Programming Tools to Understand and Communicate Receiving Water Quality Model Results

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January 24, 2024
Allegheny County Sanitary Authority (ALCOSAN)

- Provides wastewater treatment to 83 municipalities in Allegheny County, including the City of Pittsburgh.
- The ALCOSAN regional conveyance system conveys wastewater from municipal collection sewers to the wastewater treatment plant.
- Clean Water Plan, 2019
- $2 billion to address CSOs
- Interim wet weather plan implemented by 2036
The Clean Water Plan Includes 4 Components

- Regionalization
- GROW/Source Control
- Plant Expansion
- Regional Tunnel System
Clean Water Plan Water Quality Benefits

• Interim Wet Weather Plan
  • CSO reduction by ~7 billion gallons per year by 2036

• Selected Plan
  • Additional work until compliant with regulatory requirements to not preclude attainment with water quality standards.

By 2036
As expeditious as practicable
Annual Fecal Coliform Loads
Existing Conditions

- Main Rivers Boundary
  [Stormwater Runoff, Base Flow, Other Sources]
  66%

- ALCOSAN CSO
  29%

- ALCOSAN SSO
  1%

- Municipal CSO
  2%

- Municipal SSO
  2%

- Tributary Stormwater Runoff
  <0.1%

- Tributary Base Flow
  <0.1%

- ALCOSAN Plant Discharge
  <0.1%
Water Quality Modeling Measures Impacts

Existing Conditions

CSO/SSO Impacts Only
Questions: How do CSOs affect water quality?

Plan:
- Build a model to simulate river WQ

Model:
- Create a model and validate results

Solution:
- Use the model to simulate future conditions with improved water quality

Design:
- Build new infrastructure based on modeling plan
Models and R Script

• SWMM – Collection System Model and Tributary Model
• EFDC – Main Rivers Model
• R Script

```
systemwide <- data.frame(matrix(nrow = 0, ncol = 27),

for(i in 1:length(systemwideoutfilepath)){
temp <- fread(paste0("./systemwide_no_ph/", systemwideoutfilepath[i]), header = TRUE, dec = ".", skip = 384)
quarter <- as.numeric(substr(systemwideoutfilepath[i], 2, 2)) # pull quarter from filename

temp <- filter(temp, Mon %in% n_months[quarter]) # only keep rows for specified quarter

systemwide <- rbind(systemwide, temp)
}
```
Modeling Plan

• Validation Model
  • Calibrate model for hydrodynamics and bacteria concentration

• Planning model
  • Used to simulate the typical year
  • Current conditions
  • Future conditions
Model Validation Approach

- Flow timeseries
- Bacteria counts for events
- Flow scatterplot
- Bacteria counts along river length
Validation Parameters

- **Flow (Continuous)**
- **Stage and Temperature (Continuous)**
- **Velocity (Discrete)**
- **Temperature & Water Quality (Discrete)**
Temperature Validation

• Modeled Seasonal and Diurnal Variation
• Bacteria decay is dependent on temperature
Water Quality Validation Approach

• Validate Fecal Coliform and E. Coli Bacteria Concentrations
  • 31 water quality sampling stations
  • Discrete samples throughout validation period
Using R Script to Understand Validation

1. Full Scatter Plot of All Data

2. Individual Sample Point

Sample:
- PP Pool
- PW1 Sample
- Station A-02.0
- Left Bank sample point
- Date: 6/18/2009 (Event 17)

3. Sampling Event Transect Plot

4. Station Time Series Plot
Typical Year Model

• Simulate the typical year
• Calculate water quality attainment based on e. coli and fecal coliform concentrations
• Simulate existing and future conditions as we remove CSOs from the system
Water Quality Benefits Will Increase as Projects are Completed
Planning Models

Existing Conditions

Clean Water Plan
Alternatives Assessment

Interim Wet Weather Plan with Improved Baseflow

Selected Plan with Improved Baseflow

Existing Conditions with Improved Baseflow
Fecal Coliform Water Quality Conditions Before and After Interim Plan

Existing Conditions

Interim Wet Weather Plan
Fecal Coliform Water Quality Conditions for Interim Plan and Final Selected Plan

Interim Wet Weather Plan

Selected Plan
Animation of WQ Attainment (DRAFT)
Conclusions

• CSO controls will improve water quality and provide enhanced recreational use experiences for Pittsburgh residents and visitors.

• Water quality monitoring and modeling are the primary tools for demonstrating attainment with water quality standards and compliance with ALCOSAN’s Consent Decree.
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Questions and Answers