



# Field Study on Removal of Dissolved Metals from Parking-lot Runoff by Catch Basin Filters Augmented with Media Containing Water-treatment Residuals



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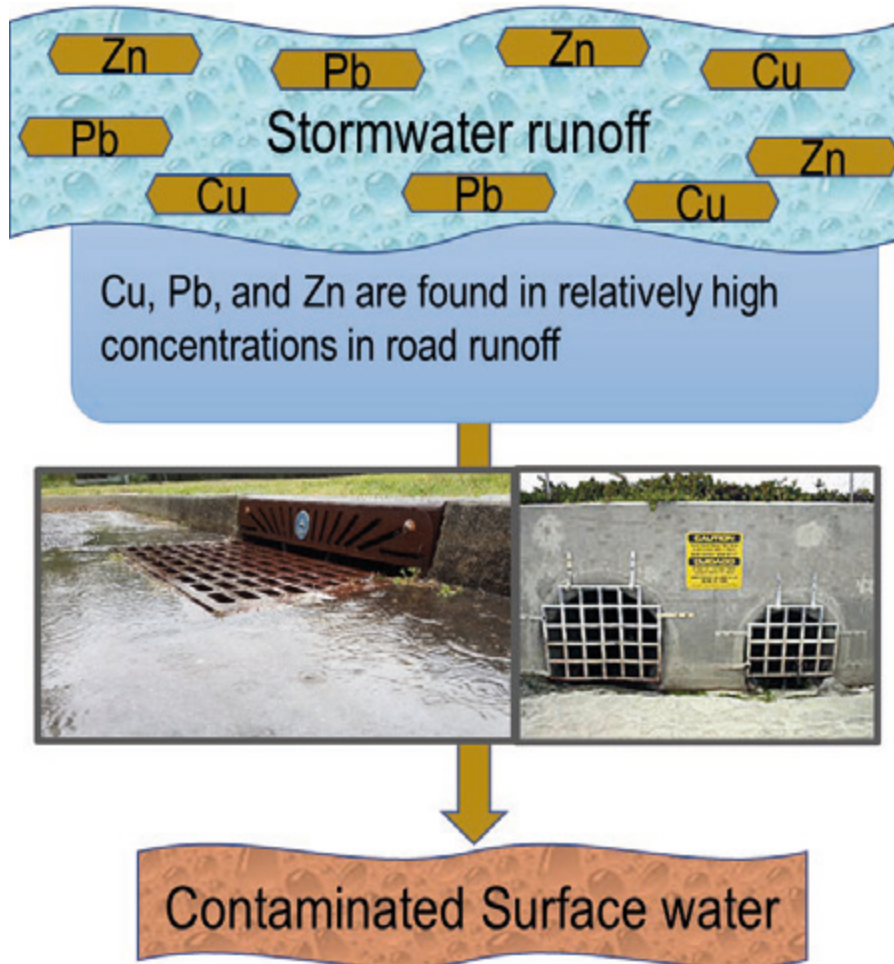


# Sources of Metals in Road Runoff



- **Cu:** pavement wear, brake linings, plumbing, electroplating wastes, and algaecides
- **Pb:** car batteries and exterior paints
- **Zn:** car tires, atmospheric fallout, exterior paint, and building sidings

# Metals in Road Runoff



## Harmful Characteristics of Metals

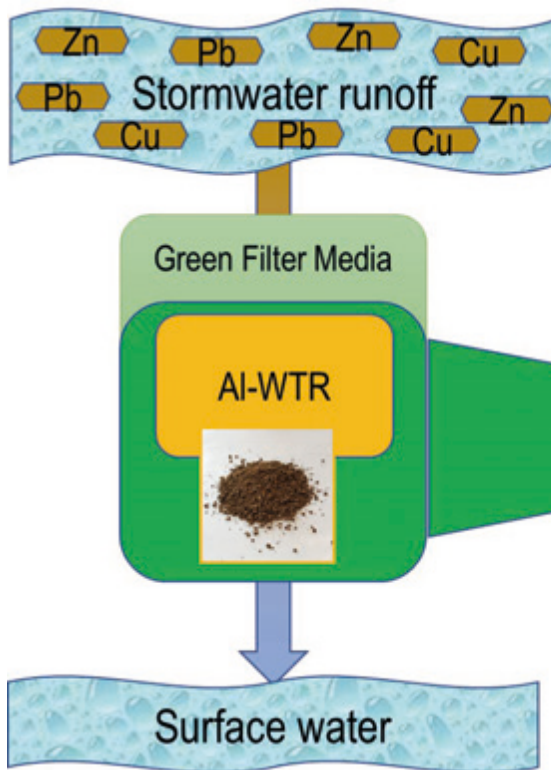
- Accumulation in the environment
- Non-biodegradability
- Biomagnification
- Toxicity

## Adverse impacts

- Affecting reproduction rates and life spans of aquatic species
- Disrupting food chains in aquatic systems
- Affecting water supplies

# Objective

To develop green catch basin filter to remove heavy metals from road runoff

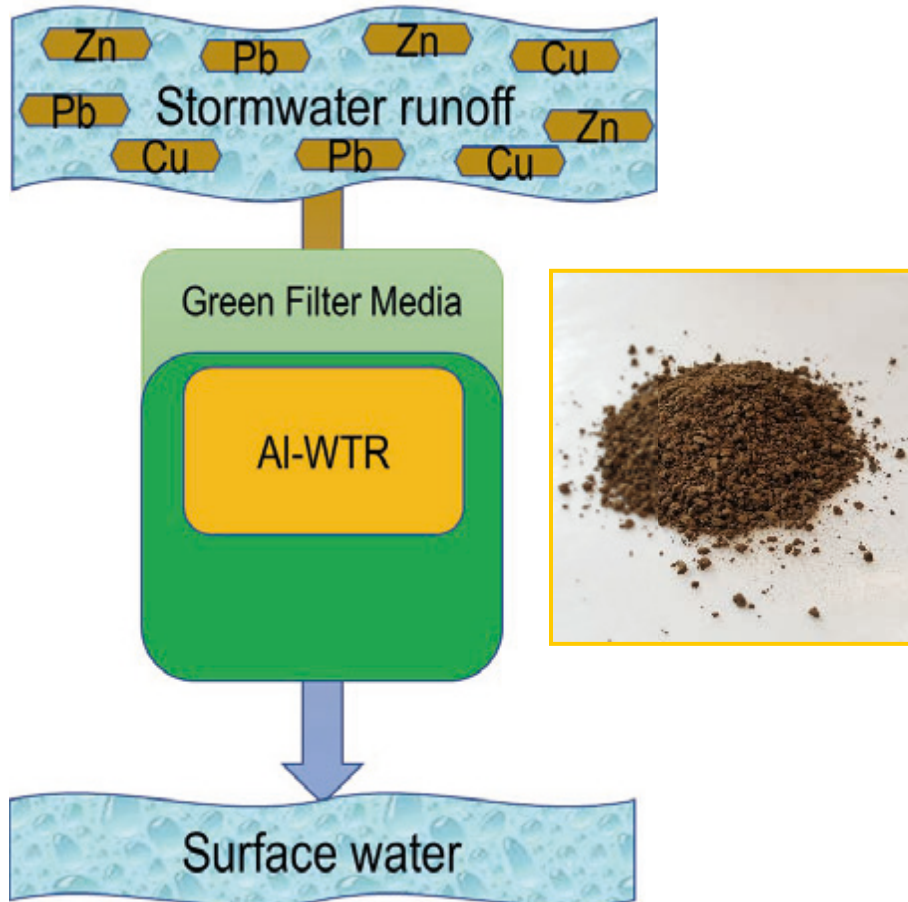


## Catch Basin Inserts

- Stormwater drain retrofit
- Easy installation and maintenance
  - Low cost

# Objective

To develop green catch basin filter to remove heavy metals from road runoff



## Aluminum-based water treatment residuals (Al-WTR)

- A byproduct of drinking water treatment process
- Available at no cost
- Primary components: Al-hydroxides
- Very high specific surface; highly effective in metal adsorption
- Everyday 2 mega tons generated in the US
- Non-hazardous waste material



# Aluminum-based water treatment residuals (AI-WTR)

## Toxicity Characteristic Leaching Procedure (TCLP)

TCLP values (mg/L) of RCRA 8 metals		
Analyte (mg L <sup>-1</sup> )	USEPA Limit (mg L <sup>-1</sup> )	AI-WTR
Arsenic	5	1.93
Barium	100	1.44
Cadmium	1	0.028
Chromium	5	0.023
Lead	5	0.239
Mercury	0.2	< MDL**
Selenium	1	< MDL
Silver	5	0.001
Copper	10	0.05
Zinc	NR	0.244
Aluminum	NR	228.9
Iron	NR	2.308

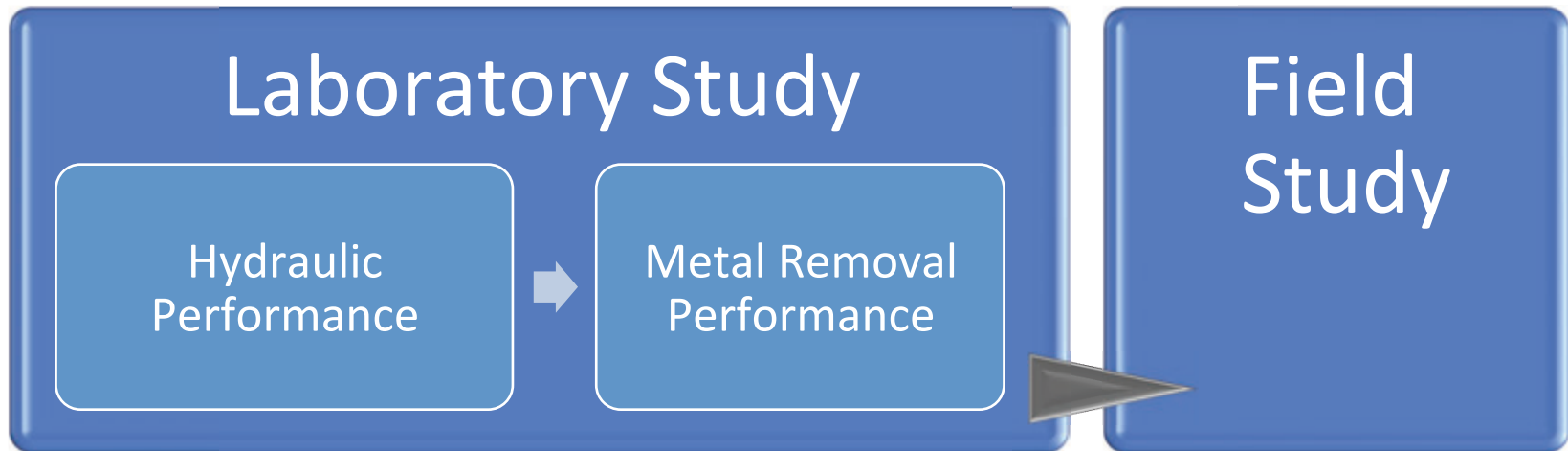


# Aluminum-based water treatment residuals (AI-WTR)

## Synthetic Precipitation Leaching Procedure (SPLP)

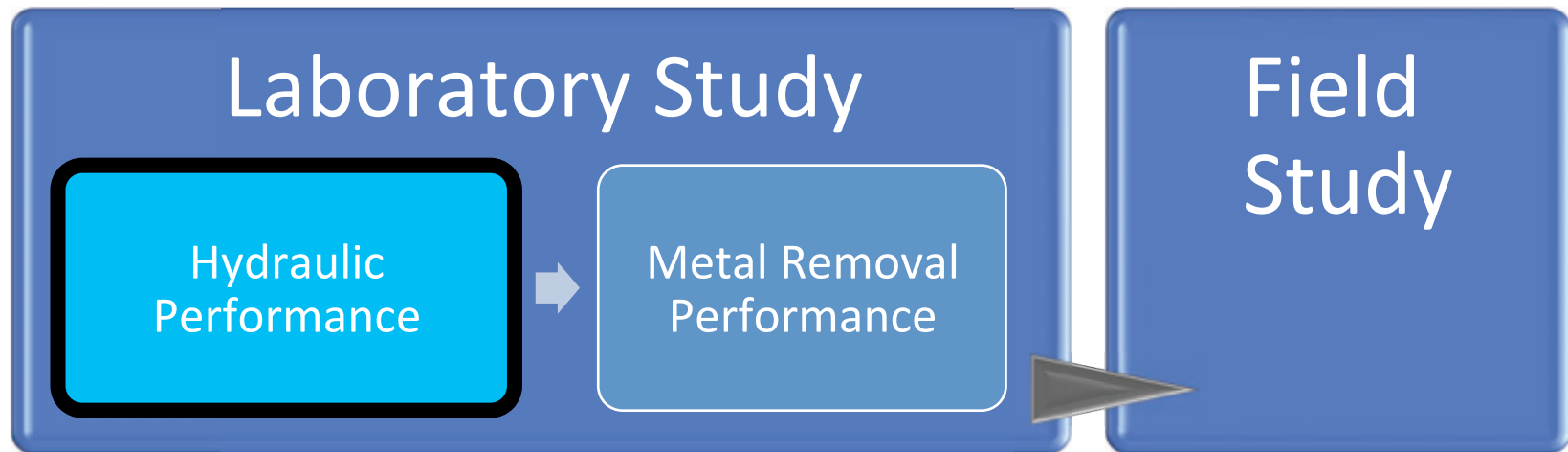
SPLP values (mg/L) of RCRA 8 metals		
Analyte (mg L <sup>-1</sup> )	USEPA Limit (mg L <sup>-1</sup> )	AI-WTR
Arsenic	5	0.002
Barium	100	0.049
Cadmium	1	0
Chromium	5	0.001
Lead	5	0
Mercury	0.2	0.004
Selenium	1	0.001
Silver	5	< MDL**
Copper	10	0.003
Zinc	NR	0.003
Aluminum	NR	10.23
Iron	NR	3.285

# Development Timeline

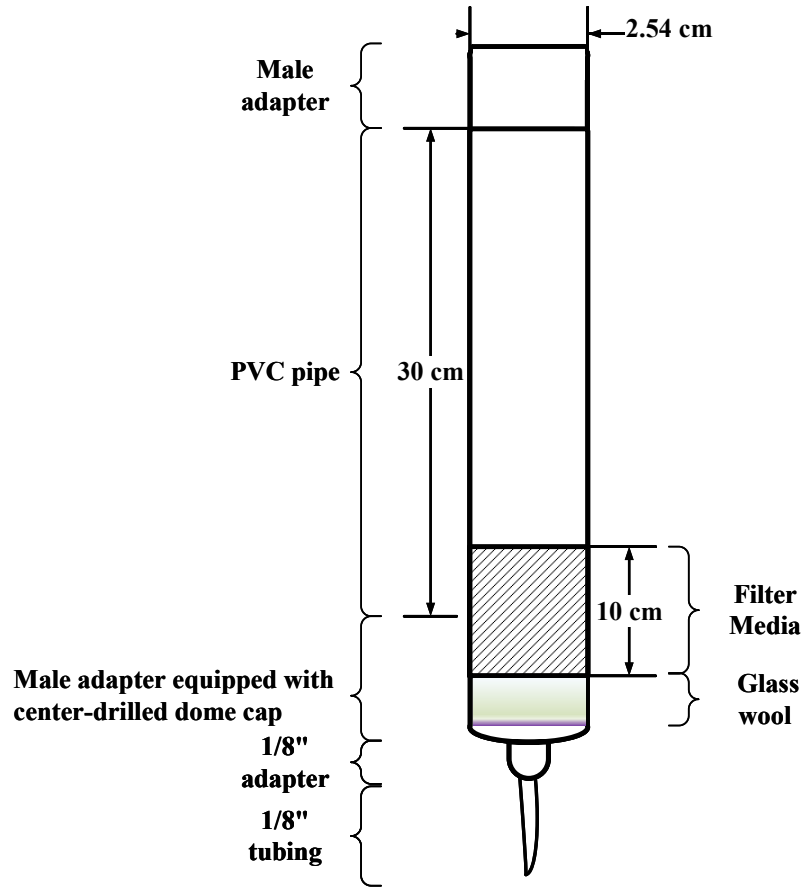




# Lab study: Hydraulic Performance Column Study



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Carbon Material (CM)



Mono-layer media



Dual-layer media

Sand + Al-WTR

Blended Sand:CM 1:1 + Al-WTR

CM + Al-WTR

2.5 cm of Al-WTR-amended sand over a 7.5 cm layer of CM

5 cm of Al-WTR-amended sand over a 5 cm layer of CM



Al-WTR

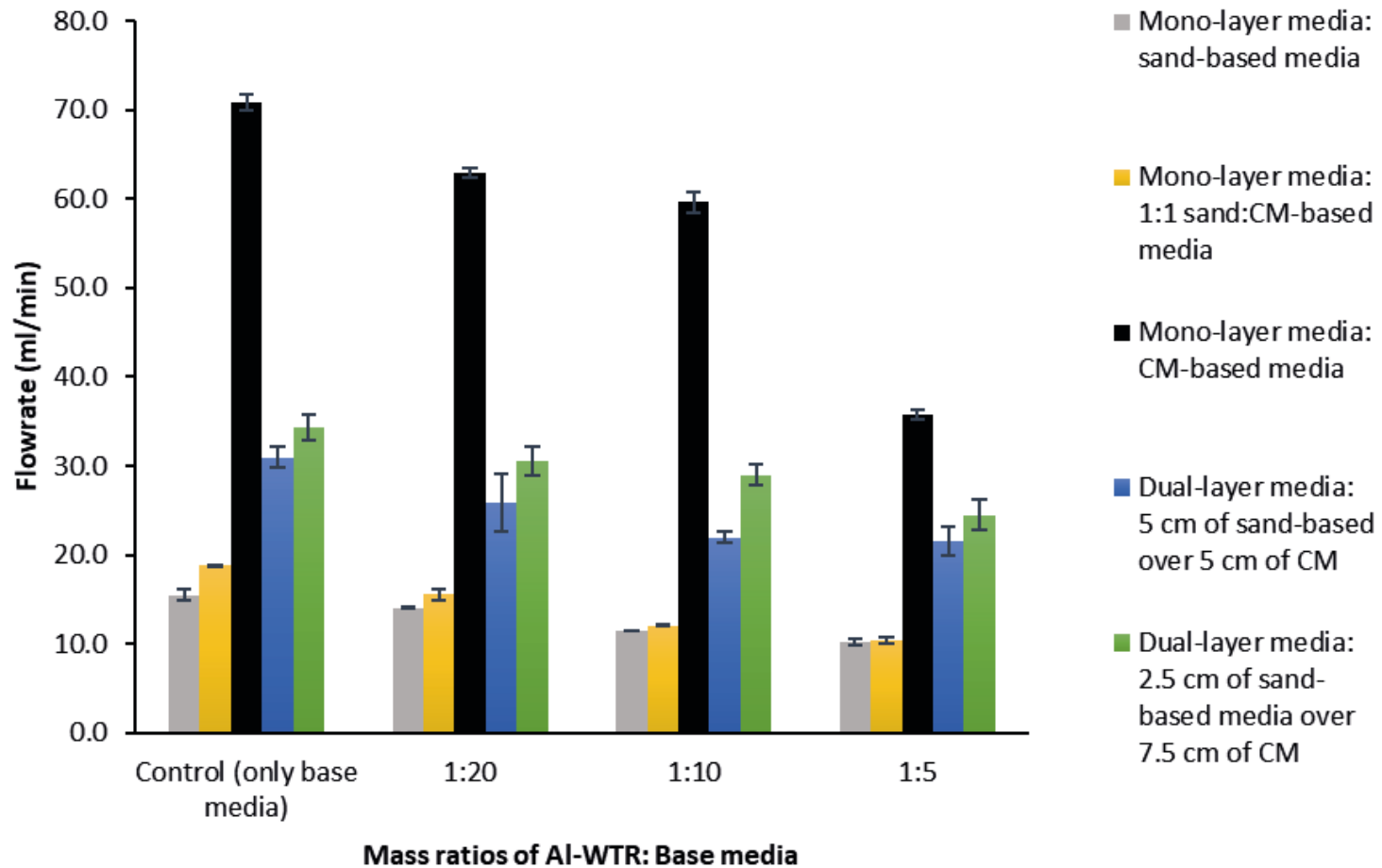


Sand

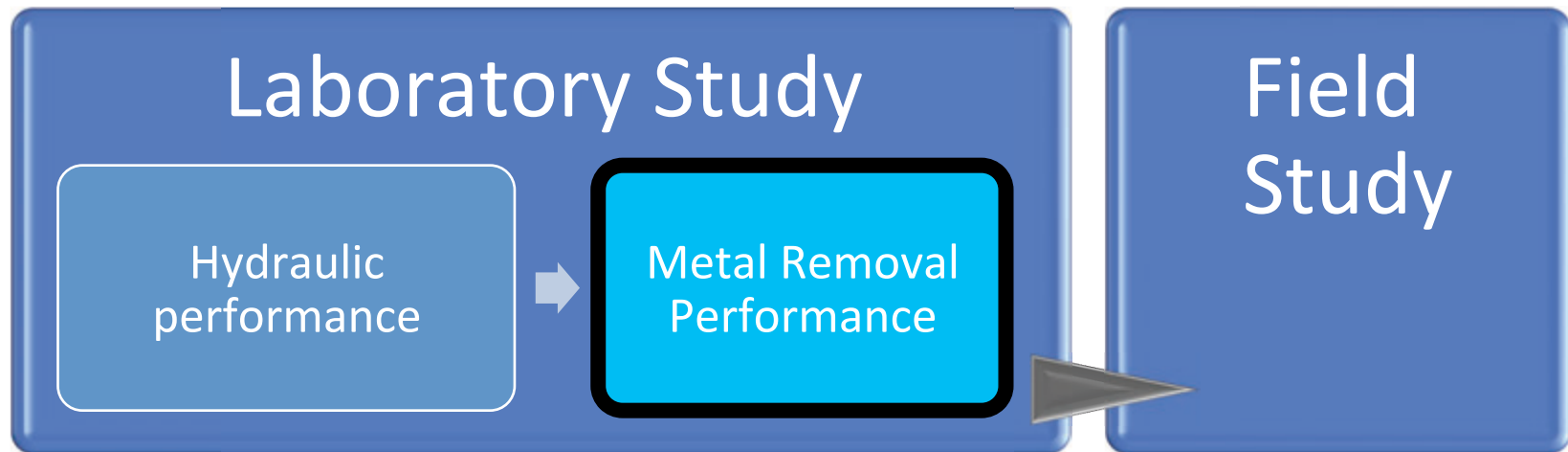
4 different mixing ratios Al-WTR: Base media (w/w): 1:20, 1:10, 1:5 and 0:1



# Lab study: Hydraulic Performance Column Study



# Lab study: Metal Removal Performance



# Lab study: Metal Removal Performance



## Synthetic stormwater

- Cu - 6.36 mg/L (Source: Nitrate salt)
- Pb - 8.16 mg/L (Source: Nitrate salt)
- Zn - 11.70 mg/L (Source: Nitrate salt)

Parameter	Value
Bed Height (cm)	10
Bed Volume (mL)	50.7
Flow Rate (mL/min)	8
Sample Collection	Every 5 minutes for the first 20 minutes, followed by geometric progression

# Lab study: Metal Removal Performance



Al-WTR: sand

0:1  
(only  
sand)

1:20

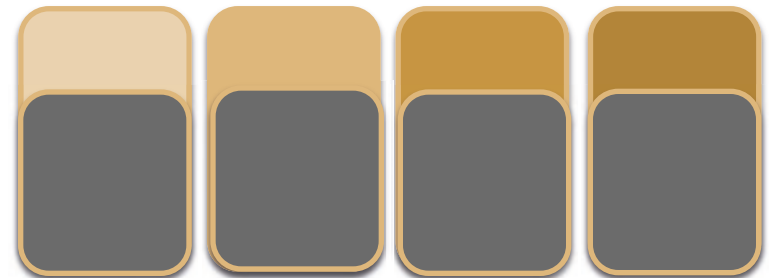
1:10

1:5

Mono-layer:  
sand-based media



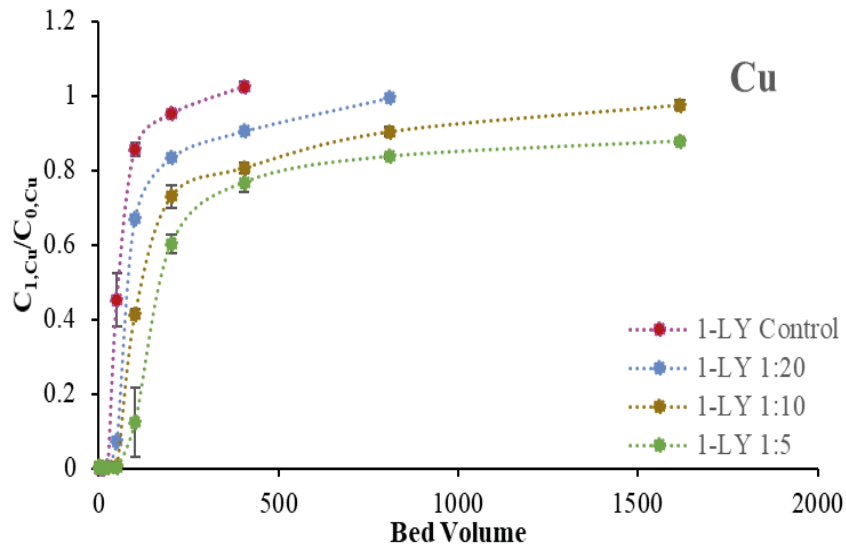
Dual-layer:  
2.5 cm of sand-based  
media over  
7.5 cm of CM



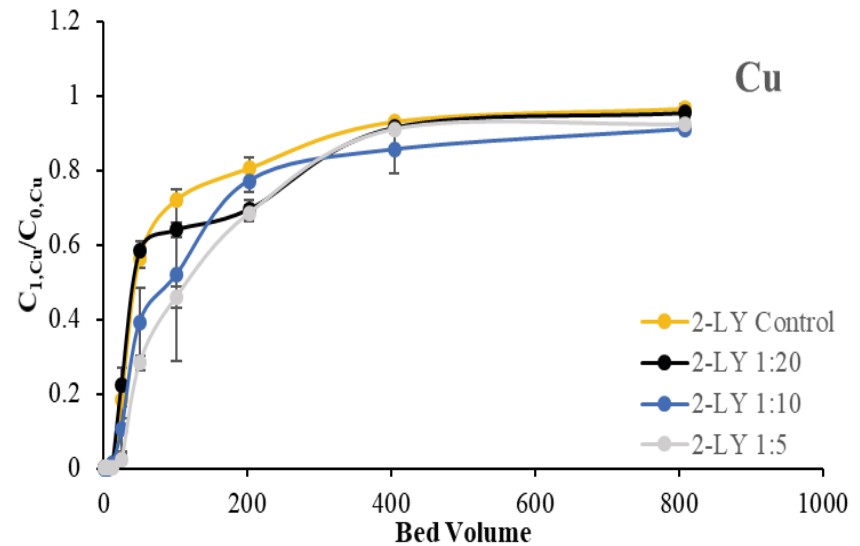


# Lab study: Copper Removal Performance

**Mono-layer:  
sand-based media**



**Dual-layer:  
2.5 cm of sand-based media over  
7.5 cm of CM**

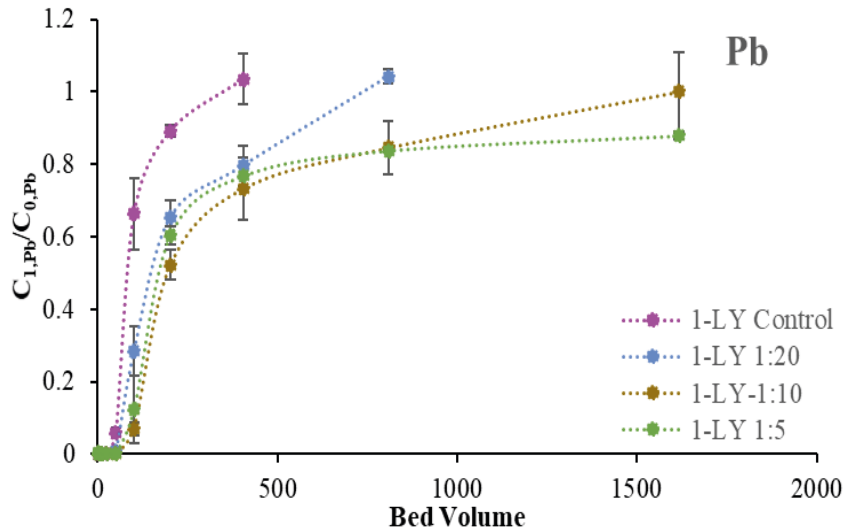




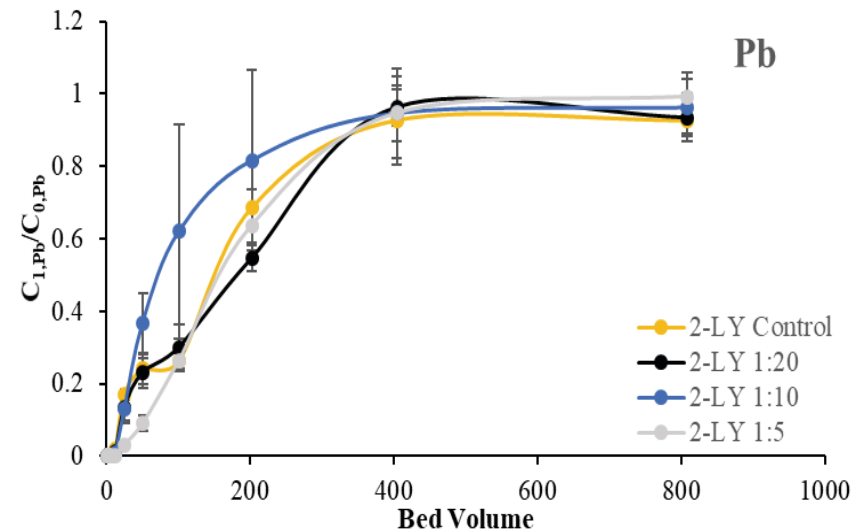


# Lab study: Lead Removal Performance

### Mono-layer: sand-based media



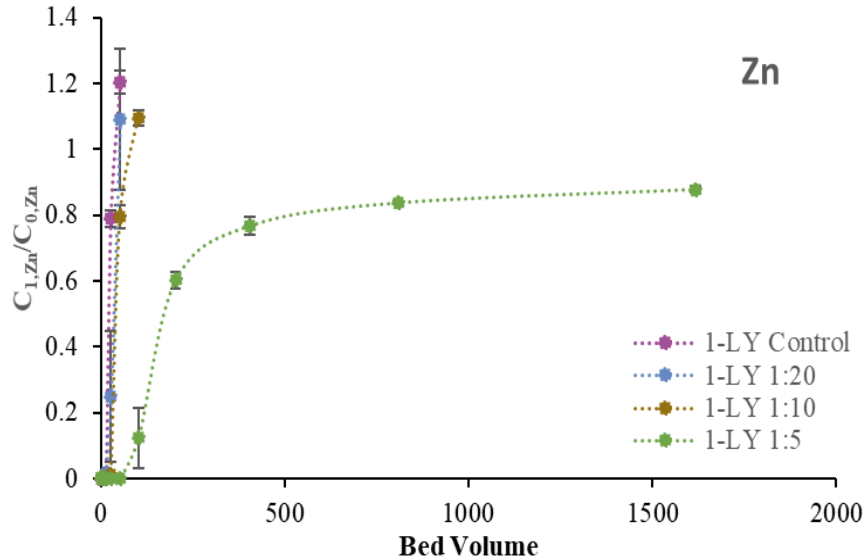
### Dual-layer: 2.5 cm of sand-based media over 7.5 cm of CM



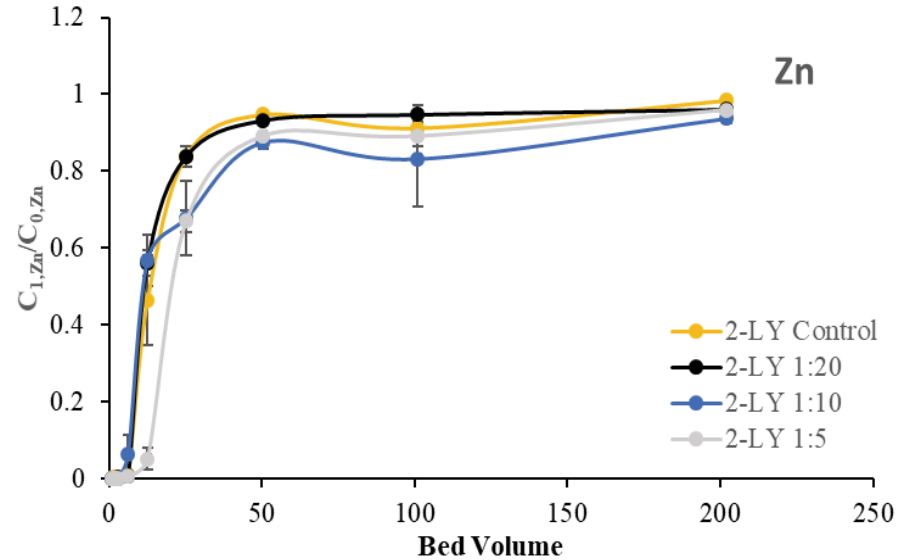


# Lab study: Zinc Removal Performance

### Mono-layer: sand-based media



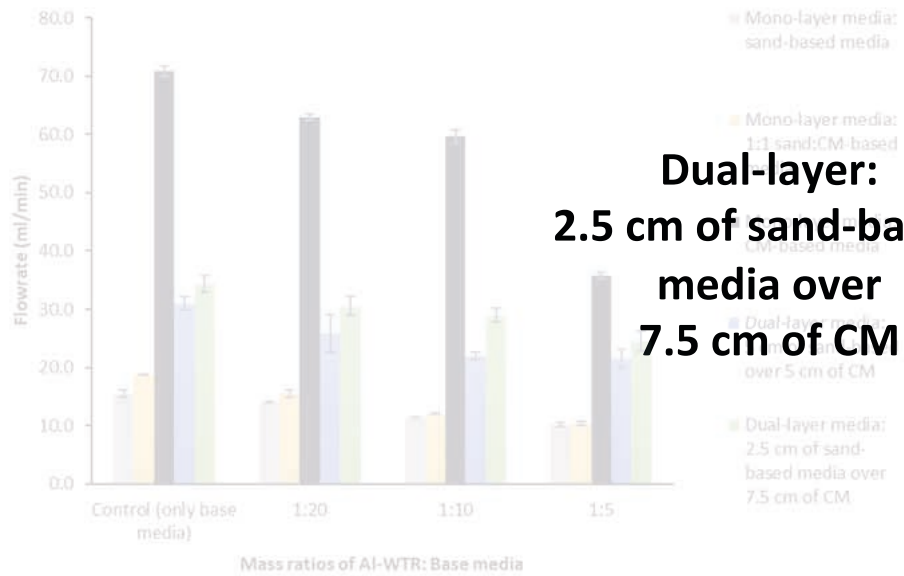
### Dual-layer: 2.5 cm of sand-based media over 7.5 cm of CM



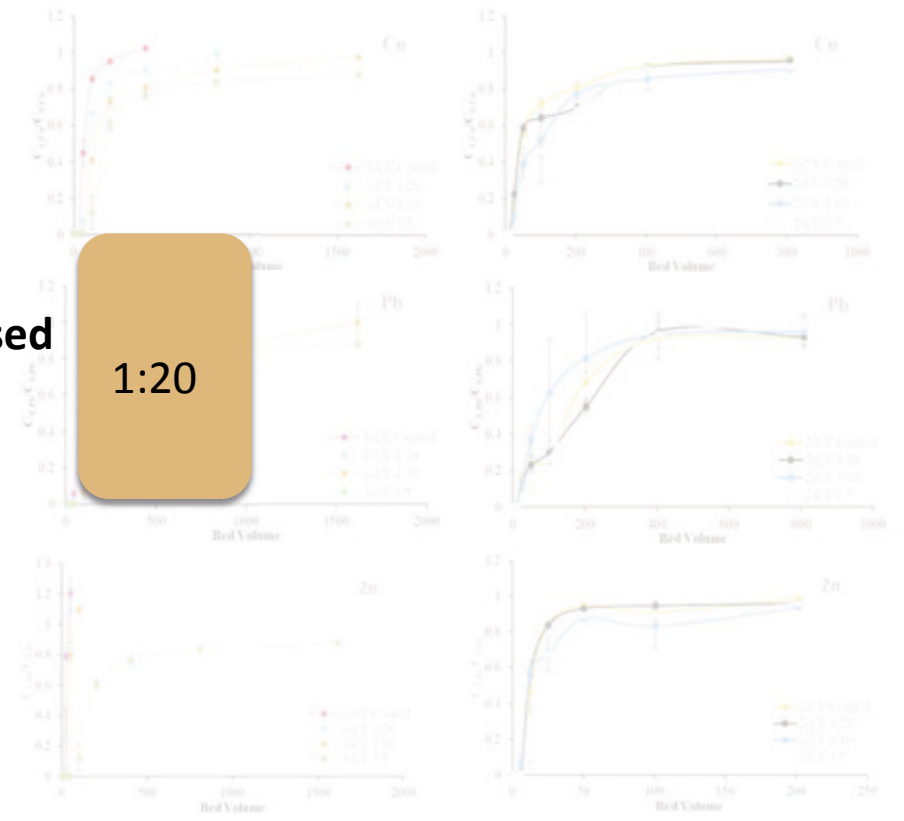
# Lab study

Hydraulic performance

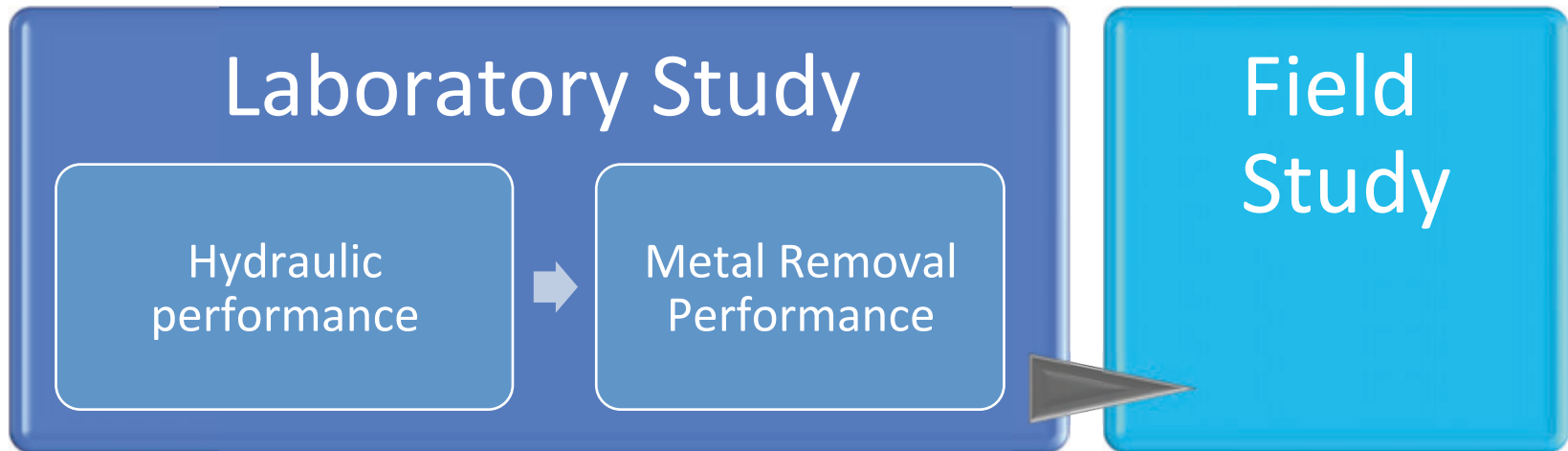
Metal Removal Performance



**Dual-layer:  
2.5 cm of sand-based  
media over  
7.5 cm of CM**

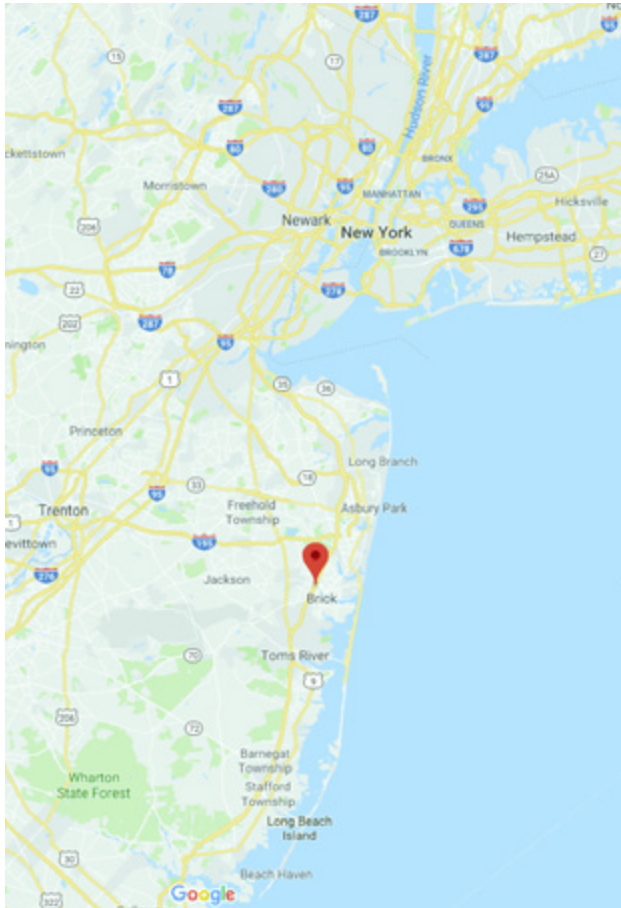


# Field study



# Field study: Study area

Township of Brick Municipal Building

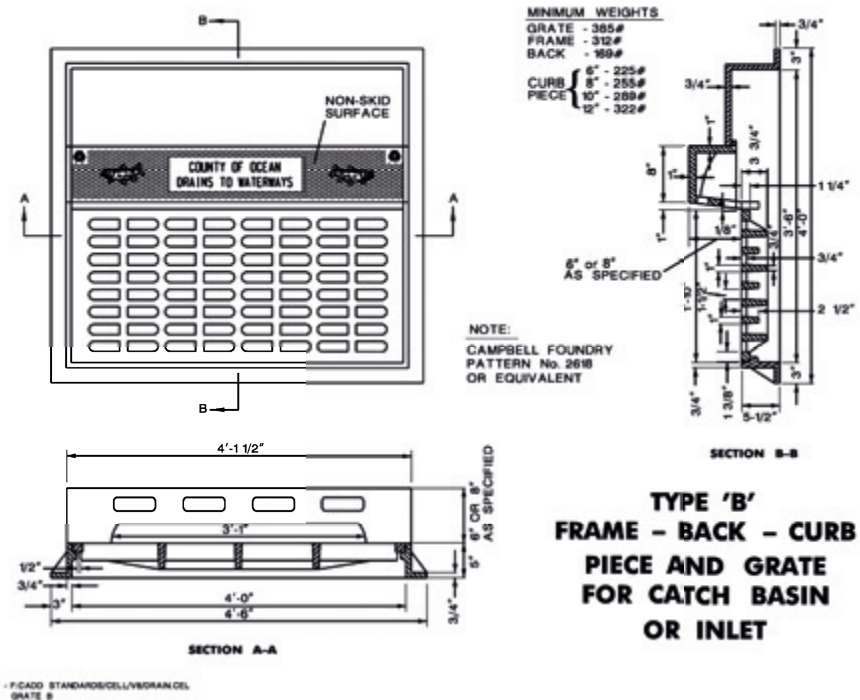


# Field study: Setup

## Field testing setup had to be able to:

- Retain and withstand the weight of the filter media
- Direct water to pass through the filter media
- Allow us to sample water before and after passing through the filter media
- Prevent flooding in the case of big storm events through overflow window
- Fit catch basins at the site

Some commercial setups cost more than \$1800



# Field study: Setup

**Field testing setup had to be able to:**

- Retain and withstand the weight of the filter media
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- Fit catch basins at the site

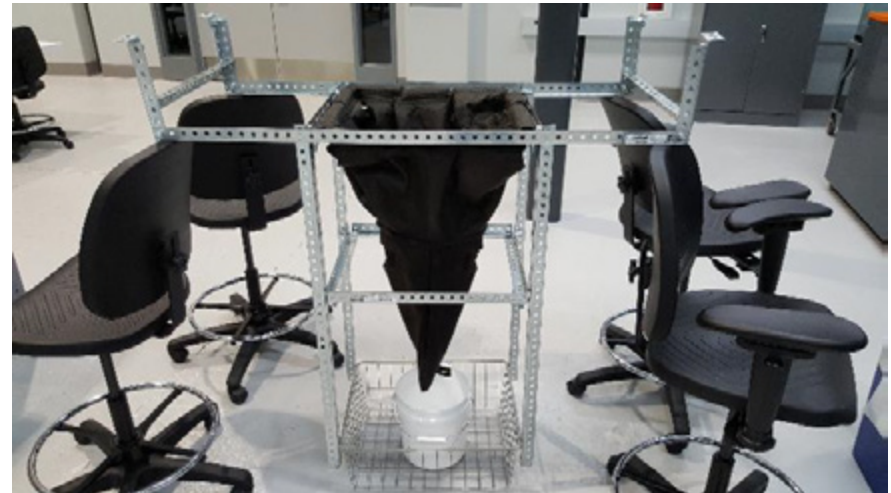
**Cost:** less than \$300



# Field study: Setup

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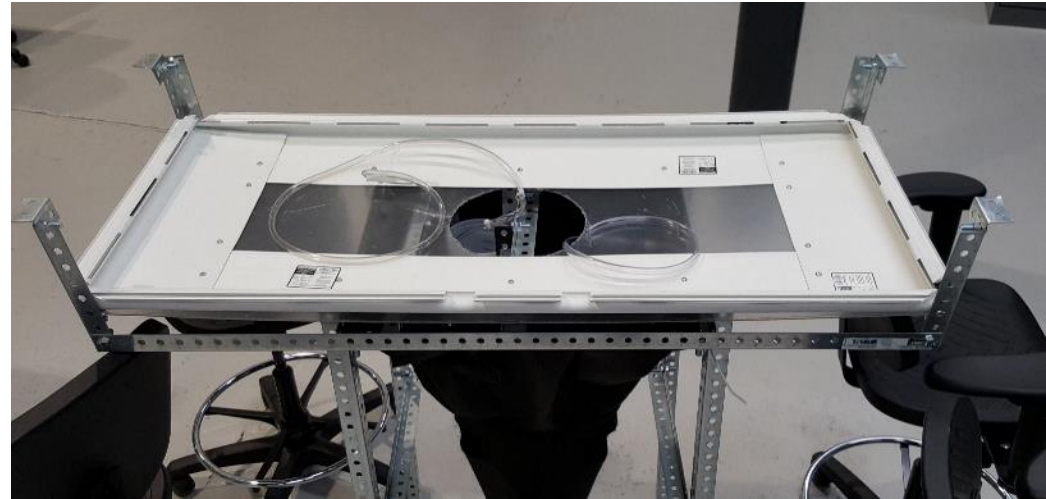




# Field study: Setup

**Field testing setup had to be able to:**

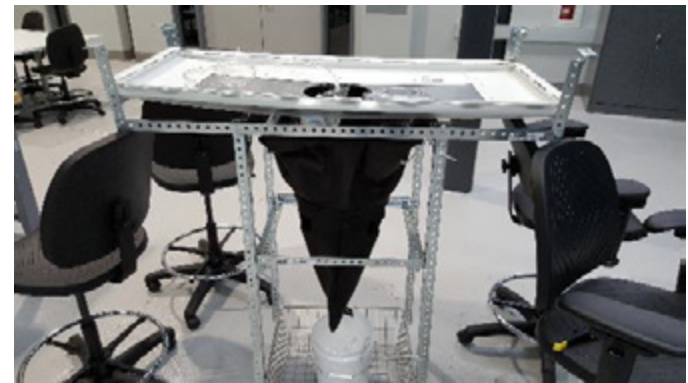
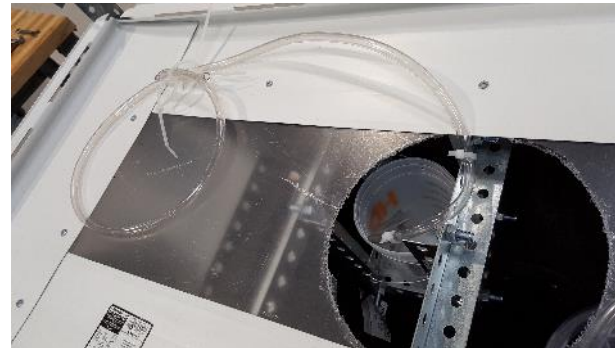
- ✓ Retain and withstand the weight of the filter media
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# Field study: Setup

Field testing setup had to be able to:

- ✓ Retain and withstand the weight of the filter media
- ✓ Direct water to pass through the filter media
- ✓ Allow us to sample water before and after passing through the filter media
- ✓ Prevent flooding in the case of big storm events through overflow window
- ✓ Fit catch basins at the site

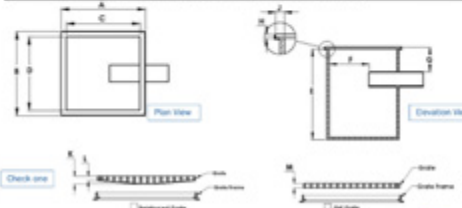
## MEASURE YOUR CATCH BASIN

Date \_\_\_\_\_ Email \_\_\_\_\_  
 Contact \_\_\_\_\_ Phone \_\_\_\_\_  
 Company \_\_\_\_\_  
 Site Address \_\_\_\_\_  
 Catch Basin-Part Number (if applicable) \_\_\_\_\_



Catch Basin / Grate	Measurement	Catch Basin / Grate	Measurement
A	Grate width (outside)	G	Top of outlet to surface grade
B	Grate length (outside)	H	Grate frame height
C	Grate width (inside)	J	Grate frame width
D	Grate length (inside frame)	K	Reinforced grate thickness (center)
E	Bump depth	L	Reinforced grate thickness (edges)
F	Clearance to outlet pipe/half	M	Flat grate thickness

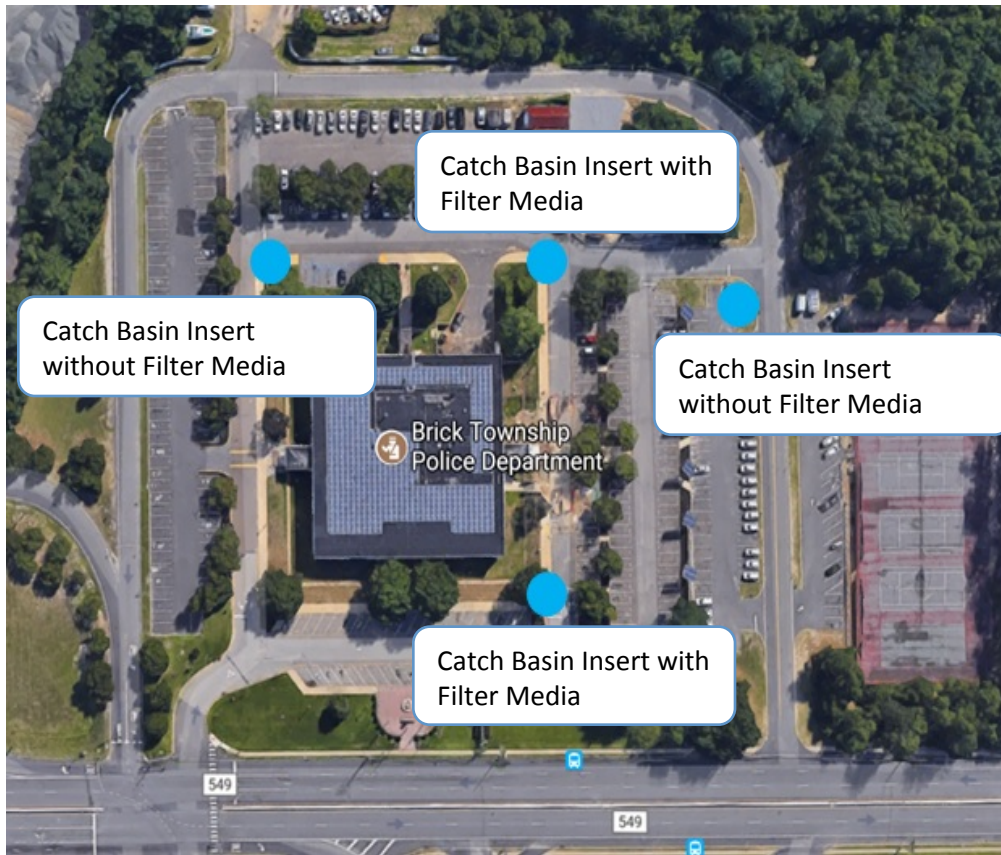
\*Please send any photos of your catch basin and grate to avoid any possible obting.



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# Field study: Storm drains location

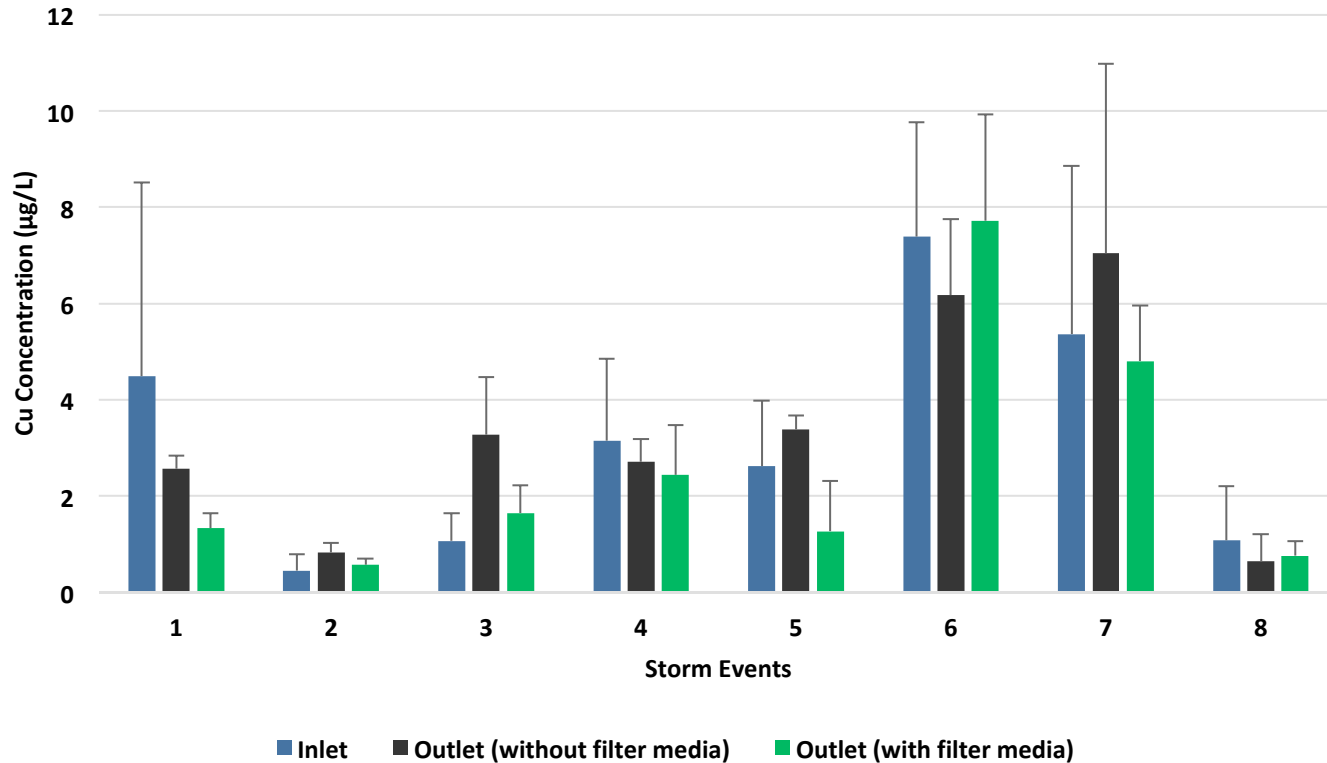


**Study Period:** 4 months (August – November)

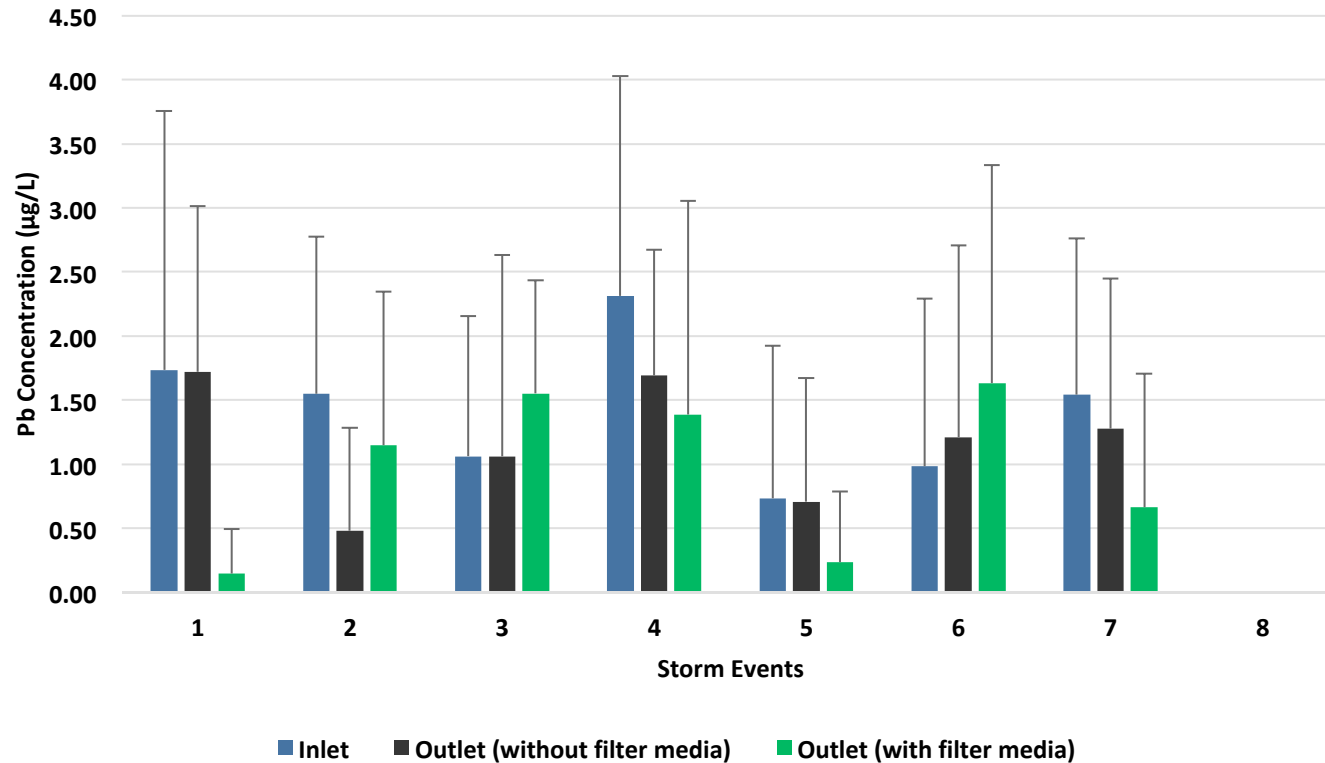
**Measured Parameters:** Dissolved Cu, Dissolved Pb, Dissolved Zn, Turbidity, pH



# Field study: Dissolved copper

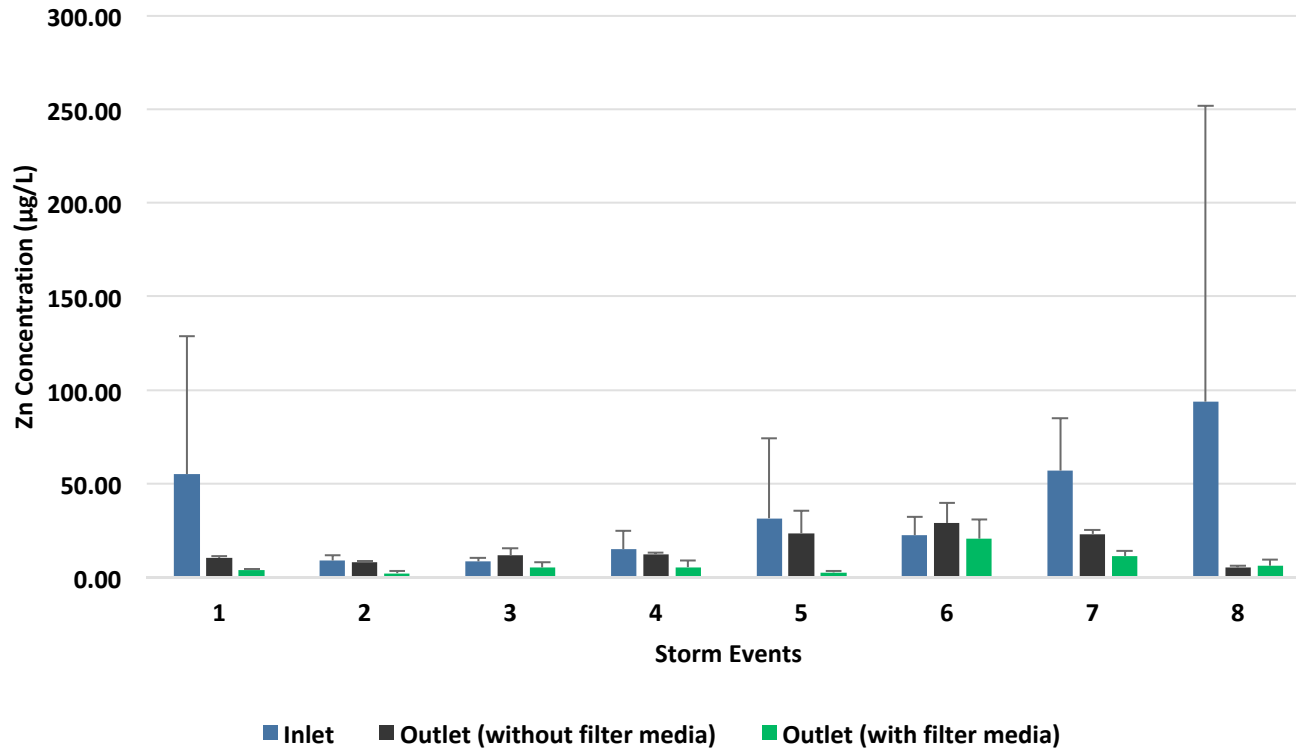


# Field study: Dissolved lead





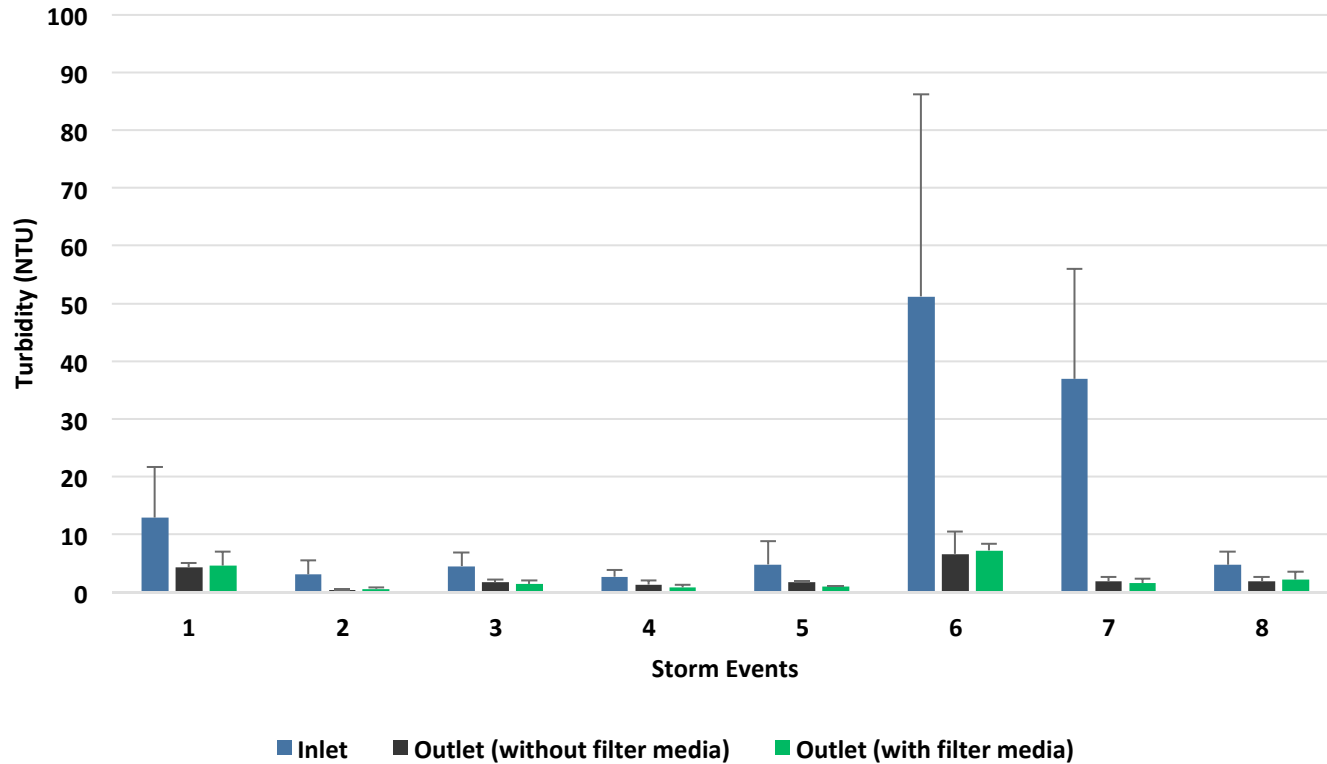
# Field study: Dissolved zinc





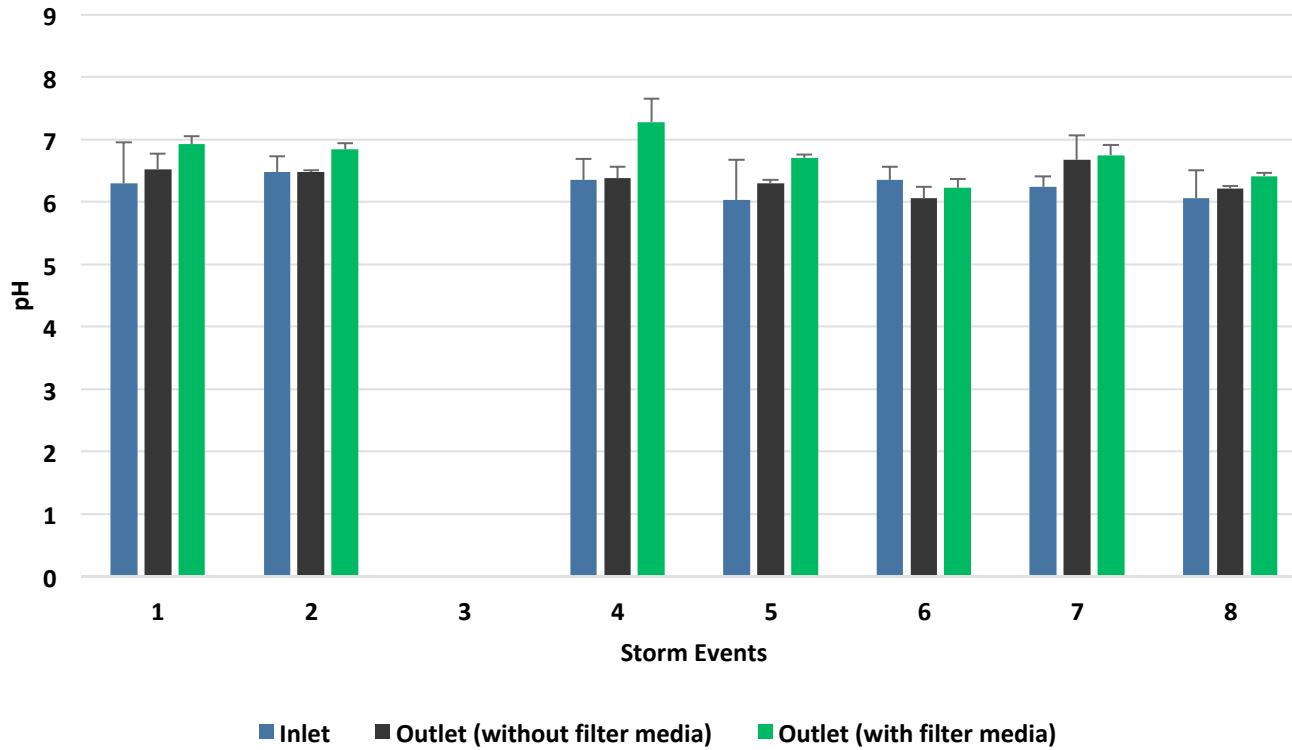


# Field study: Turbidity



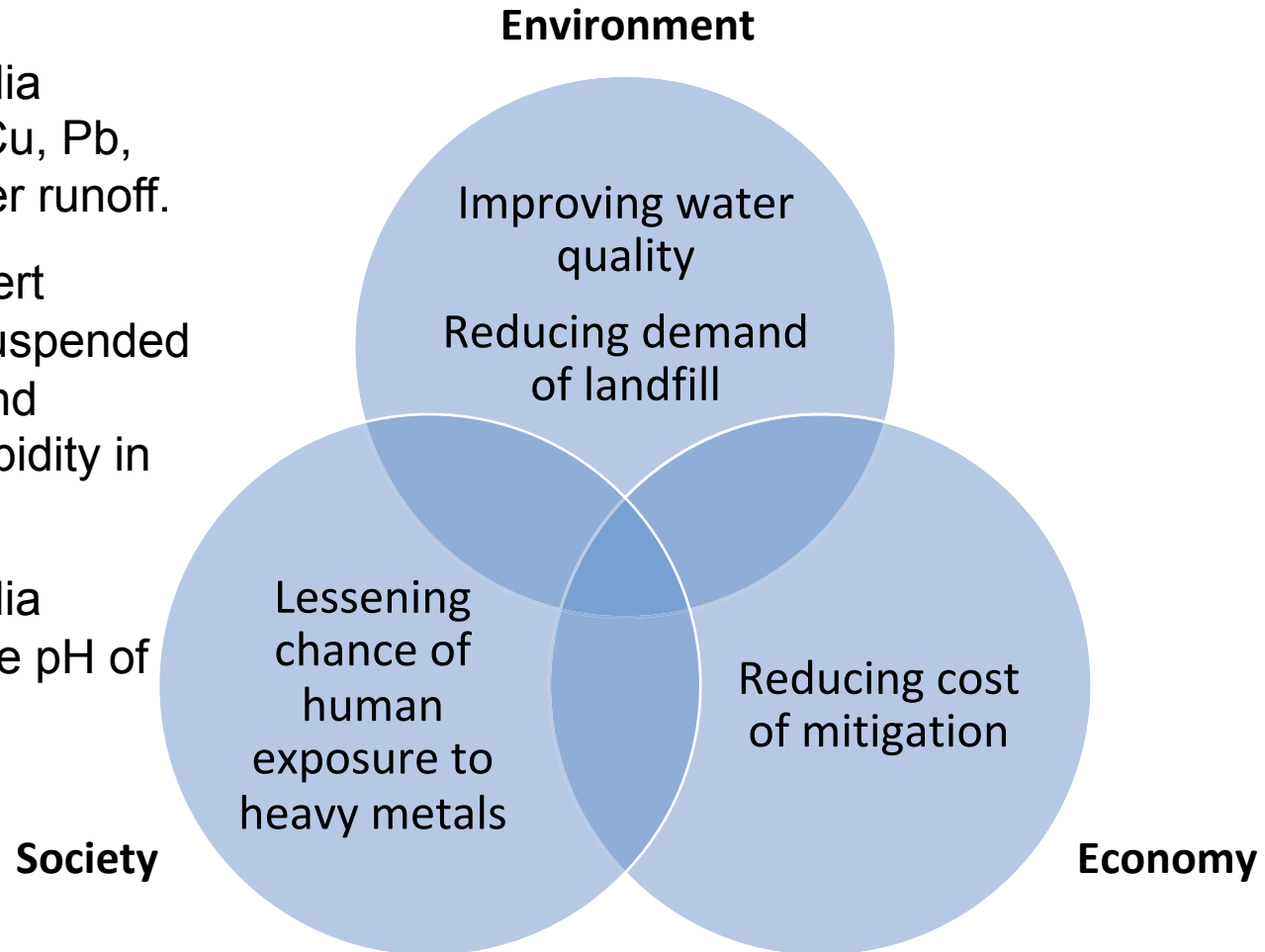


# Field study: pH



# Conclusion

- The green filter media reduced dissolved Cu, Pb, and Zn in stormwater runoff.
- The catch basin insert material captured suspended particulate matter and thereby reduced turbidity in stormwater runoff.
- The green filter media slightly increased the pH of stormwater runoff.





# Acknowledgements

- New Jersey Sea Grant Consortium with funds from the National Oceanic and Atmospheric Administration (NOAA) Office of Sea Grant, U.S. Department of Commerce under NOAA grant #NA14OAR4170085.
- Brick Township, for providing the field site for catch basin insert study.
- Stevens Institute of Technology, Hoboken, NJ for lab analysis.
- Mr. Jason Park, Mr. Sameer Neve

