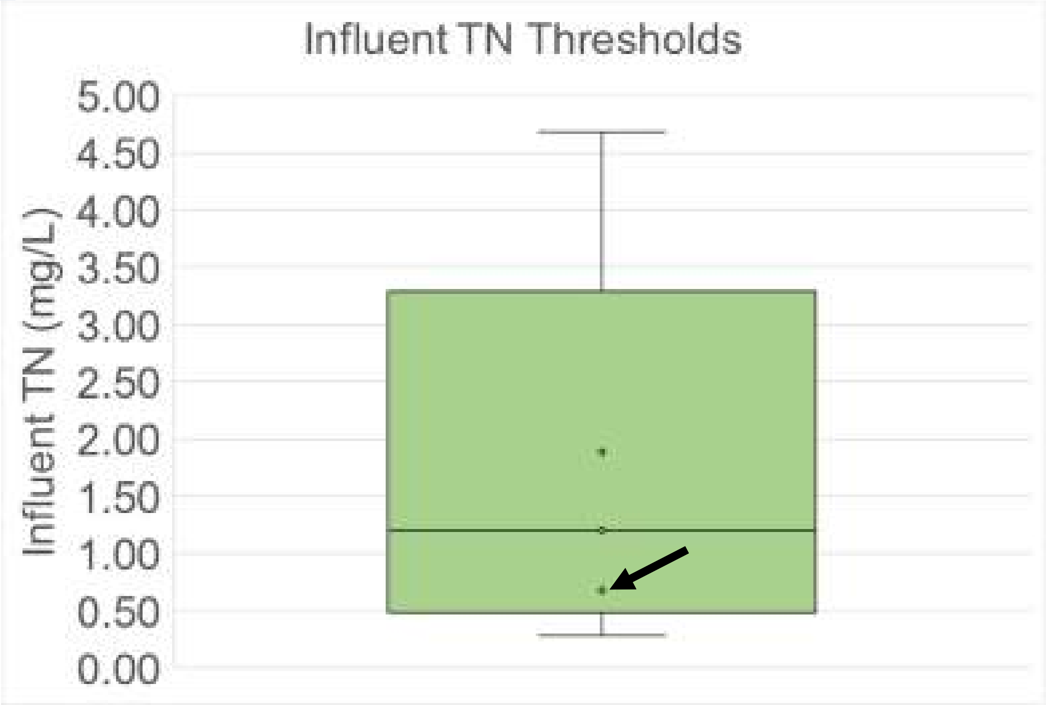
Proposed Changes to NEST Program

- Establish **influent** thresholds for TN and TP to assess proprietary systems' water quality performance
- Thresholds identified using water quality data collected in NC from:
  - Bioretention cells, stormwater wetlands, wet ponds, dry ponds, sand filters, rainwater harvesting, disconnected impervious surfaces (DIS), level spreader-vegetated filter strips (LS-VFS), green roofs, Filterra, Silva Cells, permeable pavement, swales, regenerative stormwater conveyances (RSCs), bioswales

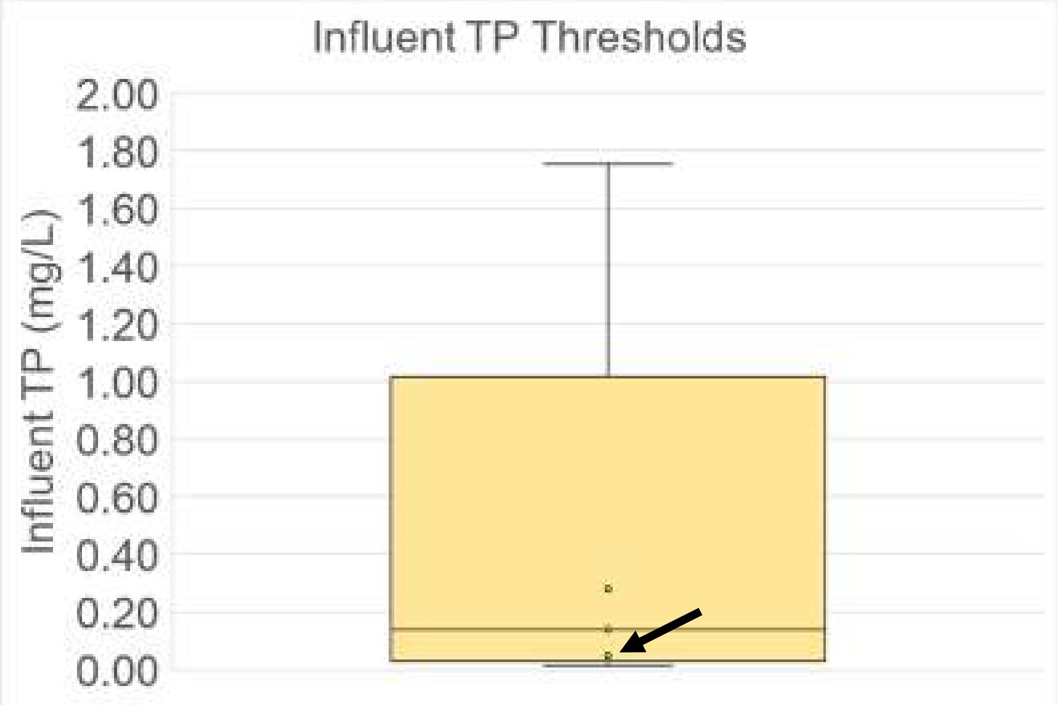
Proposed Changes to NEST Program

- Use thresholds to "screen" influent data
  - If the influent concentration greater than or equal to threshold than corresponding effluent concentration used in effluent EMC calculation
- Assess approved SCMs using thresholds to update current effluent EMCs

Influent TN Thresholds	
Minimum (mg/L)	0.29
12.5th percentile (mg/L)	0.68
50th percentile (mg/L)	1.20
87.5th percentile (mg/L)	1.89
Maximum (mg/L)	4.69



Influent TP Thresholds	
Minimum (mg/L)	0.01
12.5th percentile (mg/L)	0.05
50th percentile (mg/L)	0.14
87.5th percentile (mg/L)	0.28
Maximum (mg/L)	1.76



Screening Data

Category	Site Name	Date	Pollutant	Influent (mg/L)	Screening	Effluent (mg/L)	**Effluent (mg/L)**
WP	Bingham Wet Pond	5/19/2013	TN	1.00	Pass	1.09	1.09
WP	Bingham Wet Pond	5/23/2013	TN	1.55	Pass	0.94	0.94
WP	Bingham Wet Pond	6/3/2013	TN	2.37	Pass		
WP	Bingham Wet Pond	6/10/2013	TN	0.56	Fail	0.40	N/A
WP	Bingham Wet Pond	6/13/2013	TN	1.11	Pass	0.49	0.49
WP	Bingham Wet Pond	6/18/2013	TN	1.77	Pass	0.86	0.86
WP	Bingham Wet Pond	6/23/2013	TN	0.74	Pass	0.76	0.76
WP	Bingham Wet Pond	6/24/2013	TN	0.56	Fail	0.57	N/A
WP	Bingham Wet Pond	6/25/2013	TN	0.82	Pass	0.82	0.82
WP	Bingham Wet Pond	6/26/2013	TN	0.72	Pass	0.74	0.74

Want to Learn More?

Stormwater Nitrogen and Phosphorus (SNAP) Tool Workshop

Upcoming Workshops

August 4, 2020

In-Person Training
The McKimmon Center
1101 Gorman Street
Raleigh, NC 27606

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August 11, 2020

Online WebEx Webinar

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Visit:
https://www.bae.ncsu.edu/workshops-conferences/snap/

Questions?

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Gravel Wetlands vs. Stormwater Wetlands

- NC stormwater wetlands (Hathaway and Hunt 2010; Line et al. 2008; Mallin et al. 2012):
  - TN removal: 39 to 59%
  - TP removal: 27 to 68%
  - TSS removal: 58 to 83%
- Gravel wetlands:
  - Wastewater: up to 96% TN and 71% TP removal (Van de Moortel et al. 2009); < 20 mg/L effluent TSS (Reed and Brown 1995)
  - Stormwater: 54% TP and 99% TSS removal (Roseen et al. 2009)

Current Design Guidance- NH

- Pioneer of gravel wetlands for stormwater treatment
- Guidance (UNHSC 2016):
  - Saturated gravel within 4 to 8 in of soil surface
  - Minimum of: 8 in wetland soil, 3 in intermediate aggregate, 24 in gravel layers
  - Geotextile fabric if in-situ conductivity > 0.03 ft/day
  - Size primary orifice for 24 to 30 hr storage in gravel layer
  - Two cell system where length of each cell is ≥ 15 ft and holds 50% of WQV
  - Pre-treatment basin or forebay that is well-drained

Current Design Guidance- MD

- Guidance (MDE 2012):
  - Appropriate for HSG C or D soils or sites with high groundwater table
  - Must use impermeable liner for HSG A or B soils
  - Wetland soil specifications:

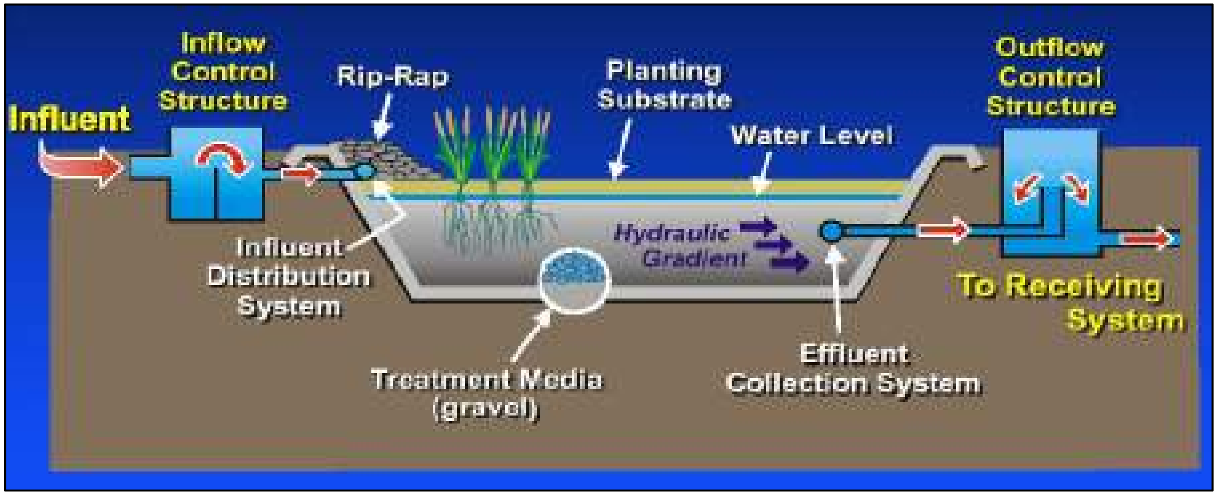
US Standard Sieve Size in/mm	Percent Passing	Percent Passing Testing Tolerances
0.5/12.5	100	± 10.0
#10/2.00	90 - 75	± 5.0
#100/0.15	40-50	± 5.0
#200/0.075	25-50	± 5.0

Current Design Guidance- NJ

- Guidance (NJDEP 2016):
  - Minimum 85% vegetation density
  - Forebay sized to hold minimum 10% WQV and drain within 9 hrs
  - Maximum ponded water at soil surface is 2 ft and drains within 72 hrs
  - Similar depths of soil and aggregate as UNHSC (2016)
  - At least 1 ft separation from SHWT

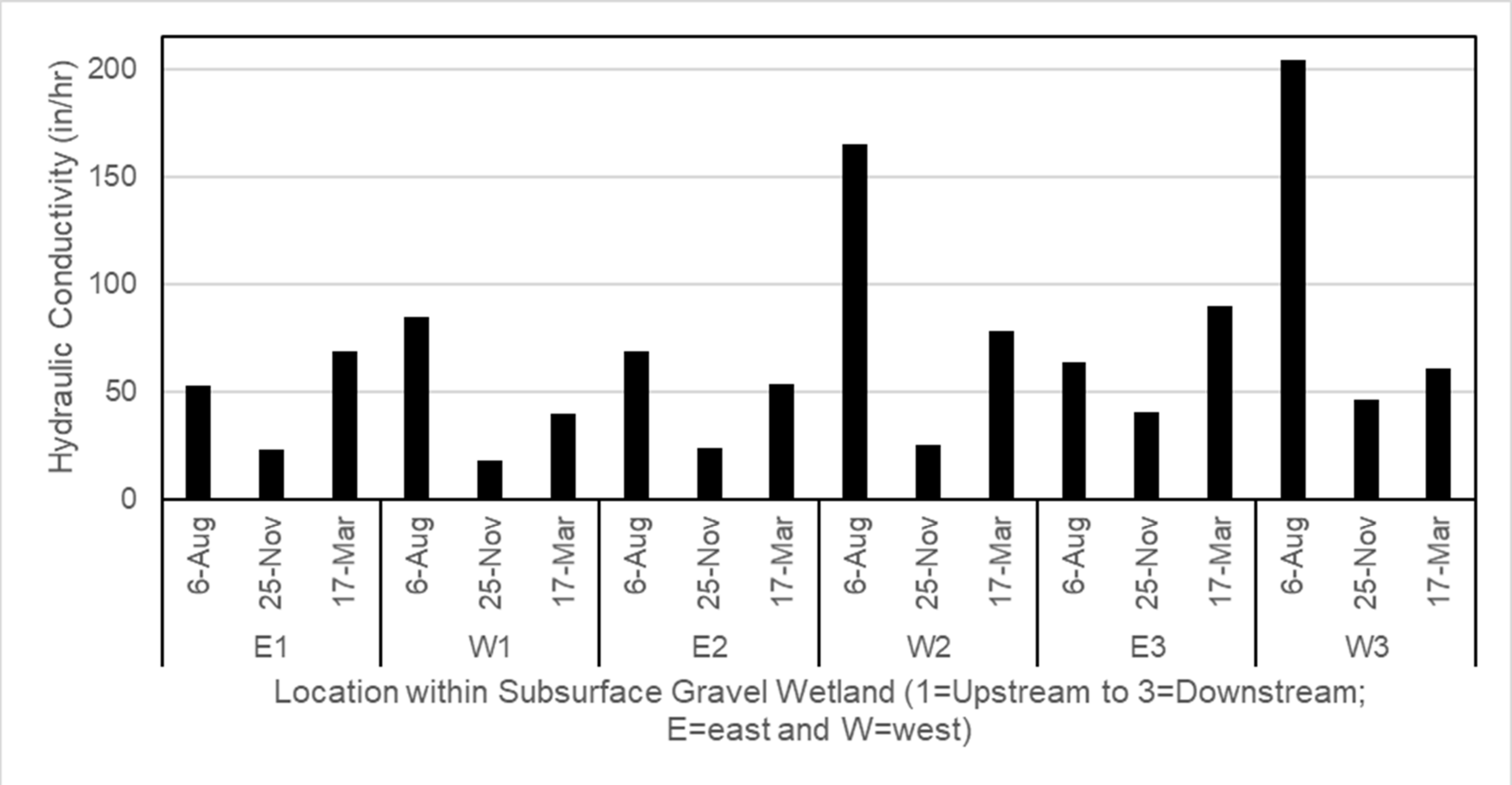
Current Design Guidance- TN

- Guidance (Knox County 2018):
  - Drainage area ≤ 5 ac with ≥ 50% impervious cover
  - SHWT separation ≥ 2 ft
  - Pre-treatment required and accounts for WQV storage
  - Minimum of 20 ft wide easement for maintenance



Current Design Guidance Synopsis

- General consensus:
  - Pre-treatment is necessary
  - Permeable in-situ soils should be avoided
  - Saturation within 4 to 8 in of wetland soil surface
  - Temporarily (≤ 72 hrs) pond water at surface
  - Drainage pipes incorporated into cell(s) to encourage infiltration into gravel layer
  - At least 8 in soil, 3 in intermediate aggregate, 2 ft gravel


Hydraulic Conductivity (in/hr)
200
150
100
50
0
6-Aug
25-Nov
17-Mar
E1
W1
E2
W2
E3
W3
Location within Subsurface Gravel Wetland (1=Upstream to 3=Downstream; E=east and W=west)

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