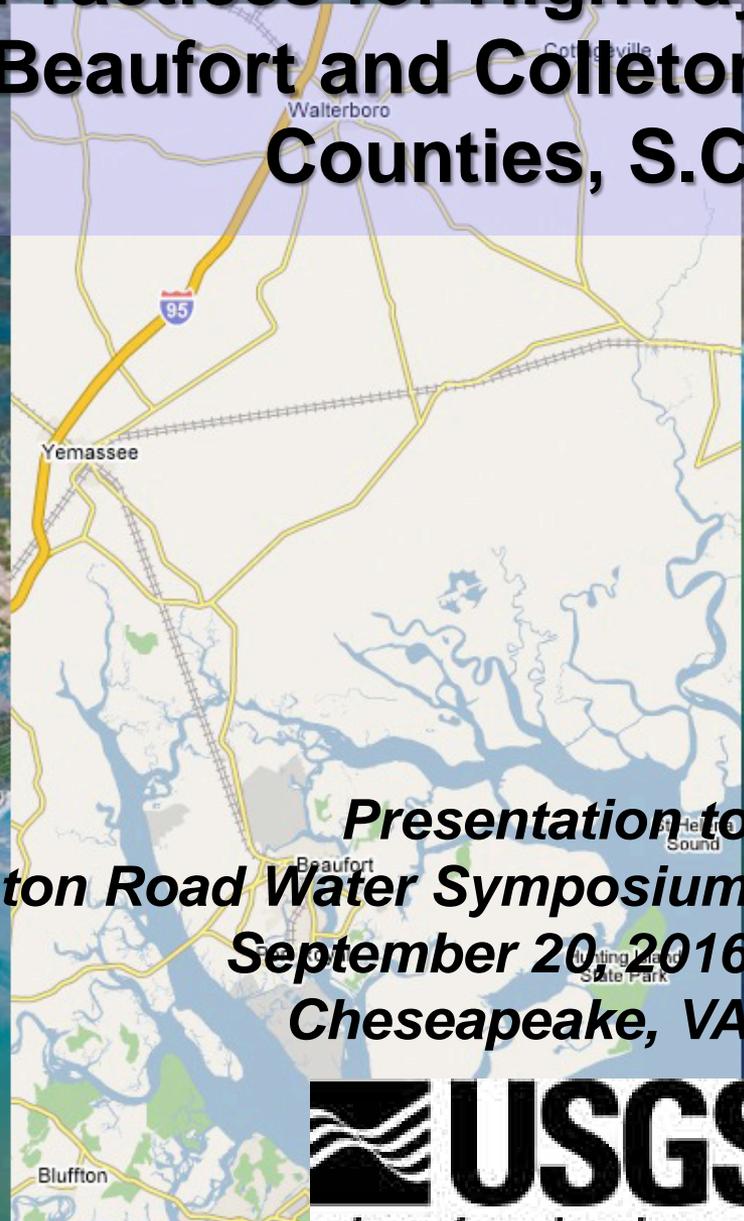


Performance of Four Best Management Practices for Highway Runoff in Beaufort and Colleton Counties, S.C.



Beaufort



*Presentation to
Hampton Road Water Symposium
September 20, 2016
Chesapeake, VA*



Presentation Topics

- Kevin Conlon

- Project Lead

- USGS, South Atlantic Water Science Center

- Sullivan's Island, SC

- Site Instrumentation and Sampling

- Celeste Journey

- Water-quality specialist

- USGS, South Atlantic Water Science Center

- Columbia, SC

- Overview

- Study Findings

Reports on the topics discussed today are available online.



Prepared in cooperation with the South Carolina Department of Transportation

Evaluation of Four Structural Best Management Practices for Highway Runoff in Beaufort and Colleton Counties, South Carolina, 2005–2006



Scientific Investigations Report 2008–5150

U.S. Department of the Interior
U.S. Geological Survey

<http://pubs.usgs.gov/sir/2008/5150/>



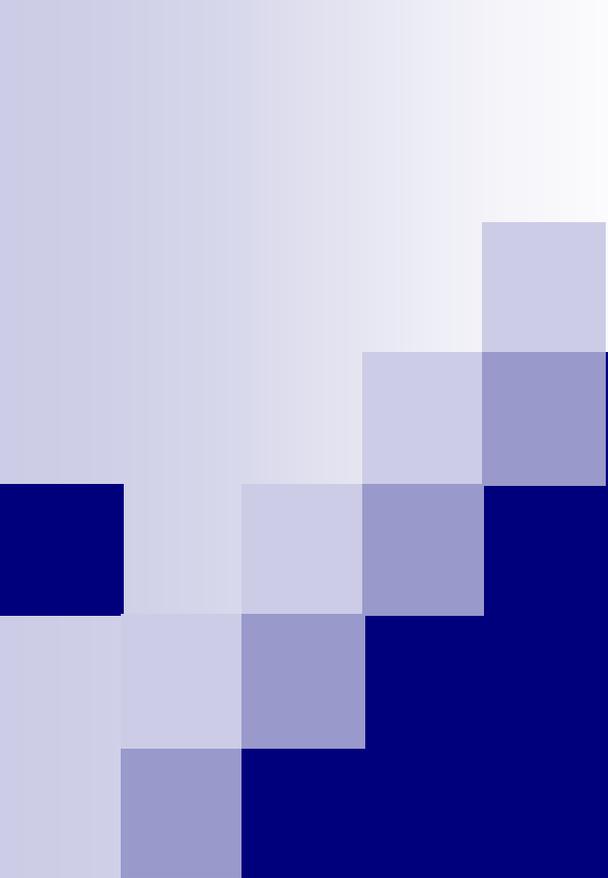
Purpose and Scope

- Evaluate the performance of in-place hydrodynamic devices on removing contaminants in storm water from highways near the coast in South Carolina
 - Related to MS4 - NPDES requirements
- Cooperative Water Program Investigation with the SC Department of Transportation (SCDOT)
- Period of study - 2005 to 2007

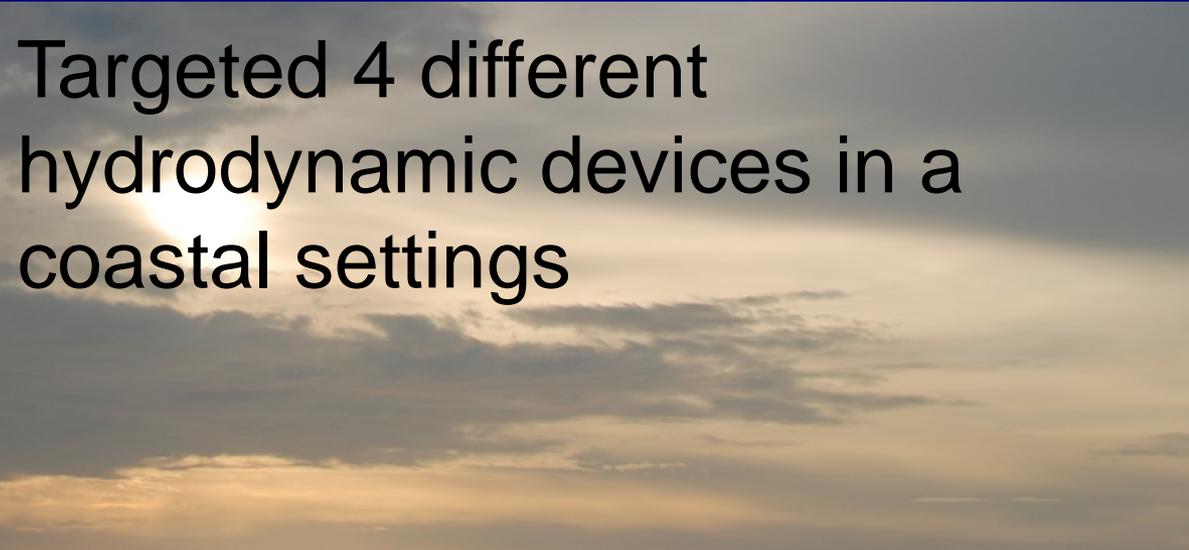


Major Objectives

- Collect storm-event samples over a range of storm intensities and seasons
- Compare **event-mean concentrations** and **constituent loads** entering and leaving the BMPs for all storm events
- Estimate the **removal efficiency** of the commercially available BMPs for suspended sediment, metals, oils and grease, and indicator bacteria from roadway runoff



Site Locations and Instrumentation



Targeted 4 different hydrodynamic devices in a coastal settings

Structural BMPs: Hydrodynamic Devices

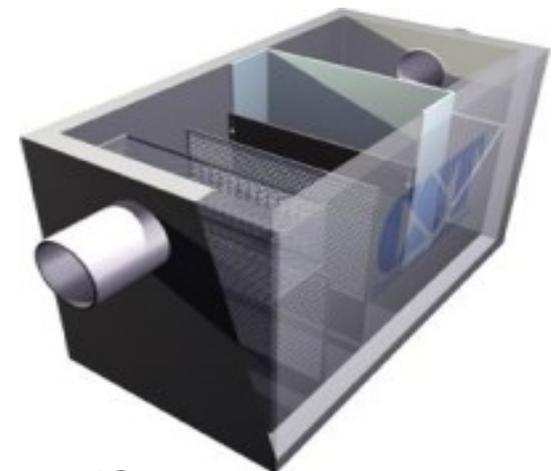
- Flow-through structures with a settling or separation unit to remove sediments and other pollutants
 - Settling – to remove particulate
 - Capturing – to remove floatables
 - Flow alteration – reduce velocity of the flow entering system



Vortech



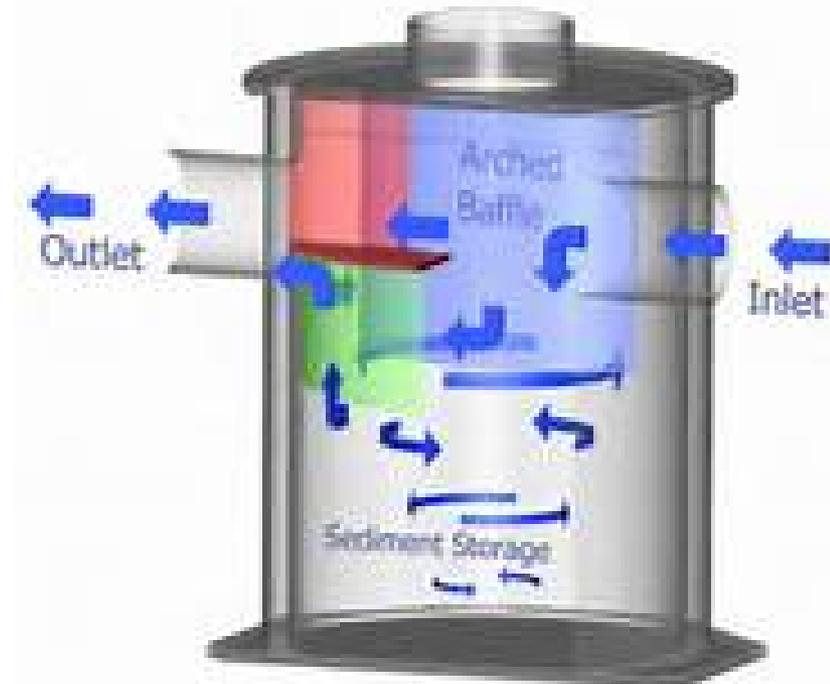
Stormceptor; CDS



CrystalStream

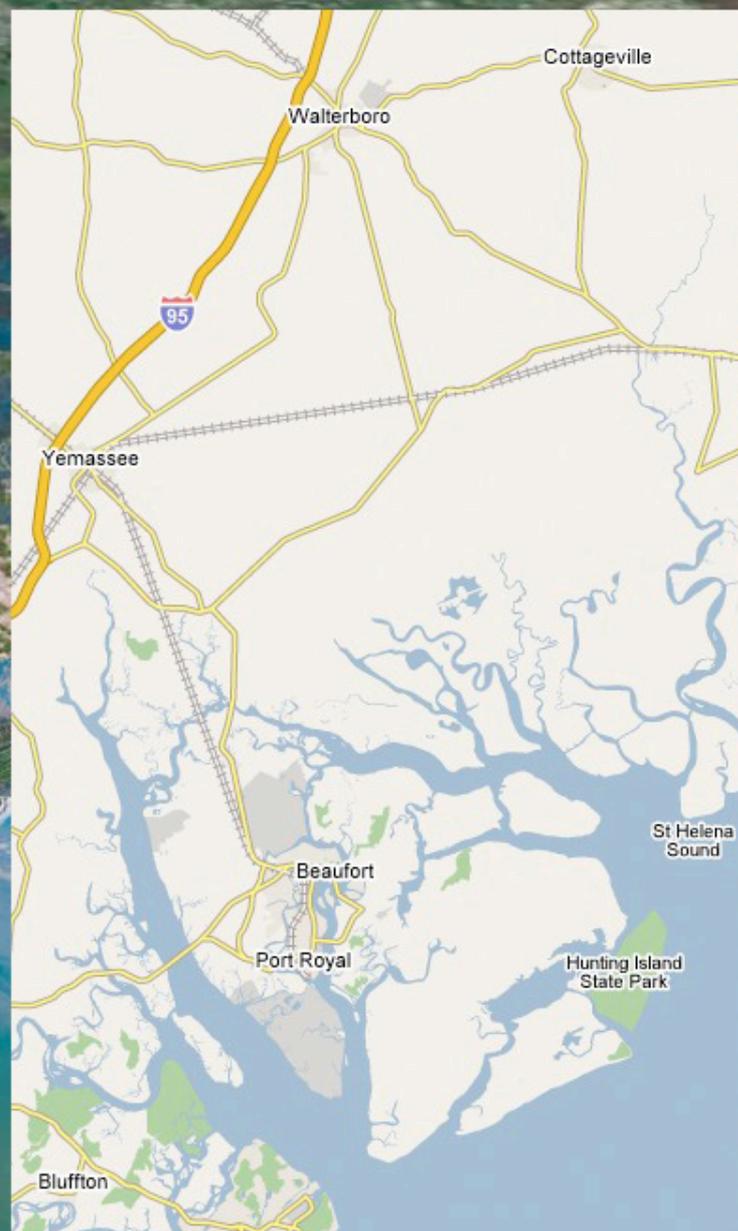
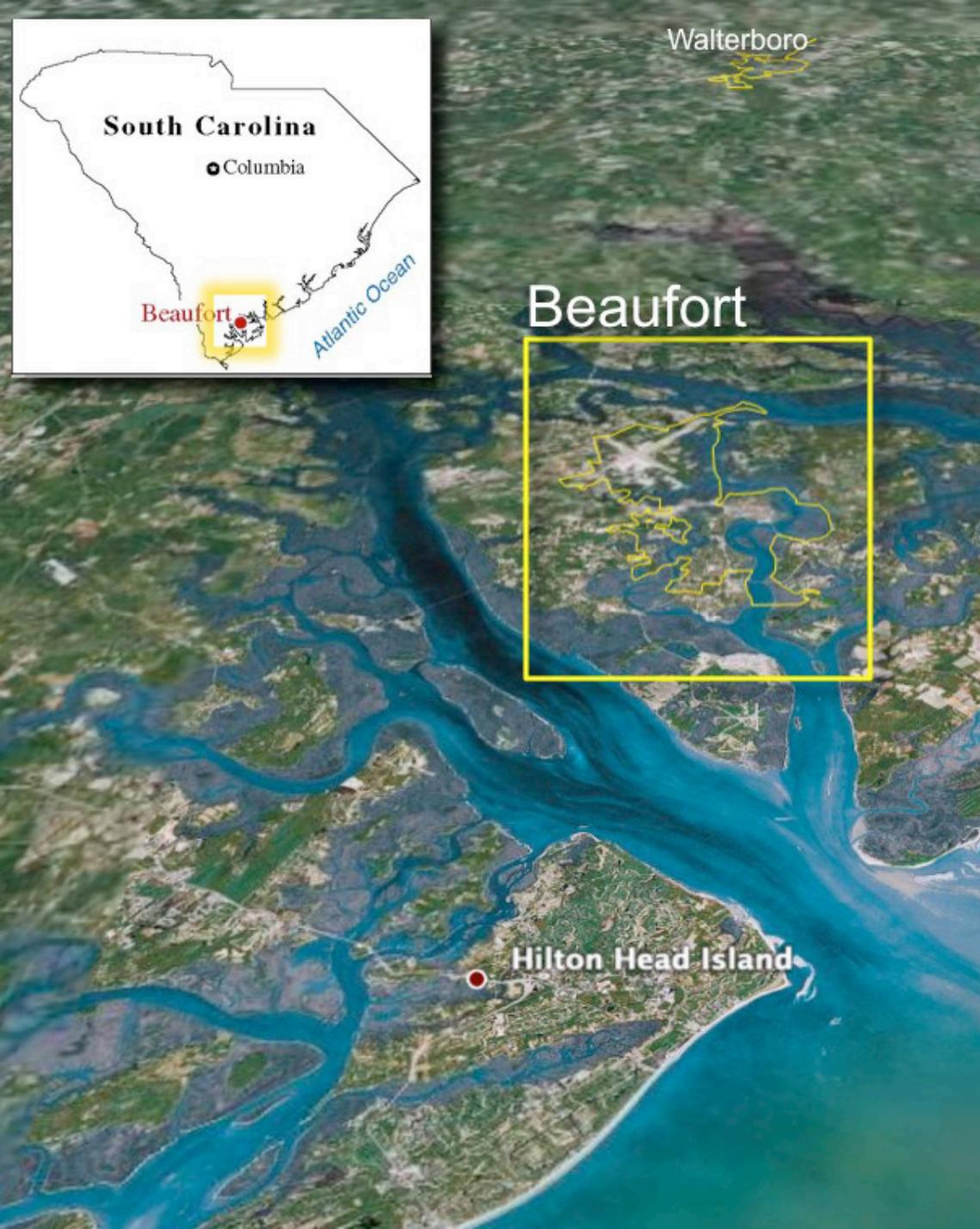
Structural BMPs: Hydrodynamic Devices

- Designed to capture sediment, total suspended solids, trash, organic material, and floatable oils and grease
 - Also contaminants that tend to attach to sediments or particles

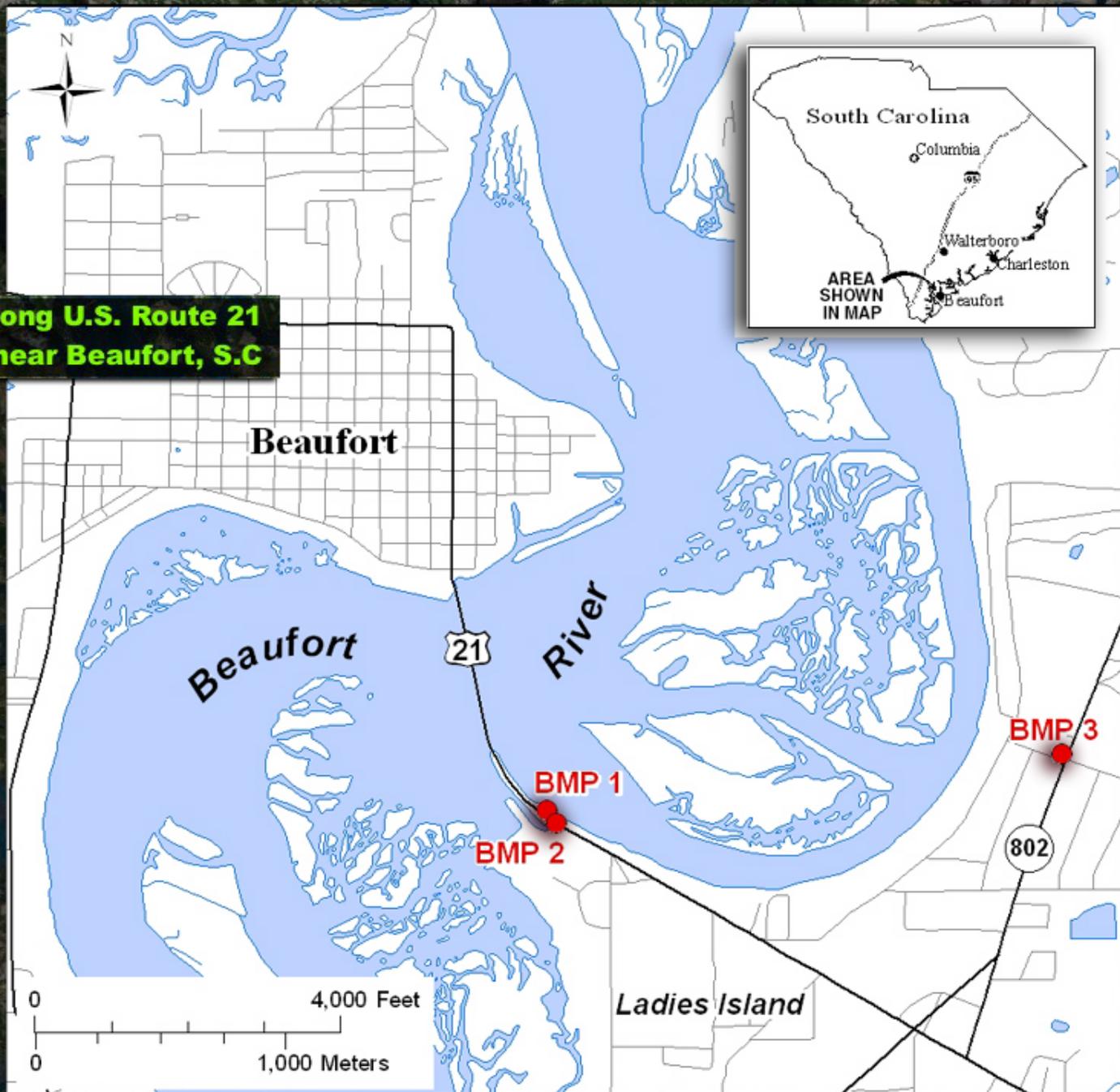


Site Information

SITE	BMP TYPE	LOCATION	DRAINAGE AREA (ACRES)
BMP 1	Stormceptor	U.S. Hwy. 21	2.24
BMP 2	CDS Technologies	U.S. Hwy. 21	1.11
BMP 3	Vortechnics	U.S. Hwy. 802	5.90
BMP 4	CrystalStream	Rest area off I-95 S	2.77



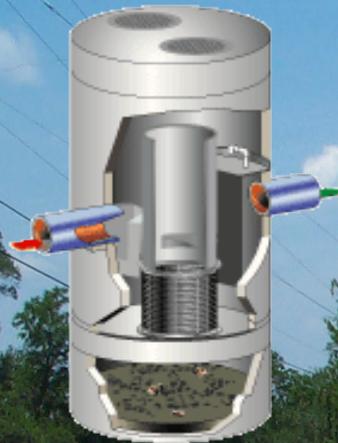
**Study area along U.S. Route 21
and S.C. Highway 802 near Beaufort, S.C**





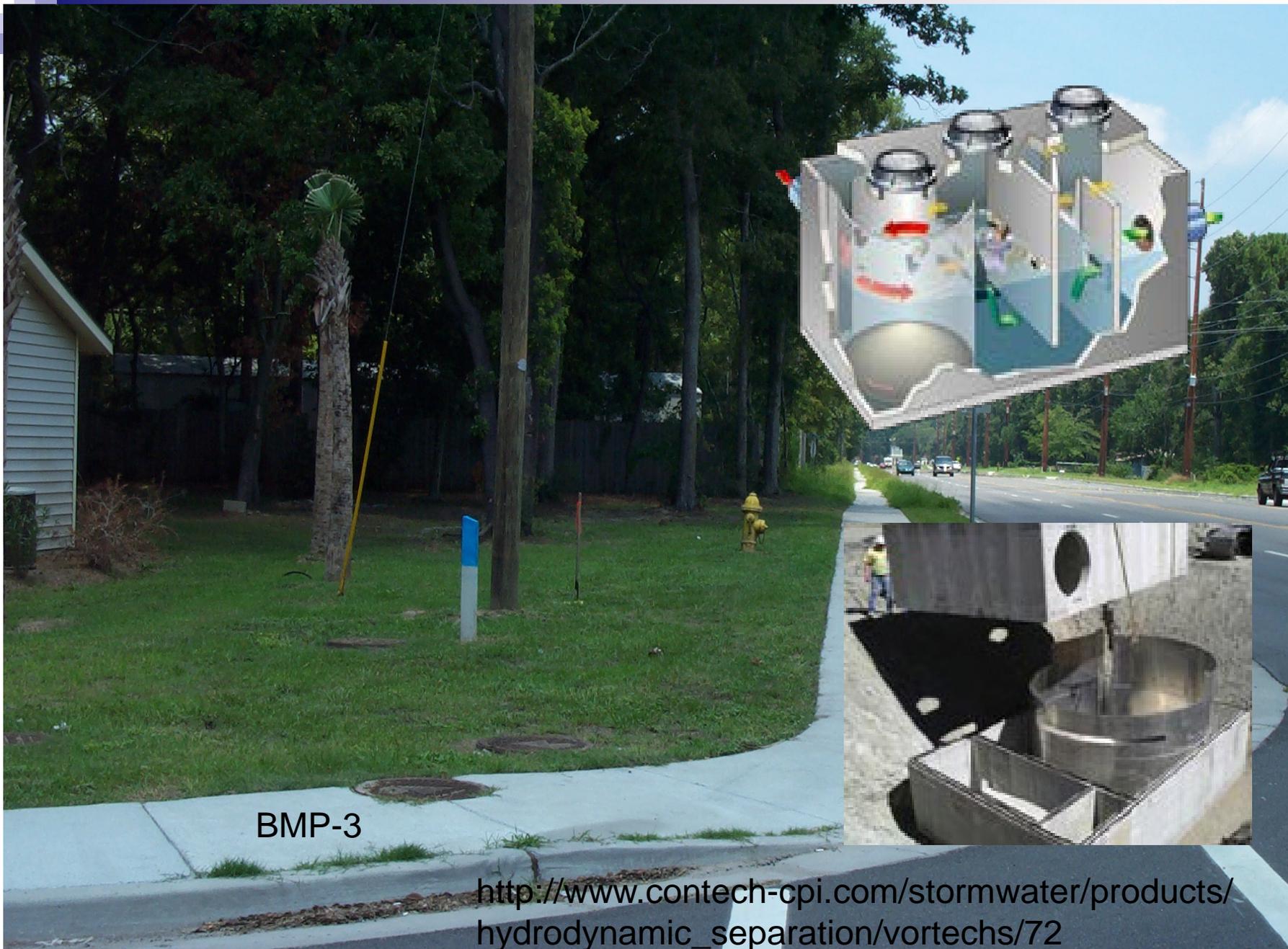
BMP-1





BMP-2

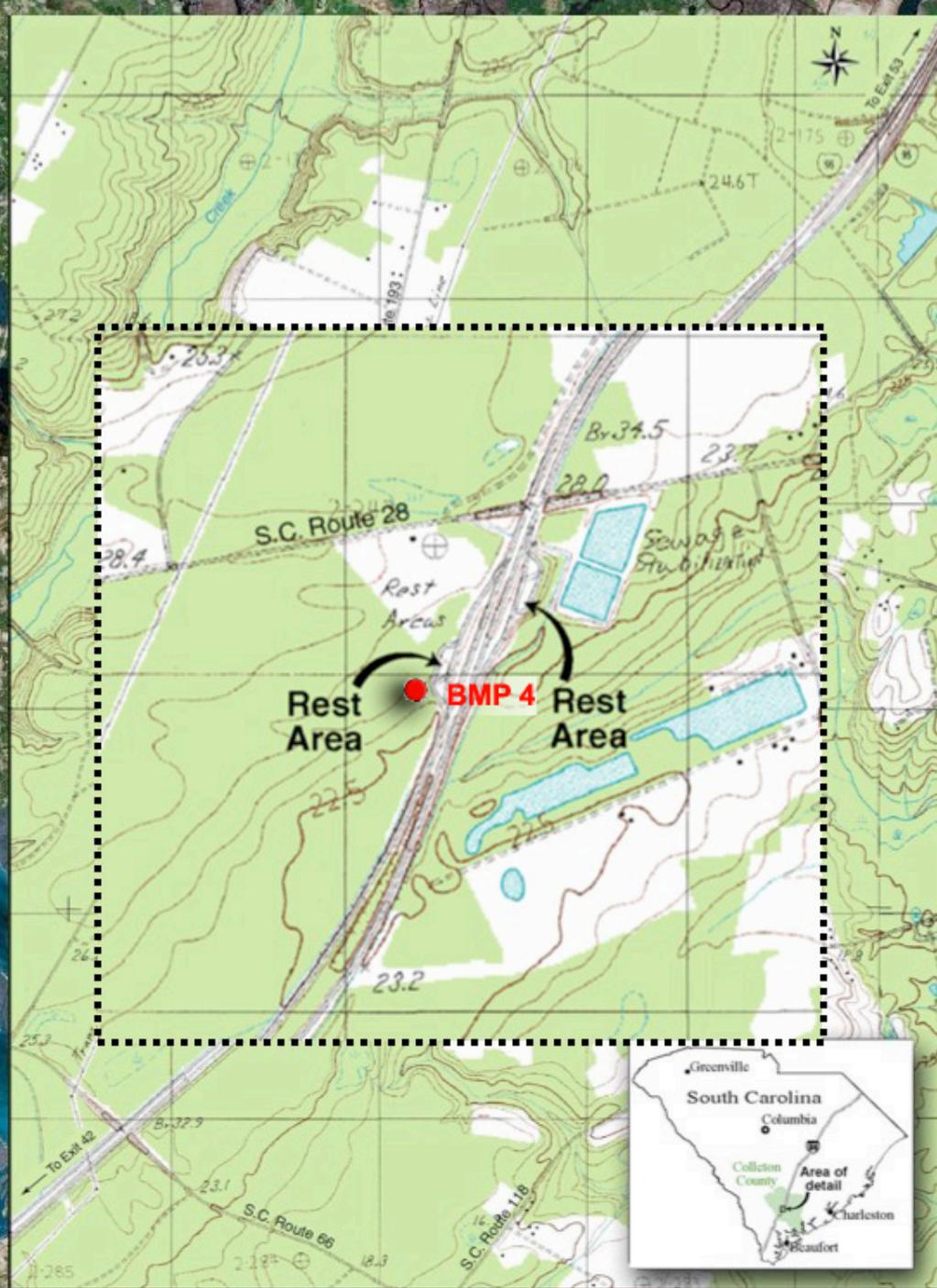
http://www.contech-cpi.com/stormwater/products/hydrodynamic_separation/cds/558

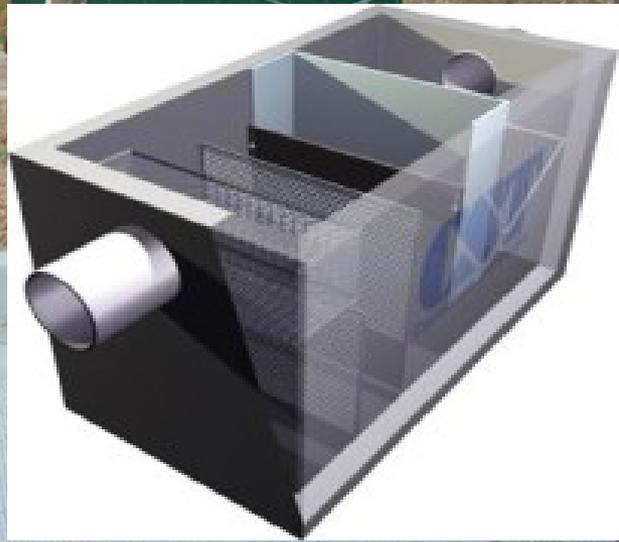


BMP-3

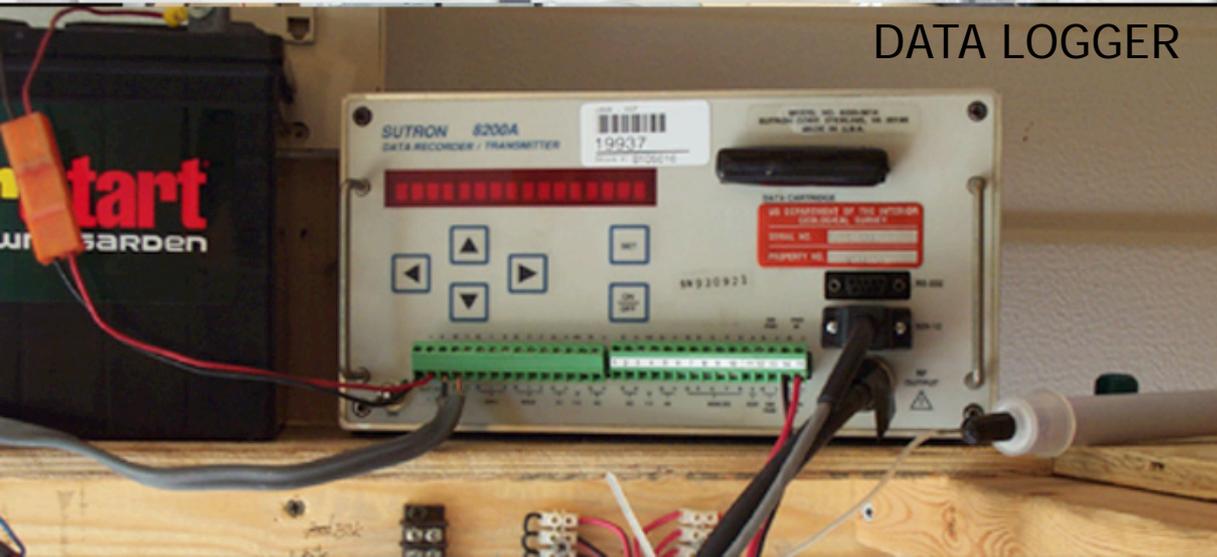
http://www.contech-cpi.com/stormwater/products/hydrodynamic_separation/vortechs/72

**Study area at I-95 rest area
in Colleton County, S.C.**

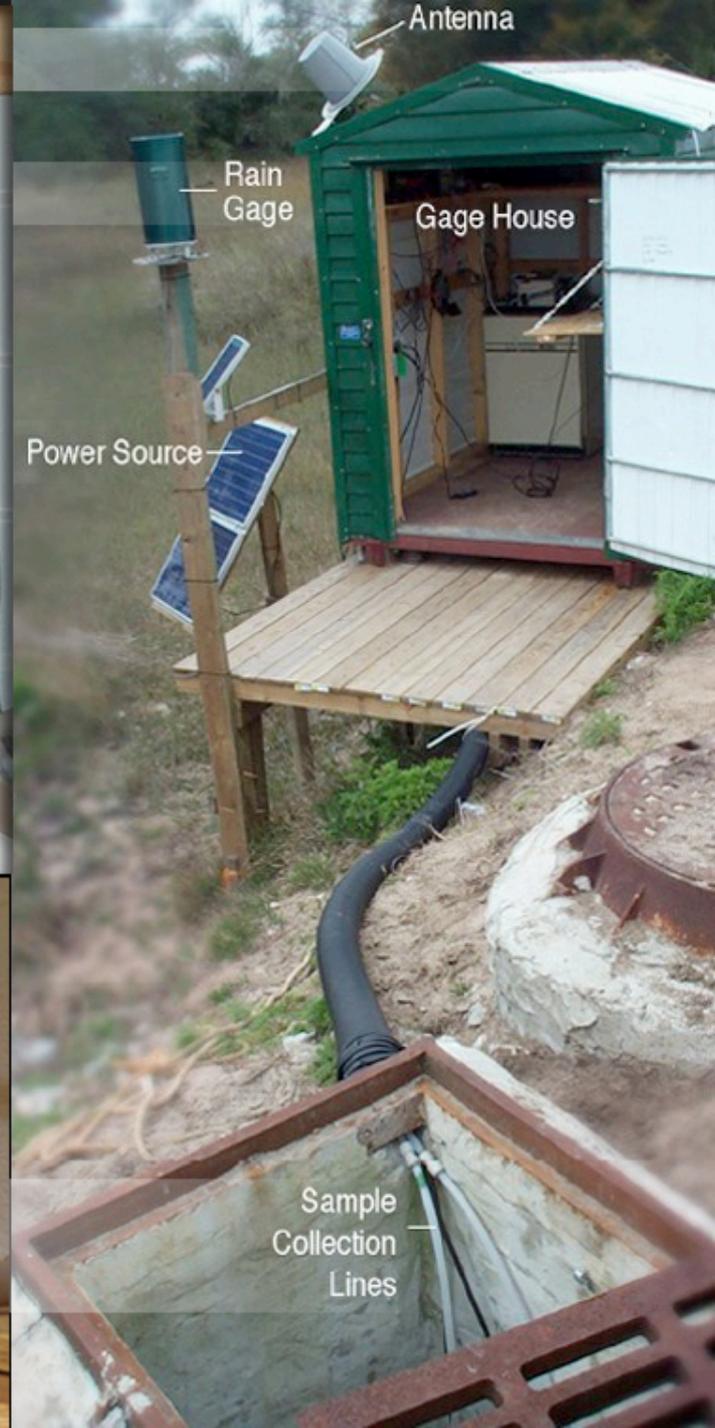




AUTOMATIC SAMPLER



DATA LOGGER



Antenna

Rain Gage

Gage House

Power Source

Sample Collection Lines

**INLET AND OUTLET LINES FROM
AUTOMATIC SAMPLER
TO HYDRODYNAMIC DEVICE – BMP2**



OUTLET SAMPLER - BMP4

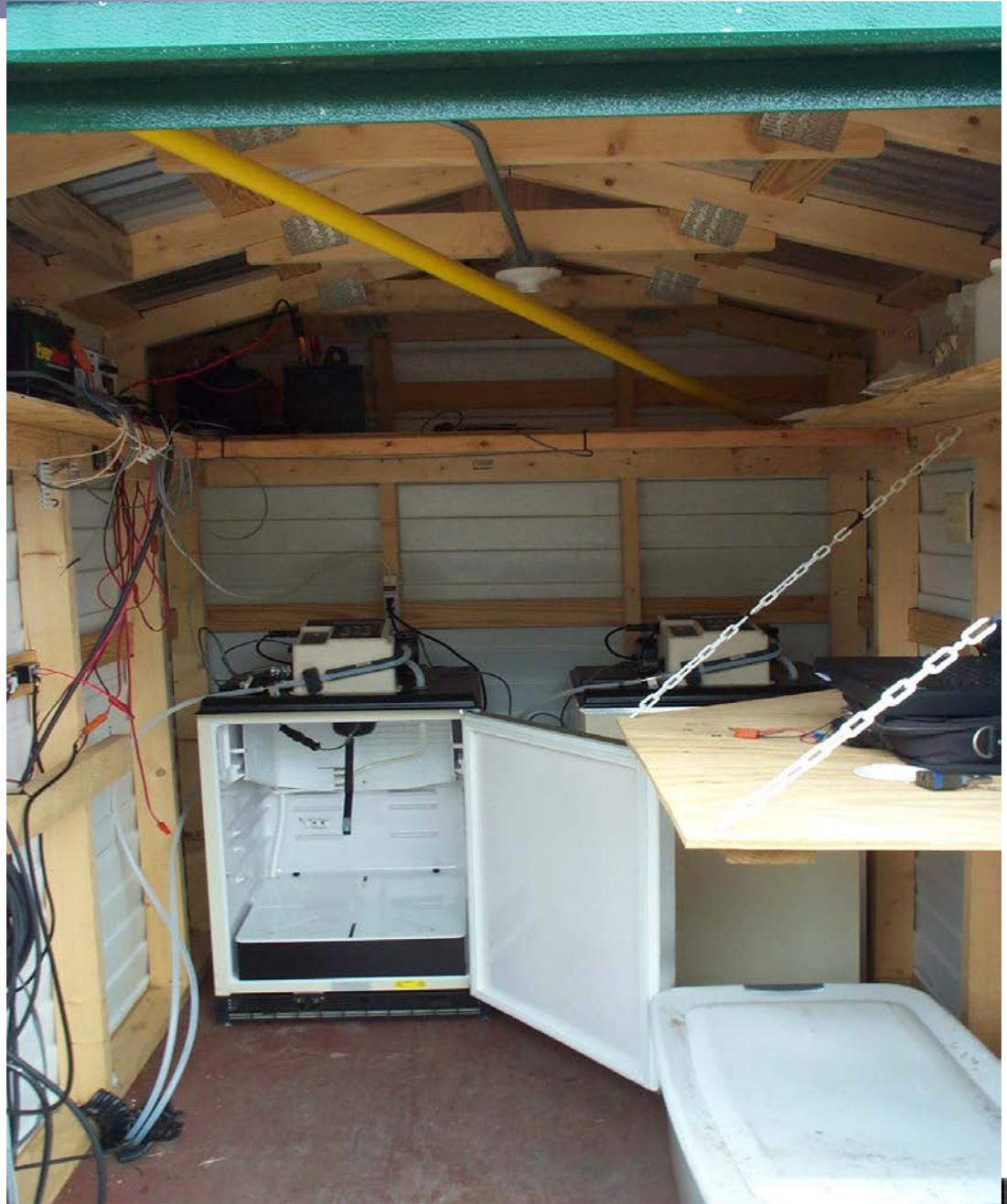




**INLET SAMPLER –
BMP 4**



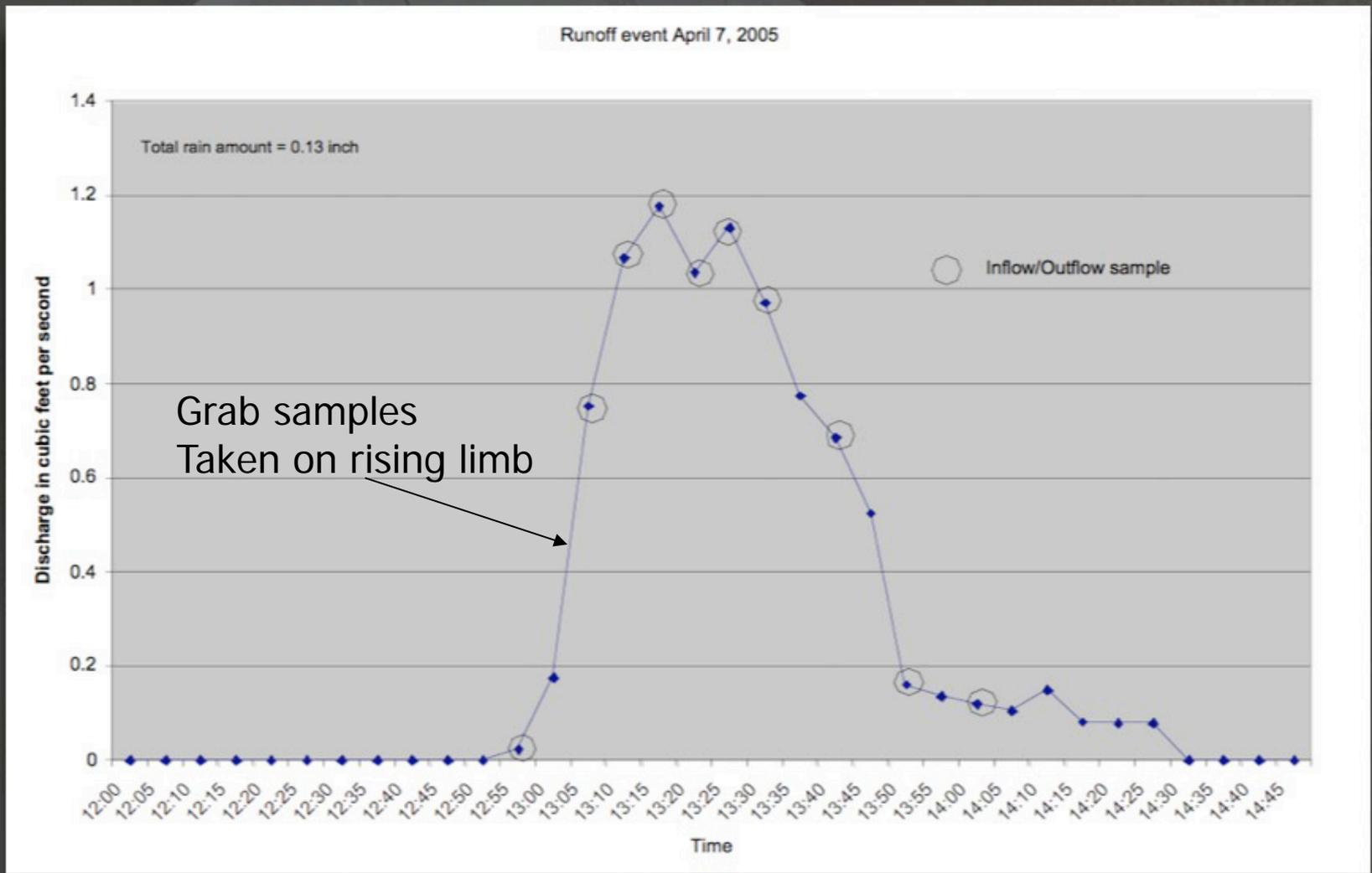
**PRESSURE TRANSDUCER
USED TO DETERMINE FLOW**



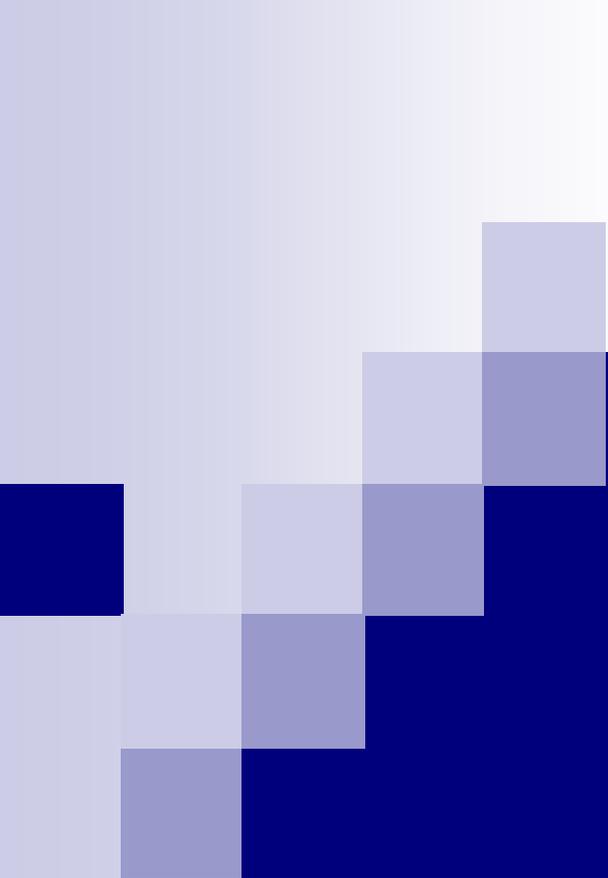
Sampled Storm Events

Parameter	Minimum	Maximum
Rainfall (inches)	0.07	2.7
Rainfall Intensity (inches/hour)	0.04	0.74
Peak Flow (cubic feet per second)	0.03	11.6
Mean Flow (cubic feet per second)	0.02	5.11

Hydrograph and water-quality samples collected during the April 7, 2005, runoff event.







Data Analysis and Findings

“Graphs & Stats”

Main questions addressed

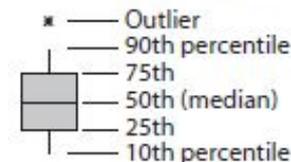
- How efficiently did each BMP reduce suspended sediment, organic material, and floatable oils and grease?
- Were the BMPs also effective at reducing fecal indicator bacteria, phosphorus, organic compounds, metals?
 - Wilcoxon signed rank test (control/treatment)
 - Evaluate removal efficiencies of each BMP by Efficiency Ratio (ER) approach (EPA, 2002)

Stormwater Quality Constituents

Constituents	Sample locations	Type of sample	Number of events sampled
pH, conductance	inlet/outlet	Sonde	12–13
Oil and grease	inlet/outlet	Grab	12–13
Turbidity	inlet/outlet	Flow-composited	12
Total suspended solids	inlet/outlet	Flow-composited	12
Chemical oxygen demand	inlet/outlet	Flow-composited	12
Nutrients (total phosphorus, total Kjeldahl nitrogen)	inlet/outlet	Flow-composited	12
Trace metal (lead, zinc, copper, nickel, and cadmium [total and dissolved])	inlet/outlet	Flow-composited	12
Base/neutral extractable organic compounds (polycyclic aromatic hydrocarbons)	inlet/outlet	Grab	8
Major ions (calcium, magnesium, hardness)	inlet/outlet	Flow-composited	12
Five-day biochemical oxygen demand	inlet/outlet	Grab	12
Suspended sediment	inlet/outlet	Flow-composited	12
Fecal coliform, enterococci, <i>Escherichia coli</i>	inlet/outlet	Grab	12
Bed-sediment inorganics	inlet/outlet	Grab	3

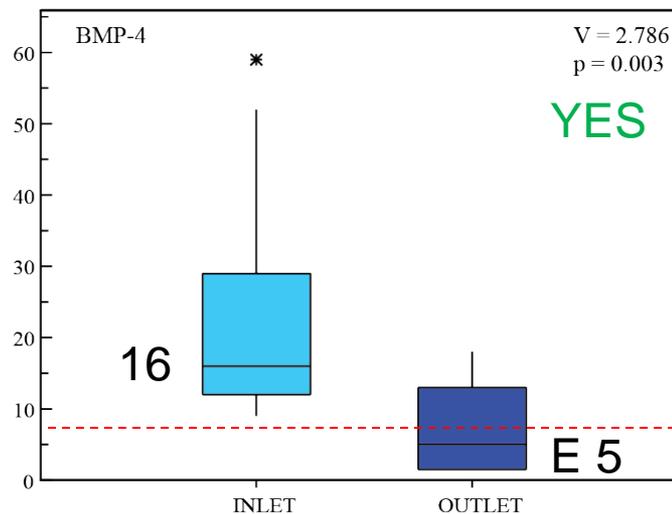
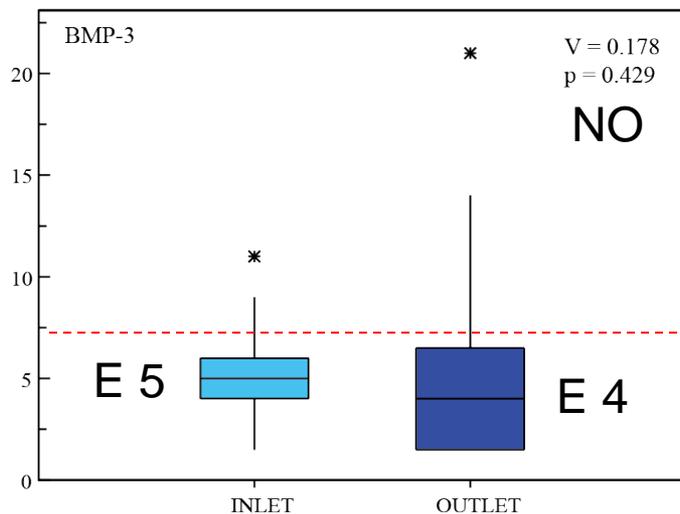
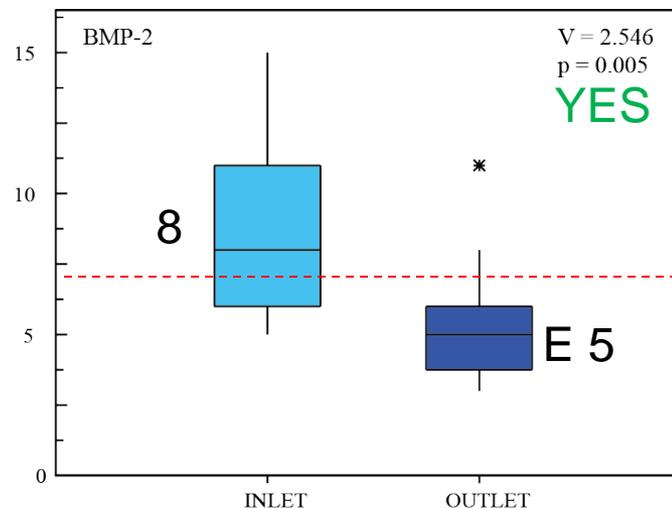
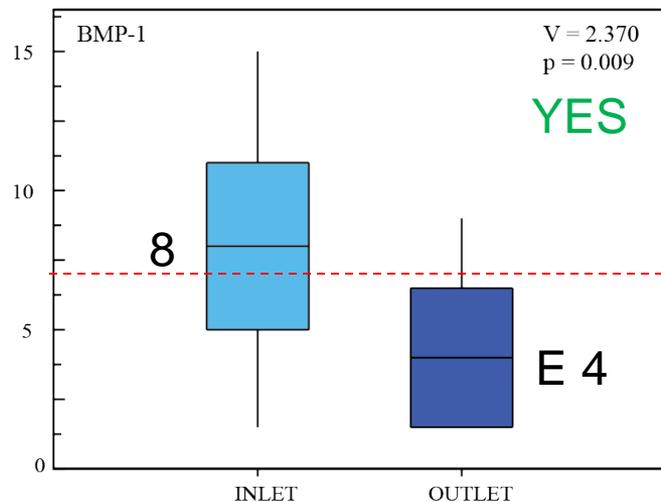
Floatable Oil & Grease

EXPLANATION



4 Median
E Estimated

EVENT- MEAN OIL AND GREASE CONCENTRATIONS, IN MILLIGRAMS PER LITER

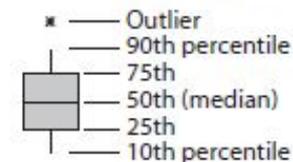


Quantification Level (Laboratory Reporting Level or LRL of 7 mg/L)

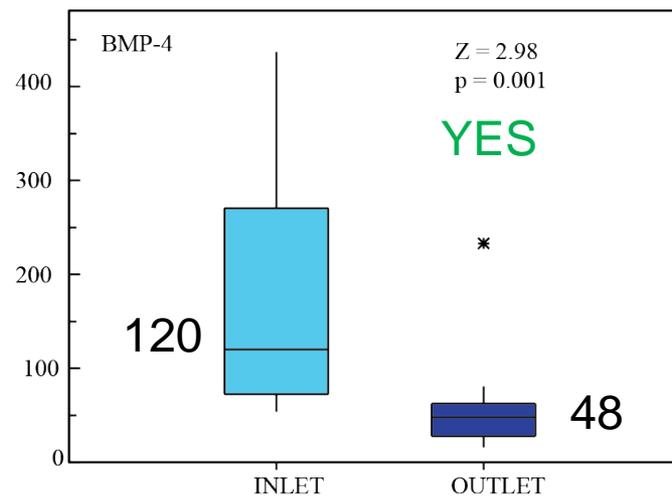
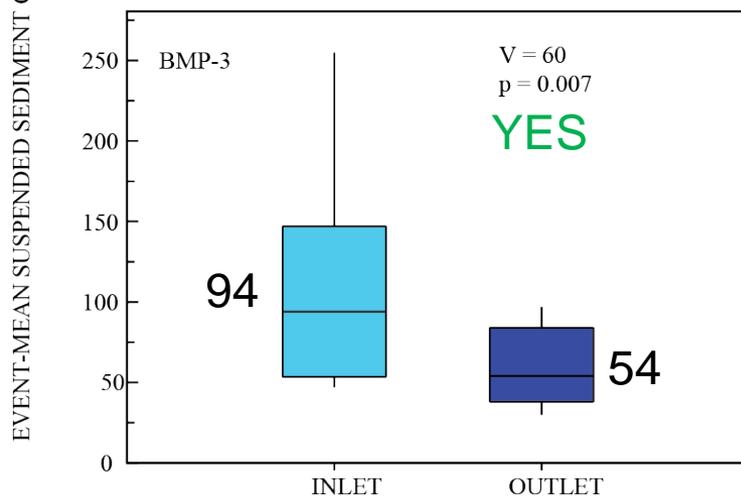
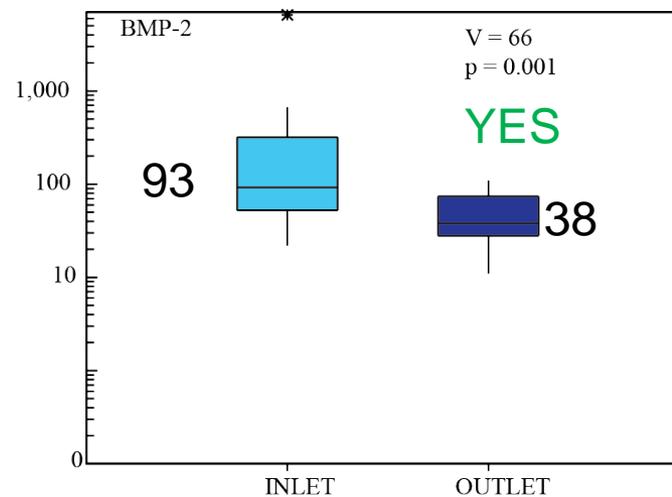
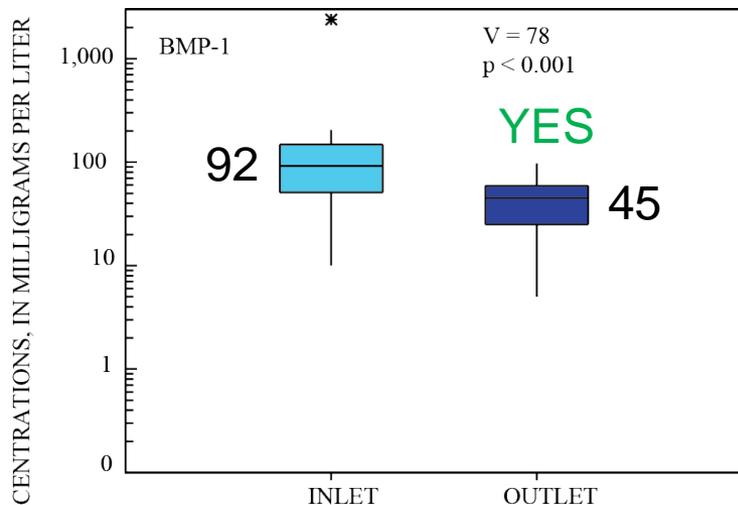
Values below the LRL are estimated and considered qualitative

Suspended Sediment

EXPLANATION

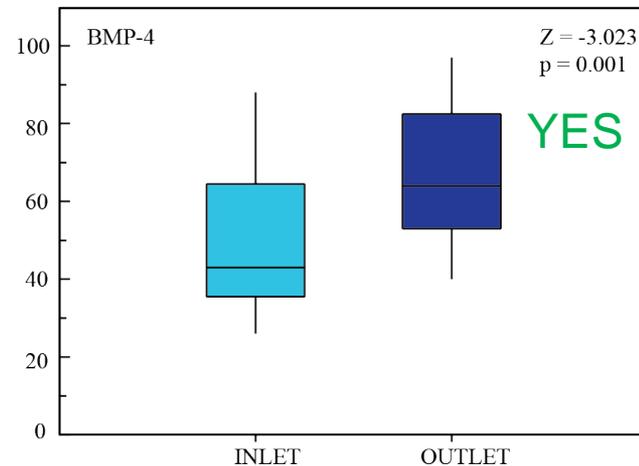
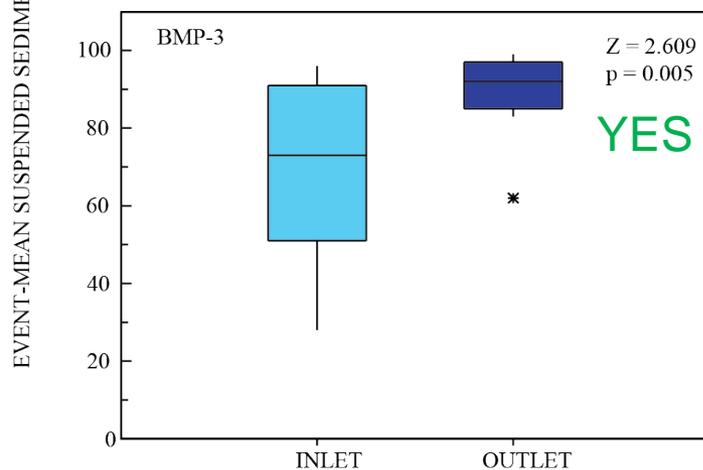
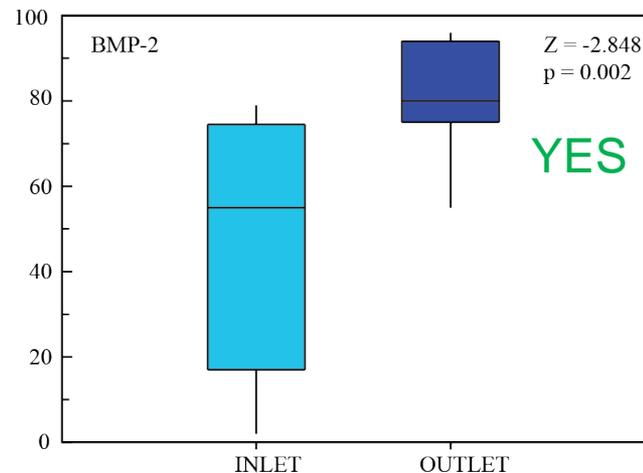
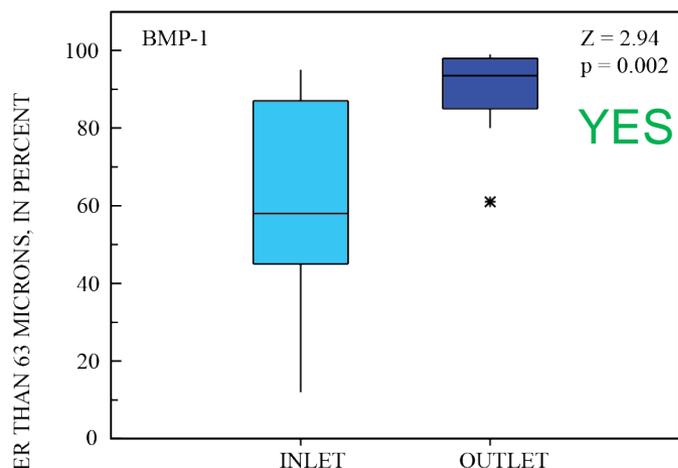
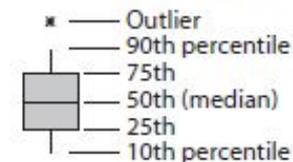


45 Median

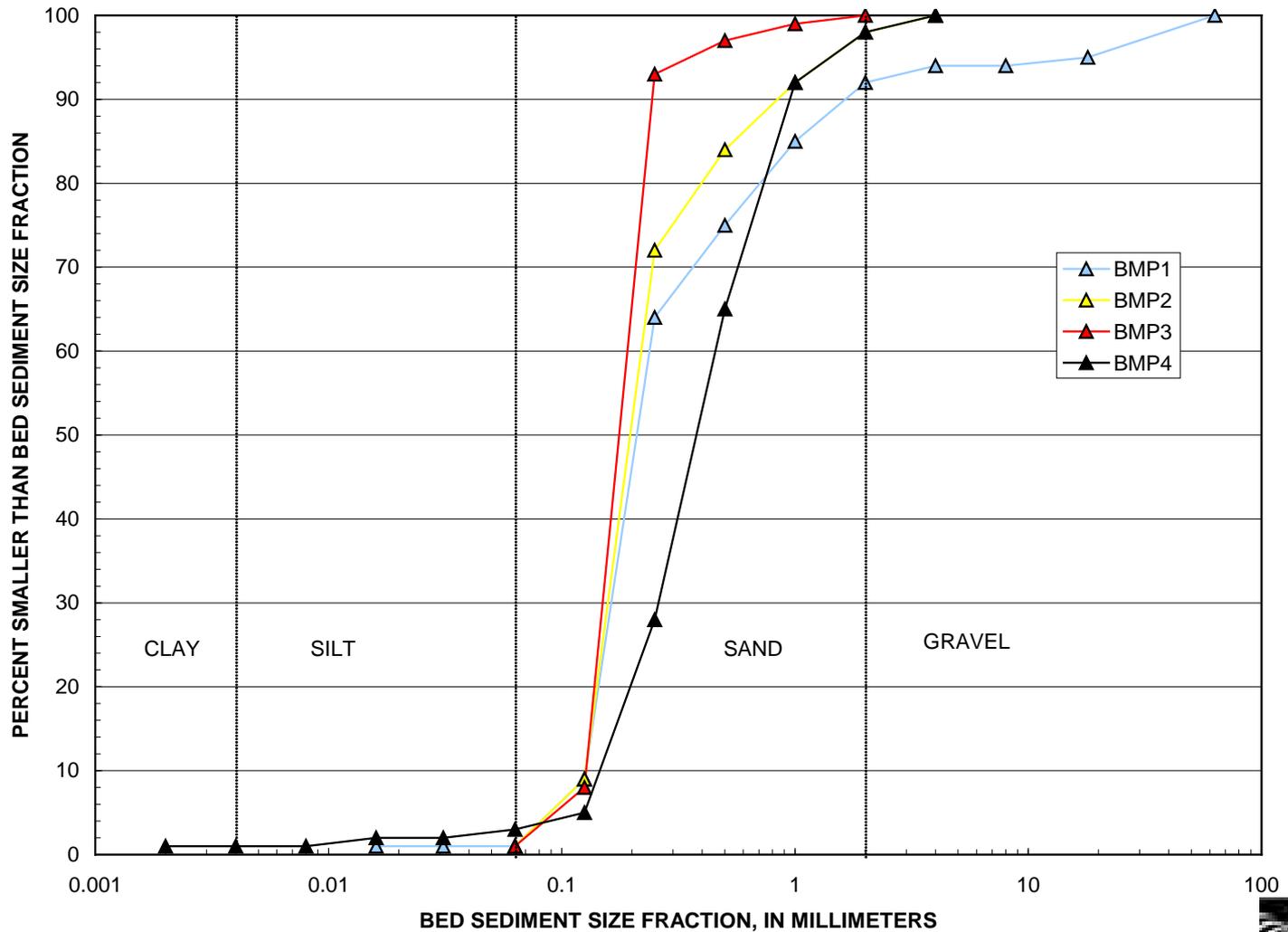


Percent of Suspended Sediment Finer than Sand

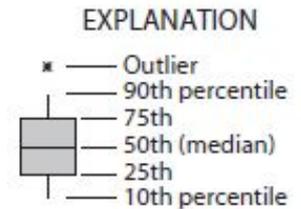
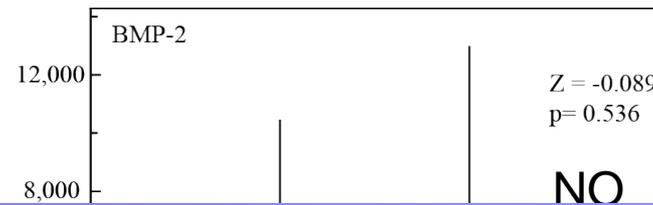
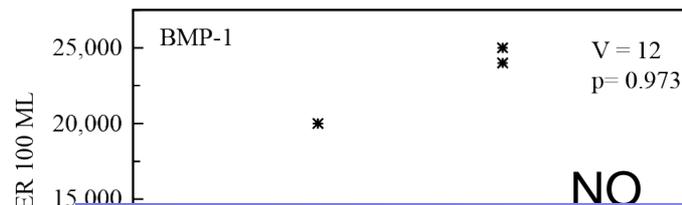
EXPLANATION



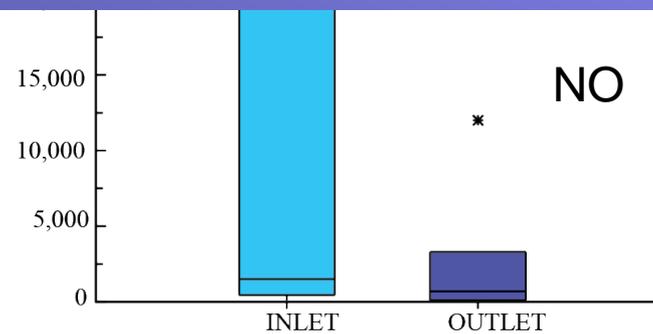
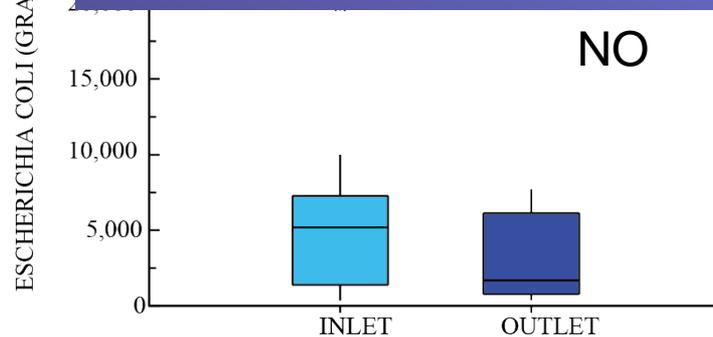
Grain Size of Accumulated Bed Sediment in BMPs



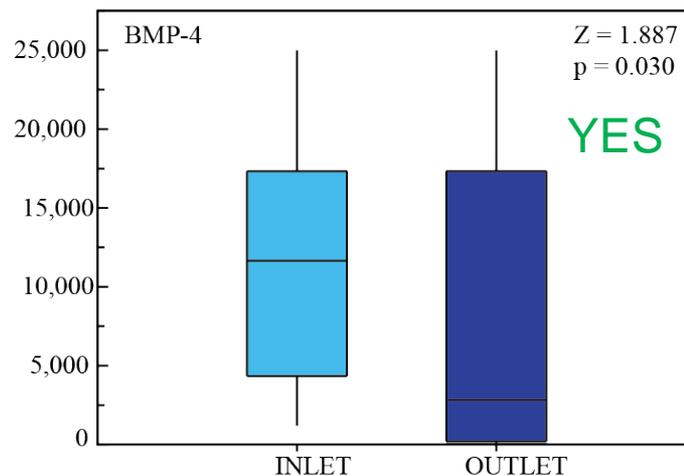
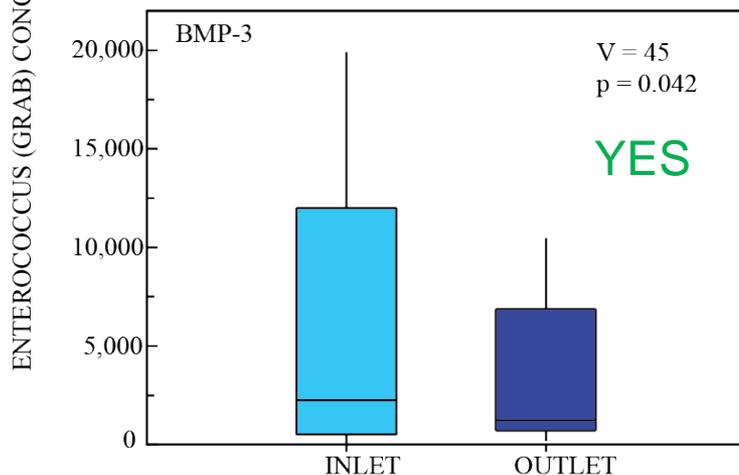
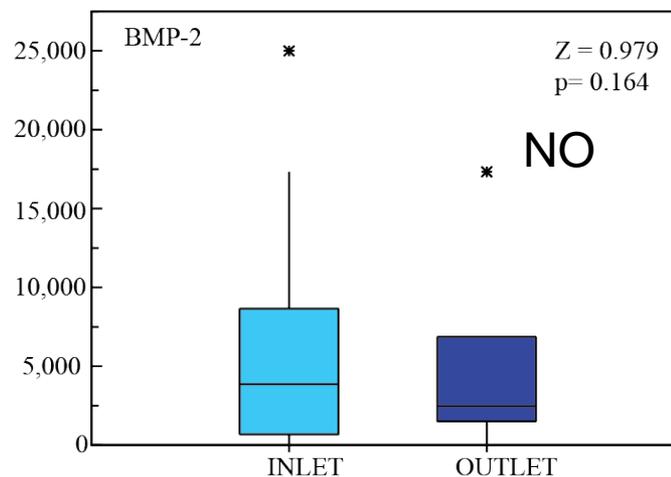
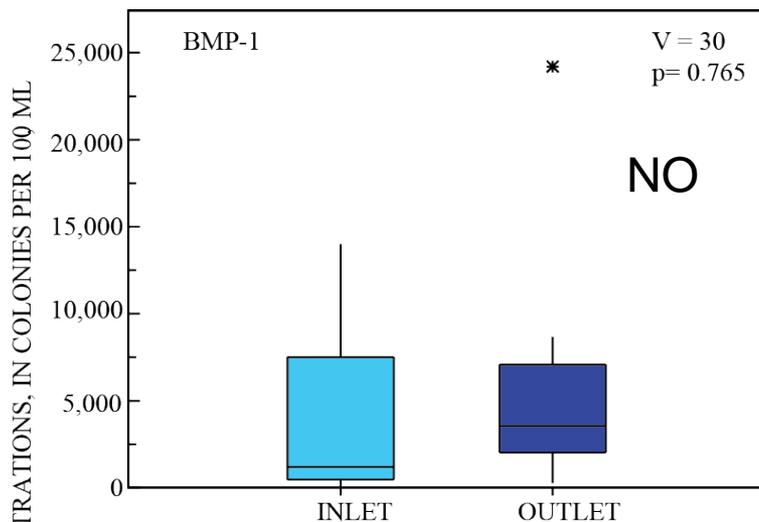
Escherichia Coli Concentrations



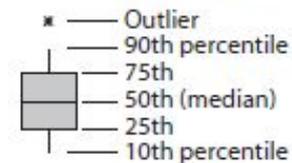
Studies have reported that *E. coli* preferentially attaches to the finer size (< 30 microns) fraction of sediment (Oliver and others, 2007, *Water, Air, Soil Pollution*, 185(1), p. 369-375; Kunkel and others, 2013, *Advances in Bioscience and Biotechnology*, 4, p. 407-414; Thupaki and others, 2013, *Journal of Geophysical Research*; 118, p. 7049-7065).



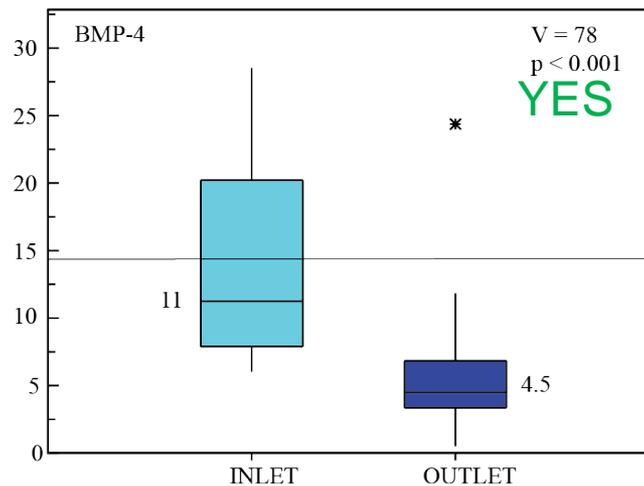
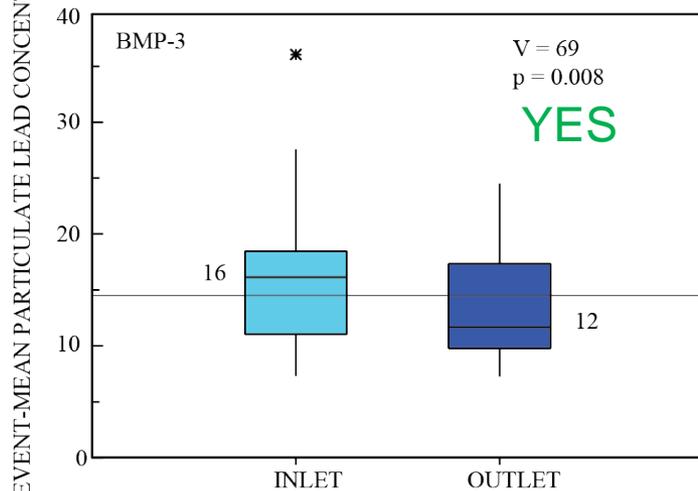
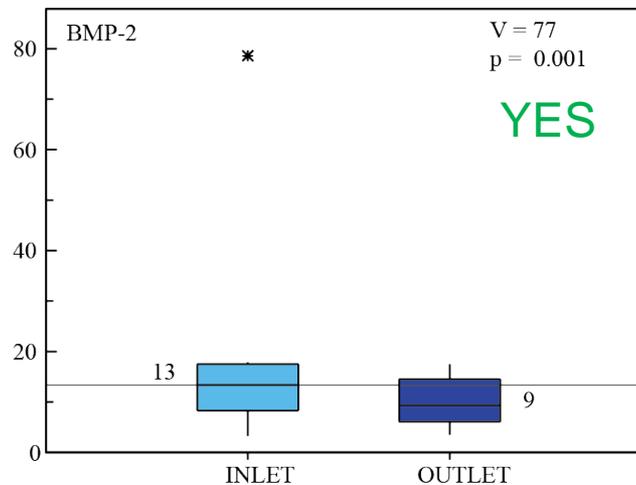
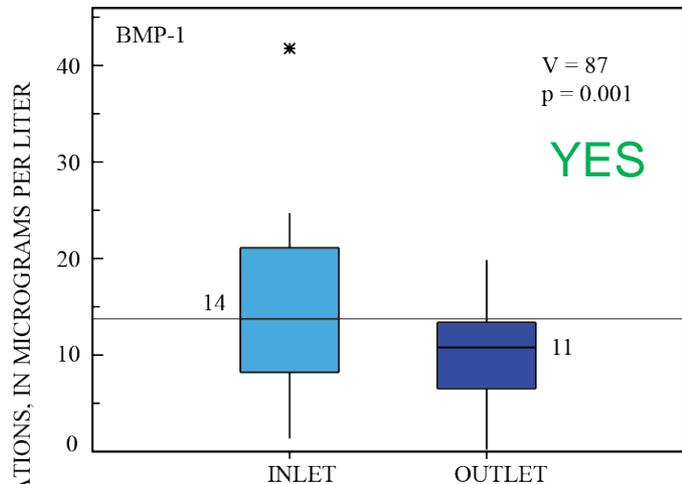
Enterococci Concentrations



EXPLANATION



Particulate Lead Concentrations



EXPLANATION



4 Median

Contaminants in Stormwater

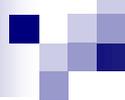
- Inlet water Aquatic Life Criteria Exceedance
- Total copper
- Total lead
- Total zinc
- E. coli
- Enterococci
- Outlet water Aquatic Criteria Exceedance
- Total copper
- E. coli
- Enterococci

Summary Table of Inlet and Outlet Water Quality

Site	SSC	SSC < 63 µm	TSS	Oil and grease	TKN, TP	BOD ₅ , COD	Fecal bacteria	Dissolved metals	Total metals	Particulate metals
¹ Event-mean concentrations										
BMP1	>	<	>	>	> (TP)	=	=	> (Cd, Cu, Zn)	> (all)	> (Pb)
BMP2	>	<	>	>	=	=	=	> (Cu)	> (all)	> (Cd, Pb, Ni, Zn)
BMP3	>	<	>	=	=	> (COD)	> (Enteroc)	=	> (all)	> (all)
BMP4	>	<	>	>	>	>	> (Enteroc)	> (Cu, Ni)	> (all)	> (all)
¹ Event-mean loads										
BMP1	>	NA	>	>	> (TP)	=	NA	> (Cd, Cu)	> (Cd, Pb, Zn)	> (Pb, Ni)
BMP2	>	NA	>	>	=	=	NA	> (Cu)	> (all)	> (Pb, Ni, Zn)
BMP3	>	NA	>	=	=	=	NA	=	> (Cd)	> (Cd, Pb, Zn)
BMP4	>	NA	>	>	>	>	NA	> (Ni, Zn)	> (Cd, Pb, Ni, Zn)	> (all)

¹ Results for fecal bacteria and oil and grease concentrations are from a “first flush” grab sample.

- >, inlet water is statistically greater than outlet water
- <, inlet water is statistically less than outlet water
- =, no difference in inlet and outlet water



EFFICIENCY ASSESSMENT

- All four BMP devices were efficient at significantly reducing suspended sediment and total trace-metal concentration
 - All but BMP 3 were efficient at reducing oil & grease concentrations.
- All four BMPs were not as successful at reducing fecal indicator bacteria, nutrient, and total organic carbon concentrations, and biochemical oxygen demand levels.

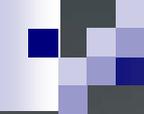
EFFICIENCY ASSESSMENT

■ Environmental conditions

- Slightly larger watershed size at BMP3.
- Greater inlet concentrations at BMP4.
- Similar daily traffic counts among sites and seasons

■ Irreducible concentrations

- All devices tended to reduce concentrations in inlet water to a relatively consistent lower limit.
- BMPs with greater inlet water concentrations would have greater reduction percentage and appear to be more efficient.



Questions?

<http://pubs.usgs.gov/sir/2008/5150/>

Contact Info:

Kevin Conlon, kjconlon@usgs.gov

Celeste Journey, cjourney@usgs.gov



SURFACE WATER SUPPLY OF THE
UNITED STATES

1916

PART X. THE GREAT BASIN

Questions

LABORATED BY
W. CLARKE, CHIEF CHEMIST



WASHINGTON
PRINTING OFFICE
1914



Hydraulic Engineer
E. HENSHAW, G. C. BARR
Engineers

the States of
OREGON, AND WYOMING

Reports on the topics discussed today are available online.



<http://pubs.usgs.gov/sir/2013/5175/pdf/sir2013-5175.pdf>

