CASE STUDY OF INTEGRATED WATER QUALITY APPROACH IN CINCINNATI WATERSHED

DR. TING LU

DEPUTY INTEGRATED PLANNING LEAD
WET WEATHER IMPROVEMENT PROGRAM

• The overarching goal of any wet weather program is to meet Water Quality targets and Clean Water Act Standard.

• Most multi-million $$$ consent decrees are based on Combined Sewer Overflow (CSO)/ Sanitary Sewer Overflow (SSO) frequency and volume reduction and are indirectly linked to Water Quality Improvements.
EVEN DURING DRY WEATHER, *E. COLI* HAS EXCEEDED THE WATER QUALITY STANDARD
Many sources contribute to water pollution in the watershed:

- Stormwater
- SSO
- Private systems
- Agriculture
- CSO
- Urban runoff
HOLISTIC WATERSHED MANAGEMENT

Water QUANTITY based
- Presumptive approach
- Reactive
- Point source solution

Water QUALITY Based

Ecological HEALTH based
- Demonstrative approach
- Watershed scale
THE VALUE OF A WATER QUALITY PROGRAM

- Focus on the outcome
- Prioritizes improvement projects
- Helps demonstrate project effectiveness
- Improves communication and regulatory buy-in
- Reduce compliance cost and risk

“Clean Water Act—restore and maintain the chemical, physical, and biological integrity”
WATER QUALITY PROGRAM COMPONENT

Water Quality Monitoring

Water Quality Modeling

Watershed planning
REMOTE SENSING: COST-EFFECTIVELY IDENTIFYING WATERSHED POLLUTION

- Remote detection of non-microbial contaminants
- Identifies sources and hotspots on watershed scale
- Documents water quality trends
REMOTE SENSING CASE STUDY: NUTRIENT AND WQ POLLUTANTS MAPPED TO GUIDE WATERSHED-BASED DECISION MAKING

7/2/2012 NATURAL COLOR

OHIO RIVER TPW 2012

OHIO RIVER TPW 2013
REMOTE SENSING OUTCOME

• Gain understanding of what's really happening across the entire watershed
  • Low flow (normal conditions) shows low total phosphorus
  • High level clusters of total phosphorus are visible
  • High total phosphorus after a major rain event

• Reduced sampling and monitoring costs

• Targeting mitigation investment
DNA TESTING: A UNIQUE AND INNOVATIVE APPROACH RECOGNIZED BY THE INDUSTRY

• 1st integrated fecal source tracking strategy
• 1st optimized study applied to large urban watershed

What is the right biomarker for water quality monitoring?

Technical Article

AN INTEGRATED APPROACH TO IMPROVE WATER QUALITY AT A WATERSHED LEVEL
by Ting Lu, Ph.D., Metropolitan Sewer District of Greater Cincinnati (MSDGC)

Fecal microorganisms are a major source of surface water contamination, which poses steep environmental and human health problems. This article presents how Metropolitan Sewer District of Greater Cincinnati (MSDGC) utilizes an integrated systematic approach to address combined sewer overflows (CSOs) to improve water quality at the watershed level.

Current Challenges
Metropolitan Sewer District of Greater Cincinnati (MSDGC) is a Hamilton County owned sewer district collecting and treating 192 MGD of wastewater by operating seven major treatment plants. The primary mission of MSDGC is to deliver responsive, customer-focused wastewater treatment services to humans, and their presence in water samples is easy to measure. However, since most of the members of fecal microbial flora are anaerobic and difficult to cultivate, (visible but not culturable microorganisms) the culture based method is not a good representative measurement for human health risk. In addition, the culture based E. coli method does not provide the source origin where the contamination is from. Consequently, it is difficult to identify the source of contamination. The fecal sources may have mixed origins, such as human and animal waste, stormwater runoff, urban runoff, CSO, non point source contamination, malfunctioning private systems, or upstream boundary flow.
MIC ROBIAL SOURCE TRACKING

Culture-based methods

Total coliform
Fecal coliform
E. coli
Bacteroides

Pathogens

Human
Bovine
Canine
Avian
E. coli O157: H7
Norovirus
Streptococcus

Molecular-based methods
LINKING THE SOURCES WITH THE CAUSES

GIS Mapping

Source Identification

Source Quantification

<table>
<thead>
<tr>
<th>Pollution origin</th>
<th>Pollution detection and causes/reasons</th>
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<tr>
<td>Human</td>
<td>Yes, CSO, SSO, and septic tanks</td>
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<tr>
<td>Bovine</td>
<td>No, no cattle in the watershed</td>
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<tr>
<td>Canine</td>
<td>Yes, pet facility nearby or parks</td>
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<tr>
<td>Avian</td>
<td>Yes, wild waterfowl</td>
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WATER QUALITY PROGRAM COMPONENT

- Traditional sampling
- Remote sensing
- DNA testing
- Online sensors

Water Quality Monitoring

Water Quality Modeling
- Collection model
- Watershed model
- Receiving stream model

Watershed planning
WATER QUALITY MODEL

GOALS

• Characterize Contaminant Sources and Load Allocations

• Refine Water Quality Model With Better Resolution and Nutrient Fate and Transport

• Provide Guidance for Phase II Wet Weather Improvement Program and Watershed Operations Division
INTEGRATED MODEL FOR EACH STREAM

Sewered area
- Hydraulic model (SWMM)

Non-sewered area
- Watershed model (EFDC)

Surface Water Model
EFDC or WASP

River Hydrographs

River Pollutographs

Component Analysis
- Dry weather
- CSOs
- SSOs
- Stormwater
- Other

Pollutograph
- flow/concentration

- pollutograph
- hydrograph
WATER QUALITY PROGRAM COMPONENT

**Water Quality Monitoring**
- Traditional sampling
- Remote sensing
- DNA testing
- Online sensors

**Water Quality Modeling**
- Collection model
- Watershed model
- Receiving stream model

**Watershed planning**
- Pollutant sources/Causes Determination
- Integrated Watershed planning
WATER QUALITY STRESSORS AND POTENTIAL SOURCES

Biological and Water Quality Studies 2011-2014
BIOASSESSMENTS HAVE VERIFIED CSOs ARE NOT THE ONLY SOURCE OF IMPAIRMENT
STRESSOR PRIORITIZATION: MULTIVARIATE ANALYSIS

- Missing Species

Figures courtesy of Scott_Dyer_PG
IPS DASHBOARD - SHOWS RANKINGS FOR STREAMS AND SITES

Excel spreadsheet allows user to select specific streams, sites, & year of data

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<th>Year</th>
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<th>Substrate Rank</th>
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</tbody>
</table>

Row Labels: Dry Run-Little Miami River, Dugan Gap, Eagle Creek, East Branch Mill Creek, East Branch Upper South Branch, East Duck Creek, East Fork Mill Creek-Mill Creek

Bar Graphs, Scatter Plots, Bubble, Map, Ranking

Hamilton County Watershed

[Excel spreadsheet interface with data entries]
HOLISTIC WATER QUALITY MANAGEMENT

Water Quality

Habitat Restoration

Meeting Compliance
WATER QUALITY PROGRAM ANSWERS

• What are impacts of CSOs and SSOs on the water quality?

• What are the other pollution contributions?

• What is impact of water quantity vs. water quality?

• How to prioritize engineering projects?

• How to measure engineering project effectiveness?

• How should we optimize the watershed operation?

• How do we assess human health risk when exposed to the impairment of water body?
COLLABORATED PROGRAM

- Conduct wet weather sampling
- Update water quality models
- Scenario evaluations with Integrated Priority System Tool
- Perform additional innovative technologies
Building a world of difference.

Together

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