East Fork Watershed Cooperative – Quarterly Meeting
February 22, 2018

Disclaimer: The views expressed in this presentation are those of the authors and do not necessarily represent the views or policies of the US Environmental Protection Agency (EPA). Mention of trade names or commercial products does not constitute EPA endorsement or recommendations for use.
Agenda

- Introduction and Overview – Chris Nietch
- Update on DWTP Cost Analysis – Matt Heberling
- AgBMP Project Update – Chris Nietch- Hannah Lubbers
- AgBMP Project Funding Update – John McManus
- Watershed-scale Nutrient Reduction Utility – Group Discussion
- Lower Watershed Modeling Update – Chris Nietch/Amr Safwat/Joong Lee
**East Fork Watershed – Regional Context**

**Harsha Lake: Flood Control and Drinking Water Reservoir**

Upper EFW- 64% agriculture – 104,000 acres
70% N and P load to Lake.
Net Income - $30 Million
9 WWTPs - 1% of both N and P load to lake

**Land Use**

**Monitoring Sites and Point Sources**
East Fork Watershed Cooperative – Building Momentum for Nutrient Management

- **Federal Partners**
  - EQIP
    - 125 active contracts ($2.75Mil obligated)
  - RCPP funded Practices
    - Cover Crops – 32 practices, 5,798 acres
    - Nutrient Management - 27 practices, 5,885 acres
    - Nutrient Management Plan 940 acres
    - Amending Soil Properties with Gypsum Products - 226 acres
    - Conservation Crop Rotation - 312 acres

- **State Partners**
  - Ohio EPA
  - Department of Agriculture
  - Ohio State University

- **Local Partners**
  - Local Farmers
Harsha Lake

- Harsha / East Fork Lake – managed by **USACE & Ohio DNR**
  - Flood Control
  - Drinking Water Source – 20 mgd DWTP | 100,000 residents
  - Two swimming beaches
  - US Rowing National Championships
  - State Park – fishing, hunting, hiking, camping
  - 1,064,816 visitors in 2016
  - $2.7 Million annual economic impact
  - Harmful algae impacting economy since 2010
  - Research focuses on HABs management, nutrient budgeting, and biogenic gas dynamics
# Nutrient Enrichment Causing Harmful Algae in Lake Harsha: HAB Monitoring Tools

**HF Physico-chemical**
- Water Quality
  - Temp
  - pH
  - ORP
  - Sp Cond
  - Turbidity
  - Dis Oxygen
  - TOC
  - DOC
  - NO$_3$-N
  - UV-Vis spectra
- PAR
- Weather

**Wet Chemistry**
- Total Nitrogen
- NO$_2$-NO$_3$
- NO$_2$
- Total NH$_4$
- Total Phosphorous
- Total Reactive Phosphorous

**Phototroph Dynamics**
- *In-vivo* Fluorescence
  - Phycocyanin
  - Chlorophyll
  - Other pigments
    - Diatoms
    - Cryptophyta
- Microscopic enumeration

**Molecular Markers**
- Next Gen Sequencing
  - 16S rRNA gene
  - 18S rRNA gene
  - Cytochrome oxidase
  - Metagenome
  - Metatranscriptome
- qPCR/RT-qPCR assays
  - Toxin specific gene assays

**Cyanotoxin Analysis**
- ELISA
  - MC-ADDa
- LC-MSMS
  - MC congeners
  - Cylindrospermopsin
  - Anatoxin-a
  - MMPB

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*Contact: Joel Allen, allen.joel@epa.gov*
Drinking water treatment plant (DWTP) costs and source water quality: An updated case study

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Motivation

- Assess whether source water protection is cost-effective and determine whether drinking water treatment plant (DWTP) has incentive to “buy” nutrient abatement from agriculture

- Understanding how treatment costs are affected by changes in source water quality is essential to understanding tradeoffs between natural and built infrastructure
  - Can provide evidence whether it is less expensive to invest in natural infrastructure than pay for treatment on site

Important knowledge gap for municipalities and DWTPs (Gartner et al. 2013)
• Heberling et al. (2015)
  • Developed a framework to compare costs:
    • Drinking water treatment to source water protection
  • Examine treatment costs with changes in source water quality, production, and seasonal variables
  • Presents steps to estimate the incentives for source water protection vs. treatment on-site
General Steps for DWTPs

Step 1: Link changes in source water quality to changes in treatment costs

- Develop a cost function using data on raw water quality variables and treatment operations

Step 2: Link source water quality to watershed load reductions (through land use management)

- Connect watershed variables (e.g., phosphorus load) to source water quality variables governing treatment cost function (e.g., turbidity or total organic carbon [TOC])
- When treatment variables differ from watershed variables a “translation” is needed

Step 3: Estimate costs of the land use management (e.g., cover crops) that leads to watershed load reductions
Case Study: Bob McEwen Water Treatment Plant (BMWTP)

- **Period 1 (Heberling et al. 2015)**
  - Before the period of significant source water quality degradation from Harmful Algal Blooms (HABs)
  - Clermont County Water Resources Dept. (operator logs, paper records, invoices)
  - US Army Corps. (reservoir characteristics)
  - Time series: 1826 daily observations, 2007-2011

- **Period 2 (Preliminary analysis)**
  - In 2012, BMWTP added a granular activated carbon (GAC) building, a significant investment
    - GAC used for addressing disinfection-by-products and algal toxins
    - Greater reliance on GAC filters might translate to increased costs creating need for source protection?
  - Same data sources as Period 1
  - Time series: 1461 daily observations, 2013-2016
## Summary Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Period 1</th>
<th>Period 2</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FINAL</strong></td>
<td>DW produced (MGD)</td>
<td>4.95</td>
<td>3.47</td>
<td>0.001</td>
<td>8.12</td>
</tr>
<tr>
<td><strong>POOL</strong></td>
<td>Pool elevation (ft)</td>
<td>731.73</td>
<td>731.84</td>
<td>728.90</td>
<td>752.67</td>
</tr>
<tr>
<td><strong>GCPOOL</strong></td>
<td>Pool minus guide curve</td>
<td>0.72</td>
<td>0.83</td>
<td>-1.85</td>
<td>23.67</td>
</tr>
<tr>
<td><strong>pH</strong></td>
<td></td>
<td>7.43</td>
<td>7.49</td>
<td>6.52</td>
<td>9.80</td>
</tr>
<tr>
<td><strong>TURB</strong></td>
<td>Turbidity (NTU)</td>
<td>11.42</td>
<td>7.68</td>
<td>0.07</td>
<td>89.80</td>
</tr>
<tr>
<td><strong>RAWTOC</strong></td>
<td>Raw water TOC (mg/L)</td>
<td>6.10</td>
<td>6.19</td>
<td>4.50</td>
<td>8.30</td>
</tr>
<tr>
<td><strong>TOTALCOST/1000</strong></td>
<td>Total costs per 1000 gal</td>
<td>0.55</td>
<td>4.29</td>
<td>0.42</td>
<td>5148.82</td>
</tr>
<tr>
<td><strong>ChemCost/1000</strong></td>
<td>Chem cost per 1000 gal</td>
<td>0.23</td>
<td>1.74</td>
<td>0.07</td>
<td>2272.19</td>
</tr>
<tr>
<td><strong>PumpCost/1000</strong></td>
<td>Pump cost per 1000 gal</td>
<td>0.23</td>
<td>0.65</td>
<td>0.07</td>
<td>636.65</td>
</tr>
<tr>
<td><strong>GACCost/1000</strong></td>
<td>GAC cost per 1000 gal</td>
<td>0.10</td>
<td>1.90</td>
<td>0.16</td>
<td>2239.97</td>
</tr>
</tbody>
</table>

 Spike in cost due to system shut down. 1 during period 1, 5 during period 2. If he removes the largest spike, avg. cost is 0.76 during period 2.
Total Cost per 1000 Gallons of Final Flow (Dec 2016$)
• Period 1 Model (2007-2011)

\[
\frac{\text{Cost}}{1000 \text{ gallons}} = f \left( \text{Lags Cost per 1000 gallons, FINAL, RAWTOC, TURB, pH, GCPOOL, ActualTOC, TEMDUM, SPRSUM, CY07 – CY10, PROCESS} \right)
\]

• Period 2 Model (2013-2016)

\[
\frac{\text{Cost}}{1000 \text{ gallons}} = f \left( \text{Lags Cost per 1000 gallons, FINAL, RAWTOC, TURB, pH, GCPOOL, ActualTOC, SPR, CY13 – CY15, five PROCESS} \right)
\]
### Period 1 vs. Period 2 Preliminary Results

<table>
<thead>
<tr>
<th>VAR</th>
<th>1% increase</th>
<th>Short-Run</th>
<th>Long-Run</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>FINAL (Per 1)</td>
<td>(=0.05MGD)</td>
<td>-0.39%</td>
<td>-0.21%</td>
<td>-0.60%</td>
</tr>
<tr>
<td>FINAL (Per 2)</td>
<td>(=0.03MGD)</td>
<td>-0.67%</td>
<td>-1.00%</td>
<td>-1.67%</td>
</tr>
<tr>
<td>TURB (Per 1)</td>
<td>(=0.11NTU)</td>
<td>0.02%</td>
<td>0.1%</td>
<td>0.11%</td>
</tr>
<tr>
<td>TURB (Per 2)</td>
<td>(=0.08NTU)</td>
<td>-0.005%</td>
<td>N/S</td>
<td>-0.005%</td>
</tr>
<tr>
<td>RawTOC (Per 1)</td>
<td>(=0.06mg/l)</td>
<td>N/S</td>
<td>N/S</td>
<td>---</td>
</tr>
<tr>
<td>RawTOC (Per 2)</td>
<td>(=0.06mg/l)</td>
<td>0.12%</td>
<td>0.52%</td>
<td>0.64%</td>
</tr>
<tr>
<td>GCPOOL (Per 1)</td>
<td>(=0.007ft)</td>
<td>N/S</td>
<td>-0.007%</td>
<td>-0.007%</td>
</tr>
<tr>
<td>GCPOOL (Per 2)</td>
<td>(=0.008ft)</td>
<td>N/S</td>
<td>N/S</td>
<td>---</td>
</tr>
</tbody>
</table>

- Period 2 preliminary results suggest:
  - Increasing final production can reduce costs more than in Period 1
  - Increase in turbidity can reduce costs (compared to increase costs in Period 1)
  - RawTOC can increase costs with the GAC building
  - GCPOOL not significant compared to Period 1
  - pH not significant in either period
Next Steps

• Statistical tests to confirm appropriate form of time series model and significance of long-run elasticities

• Step 2: How does total phosphorus (TP) load effect source (raw) water?
  • Chose TP load because its linked to:
    1. Hillslope erosion (affinity for clay particles-> sediment load->turbidity)
    2. Algal blooms (increase TOC and pH)
  • Period 2 model suggests RawTOC
Agricultural Best Management Practice Monitoring

Hannah Lubbers and Chris Nietch
Clermont County Office of Environmental Quality

With Slide Contributions from Jake Hahn
Clermont Soil & Water Conservation District
CIG Project

Use “Cover and Capture” Method to Improve Nutrient Capture in Agricultural Settings

**Cover:**
- Use of Cover Crops
  - Improve infiltration
  - Improve soil biology
  - Reduce erosion
  - Reduce fertilizer/chemical inputs

**Capture:**
- Urban Stormwater Basin
  - Remove sediments
  - Remove Phosphorus
  - **Remove Nitrogen**
Project Location
Cover Crops

- US EPA SWAT model used to project high areas of sediment yield (rust colored area)
- Those areas were used by SWCD to target fields for cover crop placement.
CIG Project Layout

700 Foot Detention

400 Foot SVB
Research Questions

• What is the removal efficiency?
  • Of the submerged vegetated bed (SVB)?
  • Of the entire system?

• Is the system a cost effective BMP for nitrogen and/or phosphorus removal?
Detention Basin

High Flow Bypass Channel

SVB

= Monitoring point

Driveway
Detention Basin

Driveway

SVB

High Flow Bypass Channel

Dam is bypassing
Detention Basin

SVB

High Flow Bypass Channel

Driveway

Dam not bypassing
Catchment Delineations at CWL Farm

Area draining to CWLUS- Upper Detention = 135.8 acres

Area draining to CWLBP= 190 acres
Water Monitoring Summary

- FWM of 88 samples = 48 wet weather sampling events (Clermont) - 12/2014-10/2017
- PreConstruction (weekly) – Post construction (triweekly) Grab Sampling (USEPA)
Based on Paired-Sample t-Test laboratory results are not significantly different except for Total Phosphorus (TP). The County laboratory results are significantly higher.
PreConstruction vs. Post Construction AgBMP Results

- CCOEQ and EPA CWL stream data parsed to analyze baseflow chemistries before and after Detention pond and SVB construction. Only sample dates that noted water flow, no rain at the time of sampling, no rain recorded in the previous 5 hours of sampling, and those collected in the months of November thru May were considered.

- All N species except urea are significantly lower post construction. P species are not different but tending lower.
Rainfall/runoff events sampled at the CWLBP monitoring site
AgBMP system hydrology - Troubleshooting

No flow?

Large Total Flow Difference?

Where is extra water coming from?

2015 Total Rain = 39"
2016 Total Rain = 43"
2017 Total Rain = 38"

No Flow Difference?

No flow?
AgBMP system hydrology- Corrected
agBMP System Load Reduction

TSS Removed - 51.7%

TN Removed - 30.8%

TP Removed - 30.1%

avg. daily loads, yields and normalized flows.
Purpose: GIFMod is designed for constructing models representing detailed hydraulic and water quality processes within stormwater green infrastructure. It can also be used for other systems involving flow and transport in surface water, groundwater, soil or combinations of them.

Features:
- User defined reaction network
- Deterministic and probabilistic inverse modeling
- sensitivity analysis
- Expandable
- Wizards (templates)
- scripting
- Application Programmable Interface (API)
- Open source

Watershed nutrient Management

- The Upper East Fork Watershed minimally needs:
  - 1040 acres of wetland
  - 2600 acres of filter strips
  - 43,000 acres of cover crops
to reduce Phosphorous loads to meet target for the inflow to Harsha Lake at a cost of $3.6 to $8.0 million annually

- Translates to a lot more implementation, monitoring that will likely require real time control, and an organizational structure to administrate it
Funds for additional Conservation/nutrient management work

• Cleared hiring for two soil conservationist positions in Clermont and Brown

• Released additional $300,000 in EQIP funds the following day to allow all applicants to be funded

• Suggested Clermont SWCD submit an application for long-term additional EQIP funds

• Application submitted for additional $500,000/year for three years – Update?

$300,000 additional for this year. And as other contracts throughout the state get canceled, then we could get even more funding. Some farmers that complete their 3 year contract continue to plant cover crops. How do we get that data? We are underestimating acreage planted.
EQIP / RCPP Status

**EQIP**

- 125 active contracts for Brown and Clermont County (48 contracts for cover crops)
- $2.75 million in funds obligated

**RCPP Funded Practices**

- Cover Crops - 32 practices, 5,798 acres
- Nutrient Management - 27 practices, 5,885 acres
- Nutrient Management Plan - 4 practices, 940 acres
- Amending Soil Properties with Gypsum Products - 3 practices, 226 acres
- Conservation Crop Rotation - 1 practice, 312 acres
2017 EQIP/RCPP Sign-up

- 47 applications submitted for Clermont County, 45 for Brown County (# in East Fork watershed not yet known)

- 8 RCPP applications (will use remainder of grant funds)

2018 EQIP/RCPP Sign-up

- Press release forth coming
- Additional specs?
Locating the BMPs for future effectiveness monitoring

- FOIA request
- Proposed Project:
  - Evaluating Best Management Practices with Spatial Stream Network Analysis
    - Do tributaries with Best Management Practices (BMPs) have lower nutrient concentrations and load than tributaries without BMPs?
Watershed-Scale nutrient Management

- Nutrient reduction is arguably the greatest challenge facing water quality protection
- Existing assessment and management approaches are failing to address the problem
  - Silo-ed and piece-meal
  - Underfunded
  - Assessment and management measures are not in sync
- New directions call for a more holistic and integrative approach
  - E.g., Statewide Nutrient Reduction Utility (ref below)
- New WQ sensing technologies and sensed data management/interpretation should play a big role in the success of such programs

Addressing Nutrient Pollution in Our Nation’s Waters: The Role of a Statewide Utility ©2017 US Water Alliance, NACWA, and WEF.
SWAT Modeling Scales in the East Fork

Salt Run HUC 12 (27196 ac)
Shayler Run (7929 ac)
Shayler Crossing (244 ac)
Land Use Status

- **SAR**
  Salt Run (HUC-12)
  28,000-ac

- **SHR**
  Shalyer Run (HUC-14)
  8,000-ac

- **SHC**
  Shayer Crossing (neighborhood scale)
  250-ac
Workflow Diagram for SWMM-SWAT Integration Procedures

**SWAT Model (Baseline)**

- Select HRUs for GI Scenarios
- Derive GI Scenarios (Time-series)
- SWMM Models for the HRUs
- SWMM Calibration
- SWMM Model (Baseline)
- SWMM GI Parameters
- HRU-GI SURQ (Time-series)
- SWAT Model (GI Scenarios)
- SWAT Outputs (Time-series)
- Results of GIs: Hydrology

**SWMM Models for the HRUs**

- HRU SURQ (Time-series)
- SWAT Calibration
- SWAT Model (GI Scenarios)
- SWAT Outputs (Time-series)
- Results of GIs: Hydrology

**HRU Parameters for GI Scenarios (FCIMP, CN2)**
GI Implementation Scenarios-1

• GI can be implemented at any urban HRUs (either high or low density), except steep areas where the surface slope is more than 5%.

• The size of GI was decided to capture the Water Quality Volume (WQv), estimated by Ohio’s Standards for Stormwater Management.

\[ WQv = C \times P \times A \]
\[ C = 0.858 \times i^3 - 0.78 \times i^2 + 0.774 \times i + 0.04 \]
\[ i = \frac{IA}{TA} \]

Where, C = runoff coefficient, P = 0.75-inch precipitation depth, A = drainage area, i = imperviousness, IA = impervious area, and TA = total area.

Reference:
### HUC12 – Salt Run (SAR)

- Number of Urban HRUs with 0-2% or 2-5% slope for GI implementation

<table>
<thead>
<tr>
<th>HSG</th>
<th>URHD 0-2</th>
<th>URHD 2-5</th>
<th>URHD Sum</th>
<th>URLD 0-2</th>
<th>URLD 2-5</th>
<th>URLD Sum</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>14</td>
<td>14</td>
<td>28</td>
<td>23</td>
<td>24</td>
<td>47</td>
<td>75</td>
</tr>
<tr>
<td>C</td>
<td>61</td>
<td>65</td>
<td>126</td>
<td>99</td>
<td>104</td>
<td>203</td>
<td>329</td>
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<tr>
<td>D</td>
<td>25</td>
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<td>49</td>
<td>36</td>
<td>36</td>
<td>72</td>
<td>121</td>
</tr>
<tr>
<td>Sum</td>
<td>100</td>
<td>103</td>
<td>203</td>
<td>158</td>
<td>164</td>
<td>322</td>
<td>525</td>
</tr>
</tbody>
</table>
GI Implementation Scenarios-2

- GI Scenario 1 (GI-1)  
  **Rain Garden (no underdrain)**  
  1. Ponding layer  
  2. Soil media layer

- GI Scenario 2 (GI-2)  
  **Bioretention (w/ underdrain)**  
  1. Ponding layer  
  2. Soil media layer  
  3. Storage layer
HRU Scale Modeling Results

- **Bsln_SWAT**: Baseline SWAT for the individual HRUs
- **BnGp_SWAT**: Baseline SWAT for the grouped HRUs
- **BnGp_SWMM**: Baseline SWMM for the grouped HRUs
- **GI1-SWMM**: GI scenario 1 from SWMM
- **GI2-SWMM**: GI scenario 2 from SWMM

H: high density  
L: low density  
B, C, D: hydrologic soil groups  
a, b: sub soil groups  
1: 0-2% slope  
2: 2-5% slope
Estimated Flow reductions for GI scenarios for subwatershed in the Lower Watershed
Estimated N and P reductions for GI scenarios for subwatersheds in the Lower Watershed
Preliminary Lower Watershed Nutrient Sources Distribution

LEFW TN with DAM

- DAM: 54%
- WWTP: 24%
- Corn: 2%
- Past: 3%
- Range: 0%
- Sept: 5%
- Soyab: 7%
- WETN: 0%
- FRSD: 3%
- ATM: 0%

LEFW TP with DAM

- DAM: 35%
- WWTP: 28%
- Corn: 4%
- Past: 10%
- Range: 0%
- Sept: 1%
- Soyab: 14%
- WETN: 0%
- FRSD: 5%
- ATM: 0%
Attendees

- Presenters
  - Chris Nietch, USEPA
  - Matt Heberling, USEPA
  - Amr Safwat, APTIM
  - Hannah Lubbers, CC-OEQ
  - John McManus, CC-SWCD
  - Joong Lee, CUGIE

- Participants
Next Meeting: May 3, 2018

County Water Resources Building, 4400 Haskell Lane, Batavia, OH 45103: Call-in 1-866-299-3188, 513-569-7460#