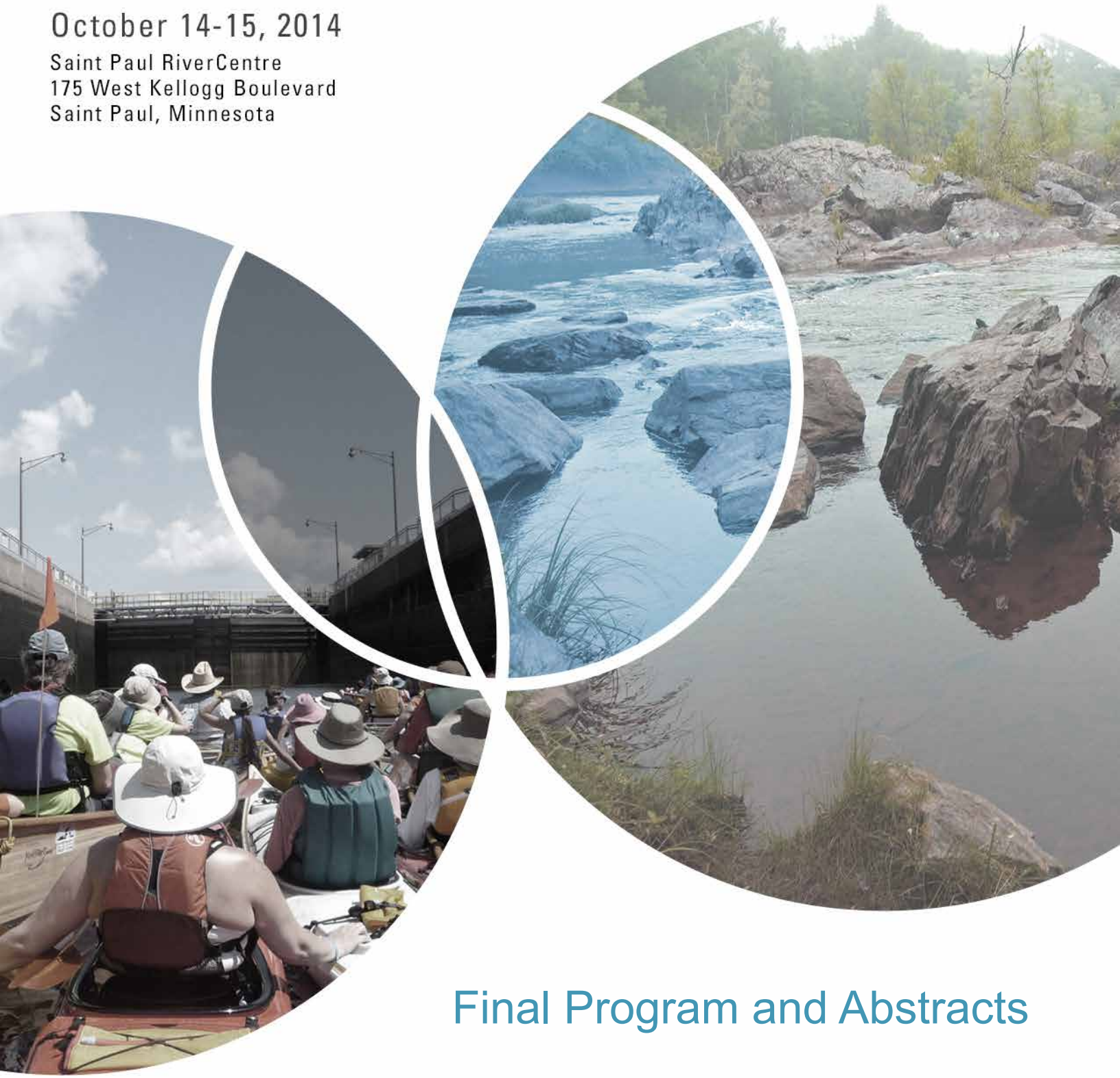
Minnesota Water Resources Conference

October 14-15, 2014

Saint Paul RiverCentre
175 West Kellogg Boulevard
Saint Paul, Minnesota



Final Program and Abstracts

www.wrc.umn.edu/waterconf

Minnesota Water Resources Conference

October 14-15, 2014

Guidebook Mobile App

The Water Resources Conference has gone mobile! Attendees can plan their days with a personalized schedule and browse concurrent session and poster abstracts, presenter biographies, exhibitors, maps, and participate in the conference "backchannel" by posting on Twitter before and during the conference.

The app is compatible with iPhones, iPads, iPod Touches, and Android devices. Windows Phone 7 and Blackberry users can access the same information via the mobile site: guidebook.com/g/mnwrc2014

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Social Media: Join the Conversation

We invite you to join the conversation about the Minnesota Water Resources Conference by tweeting about the symposium, or posting updates to your LinkedIn and Facebook pages. The conference hashtage is #mnwrc14. Type this hashtag in your tweet posts to continue the conference "backchannel," or you may also serach Twitter fro this hashtag to viewthe tweets online. These Social media efforts will help particpants network and meet noew colleagues prior to and during the conference.

Continuing Education Units (CEUs); Professional Development Hours (PDHs)

Conference attendees will receive .675 CEUs/PDHs for each day of the Minnesota Water Resources Conference. Participants who wish to receive full credit must attend all scheduled hours of the event.

Dinner Program:

Sponsored by American Society of Civil Engineers (ASCE) Minnesota Section

Thursday, October 16, 2014

"Mitigating Contaminant Vapor Intrusion into Buildings"

Check ASCE-MN website for details at www.ascemn.org.

NEW Features this year!

- Exhibitors
- Conference Mobile App for attendees
- Low Impact Development (LID) and Stormwater Management Workshop Track on Wednesday
- Extended session scheduled within program

Sponsored by:

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University of Minnesota

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Co-sponsored by:
Department of Civil, Environmental, and Geo-Engineering, College of Science and Engineering, University of Minnesota
Minnesota Section, American Society of Civil Engineers
Minnesota Sea Grant College Program, University of Minnesota
Natural Resources Research Institute, University of Minnesota

Minnesota Water Resources Conference

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Exhibitors

2014 Water Resources Planning Committee

John Baker, U.S. Department of Agriculture, and Department of Soil, Water, and Climate, University of Minnesota

Ann Banitt, U.S. Army Corps of Engineers

Jeff Berg, Minnesota Department of Agriculture

John Bilotta, MN Sea Grant and University of Minnesota Extension

Sue Borowick, College of Continuing Education, University of Minnesota

Tina Carstens, Ramsey-Washington Metro Watershed District

Heather Dorr, College of Continuing Education, University of Minnesota

Bill Douglass, Bolton & Menk, Inc.

Nicole Freese, College of Continuing Education, University of Minnesota

Lisa Goddard, SRF Consulting Group, Inc.

Lorin K. Hatch, HDR Engineering, Inc.

Andrea Hendrickson, Minnesota Department of Transportation

Kimberly Hill, St. Anthony Falls Laboratory, University of Minnesota

Karen Jensen, Metropolitan Council

Stephanie Johnson, Mississippi Watershed Management Organization

Ron Leaf, Short Elliott Hendrickson, Inc.

Salam Murtada, Department of Natural Resources, Division of Waters

Jodi Polzin, CDM Smith, Inc.

Randy Neprash, Minnesota Cities Stormwater Coalition and Stantec

Shawn Schottler, St. Croix Watershed Research Station

Wayne Sicora, Natural Resource Group

**Faye Sleeper,* Water Resources Center, University of Minnesota

Gene Soderbeck, Minnesota Pollution Control Agency

James Stark, U.S. Geological Survey

Deborah Swackhamer, Water Resources Center, University of Minnesota

Stew Thornley, Minnesota Department of Health

Rick Voigt, Voigt Consultants, LLC

Greg Wilson, Barr Engineering Company

**Brad Wozney,* Minnesota Board of Soil and Water Resources

** Committee Co-Chairs*

Program Schedule – Tuesday, October 14, 2014

8:00 – 8:10 **Welcome**
Faye Sleeper, Water Resources Center, University of Minnesota

8:10 – 8:20 **Dave Ford Water Resources Award**

8:20 – 9:30 **Plenary Session**
Research in the U.S. EPA
Janet Keough, Associate Director for Science, Environmental Protection Agency Mid-Continent Ecology Division

9:30 – 10:00 **Break**

10:00 – 11:30 Concurrent Sessions I

Track A Rooms 1–3

Hydrologic Methods

Moderator: *Ann Banitt,* U.S. Army Corps of Engineers

Co-Moderator: *Jodi Polzin*, CDM Smith, Inc.

Potential Pitfalls in Hydrologic Analysis

Daniel Reinartz, Minnesota Department of Natural Resources

Effects of Updating Rainfall to Atlas 14, Case Study of the Rice Creek Watershed District

Michael Lawrence, Houston Engineering, Inc.; *Phil Belfiori*, Rice Creek Watershed District; *Chris Otterness*, Houston Engineering, Inc.

Development of New Methods to Quantify Effective Impervious Area in Urban Watersheds

Ali Ebrahimian and *John Gulliver,* St. Anthony Falls Laboratory, University of Minnesota; *Bruce Wilson,* University of Minnesota

Track B Rooms 4–6

Applied Hydraulic Design

Moderator: *Ron Leaf,* Short Elliot Hendrickson, Inc.

Co-Moderator: *William Douglass*, Bolton & Menk, Inc.

Modeling a Low-Head Dam Retrofit with a 2D Hydraulic Model (Adaptive Hydraulics)

Jeff Weiss, Ron Koth, and *Erik McCarthy*, Barr Engineering Company

Revisiting Tumbling Ring Design and Performance

William Douglass, Bolton & Menk, Inc.

Walls of Water, Transforming Rainwater into a Work of Art

Ron Leaf, Short Elliot Hendrickson, Inc.

Track C Ballroom C

Lakes

Moderator: *Lorin Hatch*, HDR Engineering, Inc.

Co-Moderator: *Gene Soderbeck*, Minnesota Pollution Control Agency

Minnesota's 2012 National Lakes Assessment: National, State, and Ecoregion-based Approach

Steven Heiskary, Minnesota Pollution Control Agency

Shallow Lake Management on a Shoestring Budget

Rebecca Kluckhohn and *Wes Boll*, Wenck Associates, Inc.; *Dennis Loewen*, Clearwater River Watershed District

Common Misconceptions Regarding the Use of Aluminum Sulfate (Alum) in Lakes

Joseph Bischoff and *Brian Beck,* Wenck Associates, Inc.

Track D Ballroom D

Assessment and Trends for Moving Water

Moderator: *Karen Jensen*, Metropolitan Council

Co-Moderator: *Brad Wozney,* Minnesota Board of Water and Soil Resources

Multiple Uses of Data from an Automated Monitoring Network in a Six-Mile Urban Stormwater Tunnel

Britta Suppes and *Bob Fossum*, Capitol Region Watershed District

Watershed Pollutant Load Monitoring Network: Data for Tracking and Determining Pollutant Sources, Source Contributions, and Delivery Dynamics

Patrick Baskfield, Minnesota Pollution Control Agency

Regional Progress in Water Quality: A Trend Analysis for Select Streams in the Twin-Cities Metro Area

Hong Wang, Metropolitan Council Environmental Services

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11:30 – 12:15 **Lunch**

12:15 – 1:00 **Luncheon Presentation**
Climate Impacts on Water Resources
Paul Douglas, Total Weather, LLC

1:15 – 2:45 Concurrent Sessions II

Track A Rooms 1–3

Using LiDAR and GIS Tools to Prioritize Conservation

Moderator: *Ann Lewandowski,* Water Resources Center, University of Minnesota

Co-Moderator: *Ann Banitt,* U.S. Army Corps of Engineers

Using Terrain Analysis to Implement a Watershed Restoration and Protection Strategy

Andrew Kessler, Mark Deutschman, Zach Herrmann, and *Joe Lewis,* Houston Engineering, Inc.

Identifying Priority Management Zones for Best Management Practice Implementation in Impaired Watersheds

Greg Wilson, Barr Engineering Company

Sub-Watershed Prioritization Tool

Tim Terrill, Mississippi Headwaters Board; *Mitch Brinks*, Crow Wing County Land Services

Track B Rooms 4–6

BMP Performance and Maintenance

Moderator: *Ron Leaf*, Short Elliot Hendrickson, Inc.

Co-Moderator: *Lisa Goddard,* SRF Consulting Group, Inc.

Transport of Urban Stormwater Derived Constituents Beneath Rain Gardens and Bioretention Areas in the Twin Cities Metro Area, Minnesota

Brian Davis, Metropolitan Council; *Caleb Arika, John Gulliver, Linse Lahti,* and *John Nieber*, University of Minnesota; *Peter Weiss,* Valparaiso University

Assessment of Bioretention Device Performance by Use of Water Level Recordings in Ontario, Canada

Michael Talbot, Emmons & Olivier Resources, Inc.; *Robb Lukes,* Credit Valley Conservation Authority

RWMWD Maintenance Program: Assessing BMP Maintenance

Paige Ahlborg, Ramsey-Washington Metro Watershed District

Track C Ballroom C

Sediment

Moderator: *Rick Voigt,* Voigt Consultants, LLC

Co-Moderator: *Jeff Berg,* Minnesota Department of Agriculture

From Field to Stream: Measuring Sediment and Nutrient Losses in Southeast Minnesota

Kevin Kuehner, Minnesota Department of Agriculture

Hydrologic Processes in Relation to Streambank Erosion in Three Rural Minnesota Watersheds

John Nieber, *Kerry Holmberg*, and *Christian Lenhart*, University of Minnesota

Characterizing Suspended-Sediment Concentrations and Sediment Transport Relations for Selected Rivers in Minnesota, 2007-2011

Christopher Ellison, U.S. Geological Survey; *Gregory Johnson*, Minnesota Pollution Control Agency; *Brett Savage*, U.S. Geological Survey

Track D Ballroom D

Sustainability

Moderator: *Wayne Sicora*, Natural Resource Group

Co-Moderator: *Randy Neprash*, Minnesota Cities Stormwater Coalition & Stantec

Minnesota Water Sustainability Framework: How Far Have We Come?

Deborah Swackhamer, Water Resources Center, University of Minnesota

Protecting Water Quality in Minnesota: Watershed-Based Strategies that are Moving the Needle

Michael Duval, Minnesota Department of Natural Resources; *Mitch Brinks,* Crow Wing County Land Services; *Timothy Cross*, Minnesota Department of Natural Resources; *Jeff Hrubes*, Minnesota Board of Water & Soil Resources; *Peter Jacobson*, Minnesota Department of Natural Resources; *Lindsey Ketchel,* Leech Lake Area Watershed Foundation; *Gary Michael*, Minnesota Department of Natural Resources; *Dan Steward,* Minnesota Board of Water & Soil Resources; *Paula West,* Leech Lake Area Watershed Foundation

Addressing TMDLs: Lessons Learned from the Perspective of MS4 Cities

Randy Neprash, Stantec, Inc. and Minnesota Cities Stormwater Coalition

Program Schedule – Tuesday, October 14, 2014 (continued)

2:45 – 3:15 **Break**

3:15 – 4:45 Concurrent Sessions III

Track A Rooms 1–3

LiDAR & Spatial Analysis

Moderator: *Stephanie Johnson*, Mississippi Watershed Management Organization

Co-Moderator: *Les Everett*, Water Resources Center, University of Minnesota

Using LIDAR to Assess Watershed Influence on In-channel Stream Condition for North Shore Tributaries

John Jereczek, Minnesota Department of Natural Resources

High-Resolution Maps of Forest-Urban Watersheds Present an Opportunity for Ecologists and Managers

Kirk Stueve, Natural Resources Research Institute, University of Minnesota, Duluth; *Tom Hollenhorst,* U.S. Environmental Protection Agency; *George Host* and *Lucinda Johnson*, Natural Resources Research Institute, University of Minnesota, Duluth; *John Kelly,* U.S. Environmental Protection Agency

Minnesota Statewide Potential Recharge Estimation (1997-2011) Utilizing the Soil-Water Balance Model

Erik Smith, *Melinda Erickson*, and *Stephen Westenbroek*, U.S. Geological Survey

Track B Rooms 4–6

Rethinking and Reinventing Water Infrastructure

Moderator: *Greg Wilson*, Barr Engineering Company

Co-Moderator: *Bill Douglass*, Bolton & Menk, Inc.

Reducing the Impacts of Extreme Precipitation Using Green Infrastructure: What's the Cost? An Economic Assessment

Hilarie Sorensen and *Brent Schleck,* Minnesota Sea Grant College Program, University of Minnesota

Reduce, Reuse, Replenish: The Three R's of Hugo's Stormwater Management Plan

Pete Willenbring, WSB & Associates, Inc.

Rainwater, Stormwater, Wastewater, and Industrial Water Reuse: Interdisciplinary Solutions to Water Management and Supply Problems

Erin Anderson Wenz, Barr Engineering Company

Track C Ballroom C

Nutrients

Moderator: *Jeff Berg*, Minnesota Department of Agriculture

Co-Moderator: *Lisa Goddard*, SRF Consulting Group, Inc.

Evaluating Agricultural Pesticides and Nitrogen Fertilizer Use in Minnesota

Thomas Bolas, Minnesota Department of Agriculture

Minnesota's Nutrient Reduction Strategy

Wayne Anderson, Minnesota Pollution Control Agency; *Jennifer Olson,* Tetra Tech, Inc.; *David Wall,* Minnesota Pollution Control Agency

P Speciation in Sediments of the Minnesota River Basin

Ashley Grundtner and *Satish Gupta,* University of Minnesota

Track D Ballroom D

Understanding and Managing Contaminants in Water

Moderator: *Jim Stark,* U.S. Geological Survey

Co-Moderator: *Karen Jensen*, Metropolitan Council

Presence of Pharmaceuticals in Select St. Croix River Tributaries

Sarah Elliott, U.S. Geological Survey

Groundwater and Surface-Water Interactions Down-Gradient from a Decades Old Crude Oil Spill

Brent Mason, U.S. Geological Survey

Managing Chloride Sources to the Alexandria Area Sanitary District's Wastewater Treatment Facility

Ian Peterson, Wenck Associates, Inc.

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4:45 – 5:45 **Reception and Poster Session**

Program Schedule – Wednesday, October 15, 2014

8:00 – 8:10 **Welcome**
Brad Wozney, Minnesota Board of Water and Soil Resources

8:10 – 9:30 **Plenary Session**

Carp: Biology and Politics
Peter Sorensen, Professor, Department of Fisheries, Wildlife and Conservation Biology, University of Minnesota

9:30 – 10:00 **Break**

10:00 – 11:30 Concurrent Sessions IV

Track A Rooms 1–3

Wetlands

Moderator: *Salam Murtada*, Minnesota Department of Transportation

Co-Moderator: *Tina Carstens*, Ramsey-Washington Metro Watershed District

Wetlands for Water Quality: Lessons from Field Studies and Mesocosm Experiments

Christian Lenhart, University of Minnesota; *Ken Brooks*, emeritus, University of Minnesota; *Dean Current* and *Nikol Ross*, University of Minnesota

Status and Trends of Wetlands in Minnesota: Statewide Vegetation Quality Baseline

Michael Bourdaghs, *John Genet*, *Mark Gernes*, and *Emily Peters*, Minnesota Pollution Control

Addressing the Nutrient Driver Paradigm for Dissolved Oxygen in Small, Low Gradient Streams

Jeffrey Strom and *Joseph Bischoff,* Wenck Associates, Inc.; *Diane Sander,* Crow River Organization of Waters

Track B Rooms 4–6

Fish/Trout 1

Moderator: *Gene Soderbeck*, Minnesota Pollution Control Agency

Co-Moderator: *Ron Leaf*, Short Elliot Hendrickson, Inc.

Common Carp Removal in a Shallow Urban Lake

William Bartodziej, Ramsey-Washington Metro Watershed District; *Justine Koch*, University of Minnesota; *Eric Korte,* Ramsey-Washington Metro Watershed District; *Peter Sorenson,* University of Minnesota

Diagnostic Applications of a Fish Community-based Stressor Index

John Sandberg, Minnesota Pollution Control Agency

Minnesota Super-Sentinel Lakes Program: Using Predictive Modeling to Assess Habitat Shifts for Cold-Water Fish

Richard Kiesling, U.S. Geological Survey

Track C Ballroom C

Making a Difference Through Education and Outreach

Moderator: *Andrea Hendricksen*, Minnesota Department of Transportation

Co-Moderator: *Juanita Voigt,* MnDOT

Skills for Local Water Resource Management: The Watershed Specialist Training Program

Ann Lewandowski and *Faye Sleeper*, Water Resources Center, University of Minnesota

Master Water Stewards: Community Leadership for Clean Water

Peggy Knapp, Freshwater Society

Making Research More Accessible: Updates to the Minnesota Water Research Digital Library

Christine Yaeger, Minnesota Department of Agriculture; *Erik Anderson*, Washington Conservation District; *Adam Birr*, Minnesota Corn Growers; *Ann Lewandowski*, Water Resources Center, University of Minnesota

Track D Ballroom D

WRAPS

Moderator: *Stephanie Johnson*, Mississippi Watershed Management Organization

Co-Moderator: *Greg Wilson,* Barr Engineering Company

The Applicability of Using HSPF in WRAPS/TMDL Projects

Timothy Erickson, Houston Engineering, Inc.

Predicting Pollutant Reductions for Watershed Implementation Strategies with SAM, an HSPF User Interface

Emily Javens, *Julie Blackburn*, and *Jason Love*, RESPEC Consulting and Services

Evaluation of Resource Management and Climate Change Scenarios using HSPF Model Applications, Pine River and Leech Lake River WRAPS

Julie Blackburn, Seth Kenner, and *Joe Pallardy,* RESPEC Consulting and Services

Low Impact Development (LID) and Stormwater Management Workshop

A Miscellany of Thoughts, Considerations, and Lessons Learned about Planning, Design, Construction, and Maintenance of LID Stormwater Control Measures

Scott Struck, Senior Professional at Geosyntec Consultants

Past-Chair of Urban Water Resources Research Council; ASCE-EWRI Governing Board

Program Schedule – Wednesday, October 15, 2014 (continued)

11:30 – 12:15 **Lunch**

12:15 – 1:00 **Luncheon Presentation**
Farming and Clean Water: Still Such a Long Way to Go

Craig Cox, Senior Vice President of the Environmental Working Group

1:15 – 2:45 Concurrent Sessions V

Track A Rooms 1–3

EXTENDED SESSION

NOTE: TIMING FOR THESE PRESENTATIONS WILL NOT FOLLOW STANDARD TIMING.

Sulfate, Mercury, and Wild Rice

Moderator: *Shawn Schottler*, St. Croix Watershed Research Station

Co-Moderator: *Dan Engstrom*, St. Croix Watershed Research Station

Sulfate Enrichment and Water-Level Fluctuations Increase Methylmercury Production in a Northern Minnesota Peatland

Jill Coleman Wasik, University of Wisconsin River Falls; *Daniel Engstrom*, St. Croix Watershed Research Station; *Carl Mitchell*, University of Toronto Scarborough; *Edward Swain* and *Bruce Monson*, Minnesota Pollution Control Agency; *Steve Balogh*, Metropolitan Council Environmental Services; *Jeff Jeremiason*, Gustavus Adolphus College

The Impact of Sulfate Releases on Methylmercury in the St. Louis River Watershed

Jeff Jeremiason, Theresa Reiser, and *Rachel Weitz*, Gustavus Adolphus College; *Mike Berndt, Megan Kelly,* and *Travis Bavin*, Minnesota Department of Natural Resources

Track B Rooms 4–6

Fish/Trout 2

Moderator: *John Baker*, U.S. Department of Agriculture

Co-Moderator: *Lorin Hatch*, HDR Engineering, Inc.

Overwinter Invertebrate Community Dynamics in Groundwater-Fed Streams of Southeastern Minnesota

Jane Mazack and *Leonard Ferrington*, University of Minnesota; *Bruce Vondracek*, U.S. Geological Survey & Minnesota Cooperative Fish and Wildlife Research Unit

Evaluation of Trout Stream Standards: Preserving and Enhancing the Vermillion River

Bruce Wilson, Emmons and Olivier Resources, Inc.

Recruitment Dynamics of the Invasive Common Carp at a Watershed Scale

Justine Koch, University of Minnesota; *Loren Miller*, Minnesota Department of Natural Resources; *Peter Sorensen*, University of Minnesota

Track C Ballroom C

Stormwater Management

Moderator: *Ron Leaf*, Short Elliot Hendrickson, Inc.

Co-Moderator: *Wayne Sicora*, Natural Resource Group

Re-creating Trout Brook

Kathleen Anglo, City of Saint Paul; *Bob Fossum,* Capitol Region Watershed District

Implementation of Floating Weir System for Surface Skimming of Temporary Stormwater Ponds

Dwayne Stenlund, Minnesota Department of Transportation

Webber Natural Swimming Pool - First Public Natural Swimming Pool in North America

Robert G. Schunicht and *Reid Schultz*, Landform Professional Services, LLC

Track D Ballroom D

Stormwater 2

Moderator: *Bill Douglass,* Bolton & Menk, Inc.

Co-Moderator: *Kimberly Hill*, St. Anthony Falls Laboratory, University of Minnesota

A 10-Year Commitment to Water Quality: Adopting Stormwater Techniques into a Linear Roadway Project

Chantill Kahler Royer, Lani Leichty, Bolton & Menk, Inc. *Pete Young,* City of Prior Lake

Life-Cycle Assessment (LCA) for Lower-Impact Infrastructure Design in Minnesota

Matt Metzger and *Louise Segroves,* Barr Engineering Company

Targeting Properties of Stormwater BMP Retrofits

Matt Kumka, Barr Engineering Company

LID/Stormwater Management

1:15-2:00

Case Study #1 Riverside Avenue Project

LID and Stormwater BMP Implementation for Streets and Highways

Kurt Leuthold and *Greg Wilson*, Barr Engineering Company and the City of Minneapolis

2:00-2:45

Current and Unfolding LID and Stormwater BMP Research

Andy Erickson and *John Gulliver,* St. Anthony Falls Laboratory, University of Minnesota

Track A continued

Methylmercury Production and Transport in Sulfate-impacted Lakes and Wetlands

Nathan Johnson and *Logan Bailey*, University of Minnesota, Duluth; *Daniel Engstrom*, St. Croix Watershed Research Station; *Carl Mitchell*, University of Toronto; *Jill Coleman-Wasik*, St. Croix Watershed Research Station; *Michael Berndt*, Minnesota Department of Natural Resources

Hydroponic and Mesocosm Studies on the Effects of Sulfate and Sulfide on Wild Rice Growth and Seed Production

John Pastor, Brad Dewey, and *Nathan Johnson*, University of Minnesota Duluth; *Phil Monson, Edward Swain* and *Emily Peters*, Minnesota Pollution Control Agency

Program Schedule – Wednesday, October 15, 2014 (continued)

2:45 – 3:00 **Break**

3:00 – 4:30 Concurrent Sessions VI

Track A Rooms 1–3

EXTENDED SESSION - continued

NOTE: TIMING FOR THESE PRESENTATIONS WILL NOT FOLLOW STANDARD TIMING.

Sulfate, Mercury, and Wild Rice

Moderator: *Shawn Schottler,* St. Croix Watershed Research Station

Co-Moderator: *Dan Engstrom*, St. Croix Watershed Research Station

Field Studies of Physical and Chemical Characteristics of Wild Rice Habitat in Minnesota

Edward Swain, Minnesota Pollution Control Agency; *Amy Myrbo*, Department of Earth Sciences, University of Minnesota; *Daniel Engstrom*, St. Croix Watershed Research Station

Control of Hypolimnetic Mercury Methylation by Liquid Calcium Nitrate Amendment: Redox Thresholds for Sulfide Mobilization of Iron, Manganese, Phosphate, and Methylmercury

David Austin, CH2M HILL

Synthesis: Sulfate, Mercury, and Wild Rice

Panel Discussion

Track B Rooms 4–6

Chlorides on the Move

Moderator: *Jodi Polzin*, CDM Smith, Inc.

Co-Moderator: *Andrea Hendrickson*, Minnesota Department of Transportation

Chlorides in Minnesota's Groundwater

Sharon Kroening, Minnesota Pollution Control Agency

Twin Cities Metropolitan Area Chloride Management Plan

Brooke Asleson, Minnesota Pollution Control Agency

Winter Maintenance Assessment Tool: An Innovative Planning Tool for Public Works to Manage Salt Use

Connie Fortin, Fortin Consulting, Inc.

Track C Ballroom C

Innovative Technology

Moderator: *Gene Soderbeck*, Minnesota Pollution Control Agency

Co-Moderator: *Rick Voigt*, Voigt Consultants, LLC

Lessons Learned During Woodchip Bioreactor Design and Install, Including First-Year Monitoring Results

Lisa Odens, Houston Engineering, Inc.

High Performance Green Infrastructure: Distributed Real-Time Monitoring and Control

Charlene Harper and *Marcus Quigley,* Geosyntec Consultants, Inc.

Matrix Riprap (aka Partially Grouted Riprap) for Spill-Through Bridge Abutments

Rita Weaver, University of Minnesota; *Nicole Bartelt,* Minnesota Department of Transportation

Track D Ballroom D

Water Resource Evaluation and Innovation

Moderator: *Jeff Berg*, Minnesota Department of Agriculture

Co-Moderator: *Tina Carstens,* Ramsey-Washington Metro Watershed

South Washington Conservation Corridor: Re-establishing Historic Watershed Connections

John Loomis and *Matt Moore*, South Washington Watershed District

Laying the Foundation for Characterizing the Long-Term Environmental Impact of Converting Pine Plantations to Modern Irrigated Cropping Systems

Luke Stuewe, Minnesota Department of Agriculture

Toward Effective Indicators of Animal Feeding Operation Contamination of Surface Water

Edwin Brands, University of Minnesota, Morris

LID/Stormwater Management

3:00-3:15

Continuation of Current and Unfolding LID and Stormwater BMP Research

3:15-4:15
Case Study #2
Cross Plains Wisconsin: A 38 Acre Private Residential LID Development

LID and Stormwater BMP Implementation for Private Property Development

James Bachhuber and *Caroline Burger*, Brown & Caldwell; *Roger Bannerman*, retired, Wisconsin Department of Natural Resources

4:00-4:30

Panel Q&A

4:30 **Adjourn**

Poster Display

The following posters will be displayed during the breaks and Tuesday reception.

1. Bald Eagle Lake Watershed Stormwater Re-use/Phosphorus Reduction Project
Kyle Axtell, Rice Creek Watershed District; *Pete Willenbring*, WSB & Associates, Inc.

2. Improving the Sediment Budgets of Minnesota River Tributaries with Statistical Analyses of Reach-Averaged Variables
Martin Bevis and *Karen Gran*, Department of Geological Sciences, Univeristy of Minnesota, Duluth

3.Understanding Land-Use Land Cover Effects on Water Quality in Human Dominated Watersheds
Evelyn Boardman and *Jacques Finlay,* University of Minnesota

4. Conservation Drainage for Agriculture
Chuck Brandel, ISG; *Craig Austinson*, Blue Earth County

5. Quantifying PAH Bioavailability During Habitat Restoration with Navigational Dredged Materials
Amanda Brennan, University of Minnesota Duluth

6. Lacustrine Responses to Decreasing Wet Mercury Deposition Rates: Results from a Case Study in Voyageurs National Park, Northern Minnesota
Mark Brigham, U.S. Geological Survey; *David Gay,* Illinois Water Survey and National Park Service; *David Krabbenhoft*, U.S. Geological Survey; *Mark Sandheinrich* and *James Wiener*, University of Wisconsin-LaCrosse

7. Watershed Education in the Red River Basin, A Multi-State Analysis
David Demuth, Jr. and *Gregory D. Carlson*, Valley City State University; *Karen L. Terry,* University of Minnesota Extension

8. A Watershed Management Framework for Minnesota Lakes
Michael Duval, *Timothy Cross*, and *Peter Jacobson*, Minnesota Department of Natural Resources

9. Applying a Targeted Watershed Approach to Land-Use Planning in North-Central Minnesota
Michael Duval, Minnesota Department of Natural Resources; *Mitch Brinks*, Crow Wing County Land Services Department

10. Applying a Targeted Watershed Approach to Protecting Water Quality and Other Priority Conservation Features in North-Central Minnesota
Michael Duval, Minnesota Department of Natural Resources; *Lindsey Ketchel* and *Paula West*, Leech Lake Area Watershed Foundation

11. Applying a Watershed Framework to Clean Water Program Implementation
Michael Duval, Minnesota Department of Natural Resources; *Jeff Hrubes* and *Dan Steward,* Minnesota Board of Water and Soil Resources

12. Applying Established Forest Stewardship Approaches to Private Forest Land on Targeted Lakesheds of North-Central Minnesota.
Michael Duval and *Gary Michael*, Minnesota Department of Natural Resources

13. The Presence of Contaminants of Emerging Concern in Minnesota Lakes Receiving Groundwater Influenced by Septic System Effluent
Sarah Elliott and *Richard Kiesling,* U.S. Geological Survey; *Heiko Schoenfuss*, Saint Cloud State University

14. Prioritizing Wetland Restoration and Conservation in Minnesota Using an Interactive GIS Web Tool: Phase II
Jeremy Erickson, *Valerie Brady,* and *Terry Brown*, Natural Resources Research Institute, University of Minnesota Duluth; *Mark Gernes,* Minnesota Pollution Control Agency; *Lucinda Johnson,* Natural Resources Research Institute, University of Minnesota, Duluth

15. The Southeast Lake Huron Rural Stormwater Management Model
Ryan Fleming, *Cecilio Olivier*, and *Michael Talbot,* Emmons and Olivier Resources, Inc.

16. A Long-Term Biological Monitoring Network for Understanding Variability of Aquatic Communities in Minnesota's Rivers and Streams
John Genet and *John Sandberg,* Minnesota Pollution Control Agency

17. Smart Bioremediation Technology to Achieve High-Sulfate Reduction in Mining Waters of Northeast Minnesota
David Hendrickson, Natural Resources Research Institute, University of Minnesota, Duluth

18. Conditioning Digital Elevation Models (DEM) in the Red River Basin - Methods and Lessons Learned
Zach Herrmann, Houston Engineering, Inc.; *Grit May*, International Water Institute; *Henry Van Offelen*, Minnesota Department of Natural Resources

19. Climate Change Effects on Coldwater Fisheries and Water Quality of Northern Minnesota Lakes
Meghan Jacobson, Emmons and Olivier Resources, Inc.

20. Subsurface Filtration Fish Barriers as an Innovative Carp Management Tool: Bone Lake Case Study
Meghan Jacobson and *Greg Graske,* Emmons and Olivier Resources, Inc.

21. Neighborhood Drainage Infrastructure Improvements Using Green Initiatives in the Village of Hinsdale, Illinois
Ajay Jain, HR Green, Inc.

22. Empire Wastewater Treatment Plant Volume Reduction System: A Tour of On-Site Best Management Practices
Karen Jensen, Metropolitan Council Environmental Services

23. A Method to Quantify the Impact of Seepage on River Bank Erosion
Andrew Kessler, Houston Engineering, Inc.

24. Economic Comparison of Borehole and River Sourced Water Supply System Through Life-Cycle Costing: Case Study of Ethiopia
Atekelt Abebe Ketema, Institute of Sanitary Engineering and Water Pollution Control

25. Empire Wastewater Treatment Plant Green Roof: A Study to Determine Performance Efficiency of a Small Green Roof
Jennifer Kostrzewski, Karen Jensen, Cammy Johnson, and *Kent Johnson*, Metropolitan Council Environmental Services; *Stephen Labuz,* University of Minnesota; *Scott Schellhaass*, Metropolitan Council

26. South Washington Conservation Corridor: Stabilizing East Ravine
Michael Lawrence, Houston Engineering, Inc.

Poster Display–Continued

27. Comparison of In-Stream and Laboratory Procedures to Establish Relation Between Turbidity and Suspended-Sediment Concentration
Gustavo Merten, Department of Civil Engineering, University of Minnesota

28. Wind Farms and Water
Tom Miller, *Luke Arnquist*, and *Chad Grismer*, Westwood Professional Services

29. Modeling the Hydrological Effects of Wetland Restoration in the Le Sueur Watershed with SWAT
Nathaniel Mitchell, Department of Geological Sciences, University of Minnesota, Duluth

30. Robart's Creek Box Culvert Repair Within a Detailed Flood Insurance Study Area
Scott Morgan, *Nicole Bartelet*, and *Shanna Kent,* Minnesota Department of Transportation

31. Southern Minnesota Stream Bank Repairs
Scott Morgan, Nicole Bartelet, and *Shanna Kent,* Minnesota Department of Transportation

32. Developing the Framework for the One Watershed, One Plan
Rachel Olm, University of Minnesota; *Melissa Lewis*, Minnesota Board of Water and Soil Resources; *Joseph Magner*, University of Minnesota; *Doug Thomas*, Minnesota Board of Water and Soil Resources

33. Statewide Riparian Buffer Inventory of Minnesota's Rivers and Streams
Andrew Petersen, Minnesota Pollution Control Agency

34. South Washington Conservation Corridor Project: Design and Construction of a Storm Sewer Pipeline with 40+ foot Bury Depths
Matt Redington, HDR Engineering, Inc.

35. Results of a Comprehensive Water Quality Assessment of Select Metropolitan Area Streams
Emily Resseger, Metropolitan Council Environmental Services

36. The Legacy of Civil Engineering on Riverine Management and Restoration
Marty Rye, Superior National Forest

37. Contribution-Based Fees for Water Management Units in the Sauk River Watershed District
Paul Senne, RESPEC Consulting & Services; *Tara Ostendorf*, Sauk River Watershed District; *Emily Javens* and *Seth Kenner*, RESPEC Consulting & Services

38. Iowa Watersheds Project: Planning and Assessment of Distributed Flood Mitigation Strategies in Agricultural Watersheds
Nicholas Thomas, IIHR - Hydroscience & Engineering, University of Iowa

39. Comprehensive Natural Resource Planning in Red River Basin Watersheds – Simplifying a Complex Process to Essential Objectives and Strategies Needed to Improve Watershed Health
Henry Van Offelen, Minnesota Department of Natural Resources

40.Red River Basin Watershed Planning Tool - Applying Light Detecting and Ranging (LiDAR) Data, Emerging GIS Technologies, and Established Practices to Strategically Plan Projects to Improve Watershed Health
Henry Van Offelen, Minnesota Department of Natural Resources; *Charles Fritz* and *Grit May*, International Water Institute

41. Water Quality Trading Considering Flow Pollution and Stock Pollution
Zhiyu Wang, University of Minnesota

42. Mapping Undocumented Levees Using LiDAR Data and GIS
Terry Zien, U.S. Army Corps of Engineers

Minnesota Water Resources Conference

October 14-15, 2014
Saint Paul RiverCentre

175 West Kellogg Boulevard
Saint Paul, Minnesota

Book of Abstracts

Arranged by session in order of presentation
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Plenary Session 1 8:20 a.m. – 9:30 a.m.

Research in the U.S. EPA

Janet Keough, Associate Director for Science, Environmental Protection Agency, Mid-Continent Ecology Division

Concurrent Session I 10:00 a.m. – 11:30 a.m.

Track A: Hydrologic Methods

Potential Pitfalls in Hydrologic Analysis

Dan Reinartz (daniel.reinartz@state.mn.us), Minnesota Department of Natural Resources

This presentation will reflect my 35 years of hydrological analyses experience and will focus on studies that pertain to synthetic-event based analyses used in design and FIS for discharge-frequency estimation. The primary topics will relate to Unit Hydrograph methodology including: 1.) selection of an appropriate synthetic-storm event duration, 2.) selection of an appropriate computation time interval, 3.) emphasize the importance of adopting a representative-basin, unit hydrograph, and 4.) emphasize the importance of synthetic-storm event calibration to an adopted discharge-frequency curve.

The ramifications of the recent NOAA Atlas 14 Precipitation Frequency Estimates will be addressed. If time allows, the areal adjustment of point rainfall as presented in Weather Bureau Technical Paper No. 40 and how that can be a constraint on size of watershed that is modeled will be briefly discussed.

Effects of Updating Rainfall to Atlas 14, Case Study of the Rice Creek Watershed District

Michael Lawrence (mlawrence@houstoneng.com) and Christopher Otterness (cotterness@houstoneng.com), Houston Engineering Inc.; Phil Belfiori (pbelfiori@ricecreek.org), Rice Creek Watershed District

The recently released Atlas 14 precipitation frequency estimates increase the 100-year, 24-hour rainfall depth in the north Twin Cities metro from 6" (as identified in TP-40) to approximately 7.2". Such a drastic change in the design precipitation event has been a cause for concern for both those in construction and development industry and city regulators, as fears that adopting Atlas 14 for regulatory purposes may have repercussions as regulatory flood elevations increase and stormwater infrastructure is designed for potentially larger flows. To address these concerns, the Rice Creek Watershed District (RCWD) completed a District-wide study of the effect of Atlas 14 on regulatory flood elevations and potential impacts on the design of new stormwater management features. This presentation describes the potential effects from the RCWD's adoption of Atlas 14 in both rural and urban settings of RCWD and the importance of previously analyzing the 100-year, 10-day runoff event.

Concurrent Session I 10:00 a.m. – 11:30 a.m.

Track A: Hydrologic Methods *(continued)*

Development of New Methods to Quanitify Effective Impervious Area in Urban Watersheds

Ali Ebrahimian (ebrah034@umn.edu), John Gulliver (gulli003@umn.edu), and Bruce Wilson (wilson@umn.edu), St. Anthony Falls Laboratory, University of Minnesota

The design of stormwater management practices is often done using the impervious area in a watershed. A better parameter for these designs is the "effective" impervious area (EIA), or the portion of total impervious area that is directly (hydraulically) connected to the storm sewer system. Impervious area is typically estimated using a simplistic analysis of measured runoff. Large errors are possible because of the complex role of infiltration and other factors in the observed data. Methods to improve estimates of EIA are not highly researched, and need further investigation.

The overall goal of this study is to develop a method to accurately estimate EIA in un-gauged urban watersheds. The study is based on two main approaches: (1) Statistical analysis of rainfall-runoff data and (2) GIS based techniques. We have improved the existing rainfall-runoff method in the first approach by reducing the uncertainty associated with EIA estimates. As a result of the second approach, we have proposed a new GIS based method for determination of the fraction of EIA in urban watersheds. This method is based on evaluating curve number (CN) at the basin scale from rainfall-runoff events. While providing the EIA fraction, the method investigates different CN behaviors in urban watersheds and determines the response of each watershed. The latter is particularly attractive for practitioners involved in computing and modeling runoff from urban watersheds and design of associated stormwater control measures (SCMs). The two methods were applied to several urban watersheds with different sizes and characteristics mainly within the Twin Cities metro area, MN. While the results provide a better understanding of the urban runoff mechanisms in the watersheds of study, they can be used as accurate estimations of EIA that would benefit a wide range of organizations involved in the design of stormwater control measures. Additional work is underway to further evaluate the usefulness of the GIS-CN method in un-gauged watersheds.

Concurrent Session I 10:00 a.m. – 11:30 a.m.

Track B: Applied Hydraulic Design

Modeling a Low-Head Dam Retrofit with a 2D Hydraulic Model (Adaptive Hydraulics)

Jeff Weiss (jweiss@barr.com), Ron Koth (rkoth@barr.com), and Erik McCarthy (emccarthy@barr.com), Barr Engineering Company

Adaptive Hydraulics (AdH) was used to model a recently constructed low-head dam retrofit project in which boulders were used to create a step-pool sequence that allows fish passage. AdH is a 2-dimensional hydraulic model developed by the US Army Corps of Engineers. Detailed survey data of the retrofit project was taken by using a 3D scanner during a dry period in which no water was flowing through the project and a 3D surface was generated with points within millimeters of each other. AdH was used to model the existing retrofit project, and the results were compared to HEC-RAS results. HEC-RAS is often used in the design of in-stream structures and retrofit projects such as these because it is a well-known model, easy to use, and does an excellent job of predicting upstream impacts a project may cause; however one of its primary limitations is its inability to model localized velocities. The modeling effort with AdH provides a more detailed view of the hydraulics through all portions of the retrofit project. In addition, various boulder spacings were modeled to determine impacts on velocities and pool elevations in order to target various fish species and create a more natural look in future designs.

Revisiting Tumbling Ring Design and Performance

William R. Douglass (billdo@bolton-menk.com), Bolton & Menk, Inc.

In 1990, Bolton & Menk provided the consulting engineering design for the full reconstruction of an 8 mile stretch of US Highway 169 between Blue Earth and Winnebago, Minnesota. Although the new roadway followed the same general corridor, the design included increased horizontal curve radii, raised low points and a wider roadway and shoulder design. This resulted in increased embankment widths at culvert crossings. In some areas, the fall between the culvert inlet and the culvert outlet became extreme. In fact, two of the culverts had more than 20 feet of fall across the roadway. We determined that if a standard, straight culvert was designed, the flow would become supercritical within a few feet of the upstream apron and the velocities would increase throughout the typical 200-foot remaining length of these steep culverts. Using unsteady flow calculations, we determined that the outlet velocities for the more extreme culverts would be in excess of 20 feet per second.

In working the MnDOT area hydraulics staff, we came up with a relatively maintenance free tumbling ring design to create turbulence within the pipe. Tumbling ring designs had been shown to reduce the outlet velocities to near the critical flow velocities, or near 10 feet per second. This design was deemed to provide the best protection against downstream erosion and enabled the use of standard riprap outlet protection within the right-of-way. The final accepted design included six different tumbling ring culvert designs in the 8 mile reconstruction project.

After nearly 25 years, the area has been subject to multiple high intensity rainfall events capable of testing the integrity of the design. This presentation will revisit the design procedures and key criteria associated with tumbling ring design. It will also examine the outlet conditions to show how these designs have functioned since their 1990 construction.

Concurrent Session I 10:00 a.m. – 11:30 a.m.

Track B: Applied Hydraulic Design *(continued)*

Walls of Water, Transforming Rainwater into a Work of Art

Ron Leaf (rleaf@sehinc.com) and Rebecca Nestingen (rnestingen@sehinc.com), SEH, Inc.

Tartan Crossing is a visually stunning example of how stormwater management principles and artful design come together to create a sense of place and beauty within a community. Intriguing features such as the four basin cells separated by concrete weir walls, native plants, water spouts on each wall, and the meandering channel with concrete orbs, draw residents and visitors into a unique, natural experience, while at the same time creating a functional stormwater treatment system designed to improve and protect the environment.

Tartan Crossing "artfully" directs water to where it should go, but also serves several important purposes within the neighborhood, and ultimately the region. The system cleans and filters rainwater runoff through both infiltration and filtration and native plants and provides educational value relative to stormwater issues with signage and a walking path around the basin.

Concurrent Session I 10:00 a.m. – 11:30 a.m.

Track C: Lakes

Minnesota's 2012 National Lakes Assessment: National, State, and Ecoregion-based Approach

Steve Heiskary (steven.heiskary@state.mn.us), Minnesota Pollution Control Agency

Minnesota's participation in the 2012 National Lakes Assessment (NLA) involved a collaborative approach that included USEPA, USFS, MDNR, MDH, MDA and the Red Lake and White Earth Native American Bands. Minnesota drew 42 lakes in the draw for the national survey and added 8 lakes to allow for state-based assessment. All 50 lakes received the national level of assessment and contributed to the state and national assessments. In addition, 100 lakes were added from the random sample to allow for ecoregion-based assessments in Minnesota.

This collaboration and various survey add-ons provided "value-added" elements to the NLA survey. Examples include:

- Emerging contaminants in 50 lakes;
- Pesticides in 50 lakes;
- Zooplankton analysis in all 150 lakes;
- Microcystin analysis in all 150 lakes;
- Water chemistry and profiles in all 150 lakes.

The presentation will provide an overview of Minnesota's 2012 NLA and share results on the above topics, including examples at the state and ecoregion levels.

Shallow Lake Management on a Shoestring Budget

Rebecca Kluckhohn (rkluckhohn@wenck.com) and Wes Boll (wboll@wenck.com), Wenck Associates, Inc.; Dennis Loewen (dennis.loewen@crwd.org), Clearwater River Watershed District

How do turn two turbid shallows lake with TP concentrations 13 times the state standard and no rooted plants into clear state lakes with healthy rooted plant communities in just one season? This presentation will provide a cast study of two severely impaired shallow lakes which discharge excess nutrients downstream to Cedar Lake, a large, deep, high value recreational lake with a tullibee population. The key to protecting Cedar Lake, which was starting to exhibit signs of impairment, was to restore the shallow upstream lakes. With small drainage areas, the impairments were driven more by altered hydrology and rough fish rather than watershed loads. Listen to how the Clearwater River Watershed District managed rough fish populations to take these two shallow lakes from turbid lakes, void of rooted plants to clear state lakes with healthy, growing macrophyte population.

Concurrent Session I 10:00 a.m. – 11:30 a.m.

Track C: Lakes *(continued)*

Common Misconceptions Regarding the Use of Aluminum Sulfate (Alum) in Lakes

Joe Bischoff (jbischoff@wenck.com) and Brian Beck (bbeck@wenck.com), Wenck Associates, Inc

The use of aluminum sulfate or alum in lakes started in the 1970's to reduce or eliminate internal phosphorus release from sediments that can lead to nuisance algae levels. Over the past four decades, there have been numerous advances in the science of using alum in lakes including more specific dosing calculations, improved understanding of the fate of aluminum in the sediments, and case studies documenting the long term results of the treatments. However, there are still common misconceptions about the use of alum in lakes, its safety, and its long term effectiveness. Some of the more common misconceptions include: 1. Alum treatments are overly expensive and not effective for the long term, 2. Alum treatments are not effective in shallow lakes, 3. Alum treatments should not be considered until the watershed load is addressed, and 4. Alum treatments are not safe for humans or biological organisms. Each of these misconceptions can lead to delays in the appropriate use of alum that prevents short and long term benefits to the lake. With proper planning, these benefits can be realized in the near term to the advantage of lake users. This presentation addresses these misconceptions, summarizes the current science, and offers suggestions on how these issues can be addressed when considering the use of alum in lakes.

Concurrent Session I 10:00 a.m. – 11:30 a.m.

Track D: Assessment and Trends for Moving Water

Multiple Uses of Data from an Automated Monitoring Network in a 6-mile Urban Stormwater Tunnel

Britta Suppes (britta@capitolregionwd.org) and Bob Fossum (bob@capitolregionwd.org), Capitol Region Watershed District

Since 2004, Capitol Region Watershed District in St. Paul, Minnesota has operated a comprehensive network of automated stormwater monitoring sites to evaluate stormwater flow through the Trout Brook Storm Sewer Interceptor (TBI), a 6-mile stormwater tunnel draining over 5,000 acres of a fully urbanized area to the Mississippi River.

TBI water quantity and quality data has been continuously collected, recorded, and analyzed by CRWD from 2004 to 2013, characterizing trends in total discharge, pollutant loading, and climatic patterns. The data has been utilized to inform a variety of projects, including: Hydrologic and Hydraulic model calibration for flood prediction and improved operation and maintenance of the TBI; loading calculations for the South Metro Mississippi River Turbidity TMDL; and loading calculations for minor subwatersheds of TBI to inform management decisions, such as the identification of optimal locations for stormwater best management practices.

Watershed Pollutant Load Monitoring Network: Data for Tracking and Determining Pollutant Sources, Source Contributions, and Delivery Dynamics

Patrick Baskfield (pat.baskfield@state.mn.us) and Lee Ganske (lee.ganske@state.mn.us), Minnesota Pollution Control Agency

The Clean Water Land and Legacy Amendment is providing an unprecedented opportunity for enhancing monitoring of Minnesota waters and our understanding of the relative contributions of pollutants from various sources and waters. One example is the Minnesota Pollution Control Agency's (MPCA) Watershed Pollutant Load Monitoring Network (WPLMN), a long-term statewide river monitoring network designed to obtain pollutant load information from more than 200 river monitoring sites. The program utilizes state and federal agencies, universities, local partners, and MPCA staff to collect water quality and flow data to calculate nitrogen, phosphorus, and sediment pollutant loads. Monitoring sites span three ranges of scale: basin, major watershed, and subwatershed with intensive water quality sampling occurring at all sites. In this presentation, several years of total suspended solids loading data are used from WPLMN sites within the Upper Mississippi River Basin above Lock and Dam #3 are used to highlight the benefits and strengths of this multi-scaled monitoring approach in sediment source tracking, determining source contributions, and understanding annual, seasonal, and runoff event specific pollutant delivery dynamics.

The passage of the Clean Water Land and Legacy Amendment and subsequent appropriations by the Legislature from the Clean Water Fund is enhancing monitoring of Minnesota waters and our understanding of the relative contributions of pollutants from various sources and waters. One example is the Minnesota Pollution Control Agency's (MPCA) Watershed Pollutant Load Monitoring Network (WPLMN), a long-term statewide river monitoring network designed to obtain spatial and temporal pollutant load information from more than 200 river monitoring sites. The program utilizes state and federal agencies, universities, local partners, and MPCA staff to collect water quality and flow data to calculate nitrogen, phosphorus, and sediment pollutant loads using the "Flux32" pollutant load model. Monitoring sites span three ranges of scale: basin, major watershed, and subwatershed. Intensive water quality sampling occurs at all sites with twenty-five to thirty-five grab samples collected annually, depending on the site. In this presentation, several years of total suspended solids loading data are used from WPLMN sites within the Upper Mississippi River Basin above Lock and Dam #3 are used to highlight the benefits and strengths of this multi-scaled monitoring approach in sediment source tracking, determining source contributions, and understanding annual, seasonal, and runoff event specific pollutant delivery dynamics.

Concurrent Session I 10:00 a.m. – 11:30 a.m.

Track D: Assessment and Trends for Moving Water *(continued)*

Regional Progress in Water Quality: A Trend Analysis for Select Streams in the Twin-Cities Metro Area

Hong Wang (hong.wang@metc.state.mn.us), Karen Jensen (karen.jensen@metc.state.mn.us), Jen Kostrzewski, Emily Resseger, Terrie O'Dea, Joe Mulcahy and Judy Sventek, Metropolitan Council Environmental Services

In 1989 MCES began monitoring tributary streams to assess nonpoint source runoff to metropolitan area rivers. During 2013 MCES completed a comprehensive data assessment, including trend analysis.

This presentation focuses on statistical analysis of water quality trends in 20 metropolitan area streams, with the objective to understand regional changes during the last two decades. Trends were analyzed using the USGS program QWTREND, which estimates multiple trends based on flow-adjusted concentration to identify changes in water quality over time.

The analysis was performed for total suspended solids (TSS), total phosphorus (TP) and nitrate (NO3) from 1989 to 2012. Results indicate that of the 20 streams assessed, most exhibited a substantial improvement in water quality (17 streams showed decreasing TSS and TP concentrations and 16 had decreasing NO3 concentration); none of the streams had decreasing water quality for all three parameters. There was no identifiable spatial pattern for the streams with increasing or decreasing water quality.

Luncheon Presentation 12:15 p.m. – 1:00 p.m.

Climate Impacts on Water Resources

Paul Douglas, Total Weather, LLC

Concurrent Session II 1:15 p.m. – 2:45 p.m.

Track A: Using LiDAR and GIS Tools to Prioritize Conservation

Using Terrain Analysis to Implement a Watershed Restoration and Protection Strategy

Andrew Kessler (dkessler@houstoneng.com), Mark Deutschman (mdeutschman@houstoneng.com), Joe Lewis (jlewis@houstoneng.com), and Zach Herrmann (zherrmann@houstoneng.com), Houston Engineering, Inc.

All 81 major watersheds within Minnesota will have a Watershed Restoration and Protection Strategy (WRAPS) developed. Through the WRAPS process, Hydrological Simulation Program Fortran (HSPF) models can be used to develop an implementation strategy which includes the prioritization of subwatersheds for the placement of conservation practices to achieve resource restoration and protection goals. However, additional tools are needed to allow local practitioners to target specific fields for conservation practices once priority subwatersheds are identified and to "measure" progress. This presentation demonstrates methods applied within the Sand Hill River Watershed utilizing lidar based terrain analysis and enhanced geo-spatial water quality data products to develop field level implementation strategies to target the placement of conservation practices and measure their costs and benefits.

Identifying Priority Management Zones for Best Management Practice Implementation in Impaired Watersheds

Greg Wilson (gwilson@barr.com), Barr Engineering Co.; David Mulla (mulla003@umn.edu) and Dylan Timm (timmx162@umn.edu), University of Minnesota; Jim Klang, Kieser & Associates; Dennis Fuchs, Ben Ruley, Brad Wenz, Mark Lefebvre, and Carrie Raber, Stearns County Soil and Water Conservation District

Critical Source Areas (CSAs) are portions of the landscape that combine high pollutant loading with high propensity for delivery to surface waters. Priority Management Zones (PMZs) are watershed regions targeted for conservation practices that address disproportionate pollutant loadings. New tools and technology, combined with LiDAR availability, provide the potential for rapid landscape assessments that identify CSAs and PMZs. Minnesota Department of Agriculture funded this project to thoroughly evaluate these new technologies in multiple regions of the state and determine their potential value in targeting specific areas where BMP implementation will have the greatest environmental benefit. The project resulted in the development of a compendium of assessment tools and provided decision-support guidance for identifying CSAs and delineating PMZs. Case study examples representing a range of Minnesota's agroecoregions will be presented to illustrate how our team has integrated various GIS tools, models and indices to target and prioritize areas for BMP implementation.

Sub-Watershed Prioritization Tool

Tim Terrill (timt@mississippiheadwaters.org), Mississippi Headwaters Board; Mitch Brinks (mitch.brinks@crowwing.us), Crow Wing County Land Services

In the Mississippi River Corridor there has been inconsistent data for risk assessment and prioritizing watershed projects. In 2011 the Mississippi Headwaters Board received funding from the Board of Water and Soil Resources to develop a GIS sub-watershed prioritization tool for the first 400 miles of the Mississippi river. The GIS tool was later expanded to sub-watersheds in Crow Wing County. Tool parameters include land protection, land disturbance, water quality data, and risk factors that when factored together, assign each sub-watershed a risk classification and suggest implementation strategies. This model is being added to eight county Water Plans, and is projected to be utilized in 18% of Minnesota by 2019. The end result is that the protection area will have consistent project prioritization in their water plans that will help develop strategies for clean water protection as well as additional success when applying for Legacy funds.

Concurrent Session II 1:15 p.m. – 2:45 p.m.

Track B: BMP Performance and Maintenance

Transport of Urban Stormwater Derived Constituents beneath Raingardens and Bioretention Areas in the Twin Cities Metro Area, Minnesota

Brian M. Davis (brian.davis@metc.state.mn.us), Metropolitan Council; John S. Gulliver (gulli003@umn.edu), John L. Nieber (nieber@umn.edu), Caleb Arika (arika001@umn.edu), and Linse Lahti (linse.lahti@state.mn.us), University of Minnesota; Peter T. Weiss (peter.weiss@valpo.edu), Valparaiso University

To investigate the possibility that stormwater contaminants are reaching water table aquifers at Twin Cities stormwater infiltration sites, field monitoring systems were developed at three locations in St. Paul: 1) the Beacon Bluff (BB) bioretention site, a large basin receiving stormwater from a 173 acre area; 2) the Como Park (CP) raingarden, an area receiving runoff from an area of 15 acres; 3) the Sheep Pasture (SP), a natural depression located on the Saint Paul campus of the University of Minnesota. Water sampling equipment at the sites includes suction samplers and/or zero-tension samplers located at multiple depths. Samples were analyzed for nitrate, chloride, phosphorus, and heavy metals. Samples were analyzed for total petroleum hydrocarbons (TPH) at the BB site. The sample results indicate that the three sites exceeded USEPA drinking water maximum contaminant levels (MCLs) for chloride, likely from road salt. The nitrate MCL was exceeded at the CP and SP sites, and lead and iron exceeded MCLs at the sites. The concentrations of TPH in the stormwater were as high as 58 ppm, and at the various depths of subsurface sampling the concentrations ranged from 0 ppm to 34 ppm. Additional sampling for TPH is needed to determine if there is any recognizable trend at the BB site.

Assessment of Bioretention Device Performance by Use of Water Level Recordings in Ontario, Canada

Michael Talbot (mtalbot@eorinc.com), Emmons & Olivier Resources, Inc.; Robb Lukes (rlukes@creditvalleyca.ca), Credit Valley Conservation Authority

Ten bioretention practices were equipped with water level and temperature recorders during the summer months of 2013 and data was analyzed to assess site performance based on filtration and/or infiltration losses. From the individual storm response data, the recession limbs – the receding water levels following cessation of rainfall – were chosen to define a uniform relationship between water level and the rate of change in water level. This relationship was then used to estimate drawdown times and define loss rates for individual rainfall events. From these analyses, most sites appear to be operating close to or better than design specifications. The collection of continuous water level tracking and analysis of these data is a cost-effective and un-biased method to assess bioretention performance. The use of standardized site characteristic tables that compare site design specifications to as-built characteristics (including observed loss rates) is recommended for consideration as part of bioretention assessment process.

RWMWD Maintenance Program: Assessing BMP Maintenance

Paige Ahlborg (paige.ahlborg@rwmwd.org), Ramsey-Washington Metro Watershed District

RWMWD implements volume reduction requirements for new and redevelopment projects. Developers may install multiple BMPs on their street improvement projects to comply with these requirements and maintaining them has been an ongoing struggle. RWMWD began the BMP Maintenance Program in 2013 to determine average cost of maintenance per BMP and the feasibility of implementing a maintenance program in the future to assist our Cities with this issue.

RWMWD hired a landscape company to perform routine maintenance on a variety of BMPs. Detailed documentation of completed activities was kept to assess what maintenance was done, materials used, and how much time was spent at each BMP. 2013 results were assessed to determine how maintenance costs vary depending on BMP size, age, and starting conditions. The maintenance program will continue in 2014 to compare costs with Year 1 results. Year 2 maintenance will be substantially complete by early October 2014.

This talk will present the findings on the cost of maintenance and how the District will work with its 12 cities to ensure BMPs are being maintained.

Concurrent Session II 1:15 p.m. – 2:45 p.m.

Track C: Sediment

From Field to Stream: Measuring Sediment and Nutrient Losses in Southeast Minnesota

Kevin Kuehner (kevin.kuehner@state.mn.us) and Margaret Wagner (margaret.wagner@state.mn.us), Minnesota Department of Agriculture

Reducing agricultural losses continues to pose a challenge, despite decades of work and technological advancements. To improve environmental outcomes, conservation programming must incorporate lessons learned from previous projects. To that end, the Root River Field to Stream Partnership (RRFSP) is a demonstration project addressing the need for conservation planning at the sub-watershed scale. Partners are encouraging farmer leadership, linking land management and hydrologic data and using critical source areas to target conservation.

The RRFSP provides a comprehensive assessment of nutrients and sediment delivered to the watershed outlet. Edge-of-field and in-stream water monitoring began in 2010 and will continue until 2020. Initial results show variability across sites; however important trends are emerging. For example, nearly 60% of runoff and dissolved nutrient losses occurred during frozen soil conditions and 70% of average annual sediment loss occurred in a few runoff events. We will discuss results and share our approach to conservation implementation.

Hydrologic Processes in Relation to Streambank Erosion in Three Rural Minnesota Watersheds

John Nieber (nieber@umn.edu), Christian Lenhart (lenh0010@umn.edu), and Kerry Holmberg (kerryholmberg@comcast.net), Department of Bioproducts & Biosystems Engineering, University of Minnesota

Increased streamflow in southern Minnesota in recent decades is purported to have caused higher rates of streambank erosion. We used oxygen and hydrogen isotopes, specific conductivity, riparian zone wells, stream erosion measurements and groundwater seepage surveys to assess the hydrologic drivers and mechanics of streambank erosion and the spatial distribution of these processes in three rural Minnesota watersheds. By volume most of the water in the south-central Minnesota stream occurs through sub-surface drainage. Surface runoff events are infrequent and concentrated in the spring and fall. While most streambank erosion occurs at high flow events, subsurface drainage may add to peak flow by increasing the base stage of the hydrograph. Riparian zone wells showed that streams may be both gaining and losing reaches depending on season and stage. Groundwater seepage was very sporadic longitudinally and laterally along the study rivers. Lessons learned are highly applicable to watershed and riparian zone management.

Characterizing Suspended-Sediment Concentrations and Sediment Transport Relations for Selected Rivers in Minnesota, 2007-2011

Christopher A. Ellison (cellison@usgs.gov) and Brett E. Savage (besavage@usgs.gov), U.S. Geological Survey; Gregory D. Johnson (gregory.johnson@state.mn.us), Minnesota Pollution Control Agency

In Minnesota, more than 5,800 miles of streams are identified as impaired by the Minnesota Pollution Control Agency (MPCA) due to elevated levels of suspended sediment. In 2007, the U.S. Geological Survey, in cooperation with the MPCA, began a 5-year study of suspended-sediment concentrations (SSC), total suspended solids (TSS), and turbidity in selected rivers across the state. Results from the study indicated that the TSS method of collecting grab samples yielded concentrations that were approximately half of the concentrations as determined by the SSC method. This is attributed in part to sand-sized particles, which comprised an appreciable amount of SSC at many sites. Regression analysis indicated that half of the 14 sites had poor relations between SSC and streamflow. At every site, turbidity was superior to streamflow for estimating SSC. This study provided data to characterize suspended sediment across Minnesota's diverse geographical settings and improved understanding of sediment transport relations.

Concurrent Session II 1:15 p.m. – 2:45 p.m.

Track D: Sustainability

Minnesota Water Sustainability Framework: How Far Have We Come?

Deborah L Swackhamer (dswack@umn.edu) and Charlotte Wood (woodx374@umn.edu), University of Minnesota

It has been six years since the citizens of the state of Minnesota voted to create four dedicated funds from an increase in their sales tax. One of those funds, the Clean Water Fund, receives 1/3 of the proceeds. The Minnesota Water Sustainability Framework was commissioned by the Legislature to help guide those investments by identifying what our major water resources problems are, what we know or don't know about them, what can be done to address them, and how those solutions could be implemented. The Framework was presented to the Legislature in January 2011, and now almost 5 years later I will present on the progress that has been made on those recommendations. Much of the Framework has been implemented, although slowly and not as a whole.

Protecting Water Quality in Minnesota: Watershed-Based Strategies that are Moving the Needle

Michael Duval (michael.duval@state.mn.us), Peter C. Jacobson (peter.jacobson@state.mn.us), Timothy K. Cross (tim.cross@state.mn.us), and Gary Michael (gary.michael@state.mn.us), Minnesota Department of Natural Resources; Paula West (paulaw@leechlakewatershed.org) and Lindsey Ketchel (lindseyk@leechlakewatershed.org), Leech Lake Area Watershed Foundation; Dan Steward (dan.steward@state.mn.us) and Jeff Hrubes (jeff.hrubes@state.mn.us), Board of Water and Soil Resources; Mitch Brinks (mitch.brinks@crowwing.us), Crow Wing County Land Services Department

Minnesota is the Land of 10,000 Lakes. These lakes are a cultural, economic, recreational, and natural resource asset. Despite a land use history that has impacted water quality in many lakes in the agricultural and urban settings of Minnesota, there remain many thousands of lakes in the state that currently sustain high water quality and exhibit relatively low land use disturbance in their watersheds, mostly in the form of public and private forest lands. However, this high water quality cannot be taken for granted. We applied a science-based water quality protection framework that establishes a readily comprehendible, actionable land use disturbance threshold beyond which water quality is projected to decline. We show how this framework and the relative risk of land use change is being successfully implemented by state and local governments and private conservation organizations working collaboratively in north-central Minnesota to actually move the water quality protection needle.

CONTEXT:
- Constitutional amendment
- Legislative directives
- Many lakes in good shape

SCIENCE: Assessing watershed condition (Pete)
- Connects back to Spokane presentation by Tim Cross and NALMS journal publication
- Science-based framework with readily comprehendible, actionable thresholds
- Captures a gob of managed fish lakes

PROGRAMS: Incentivizing projects and planning to intercept trending systems (Dan)
- BWSR's unique role in bridging state and local governments
- How you have used this role to catalyze water planning and implementation projects based on the science-based framework?
- Prioritize, target, & measure

POLICY: Developing watershed planning framework at local level (Mitch)
- Developing a local plan for guiding land use decisions and securing project funding
- Classifying actions based on risk
- Measures of success (Nokasippi River)

PROJECTS & PRACTICES: Implementing project work at targeted watershed scale
- Importance of private forest land owners for targeted stewardship assistance (PFM Tullibee project – Gary)
- Measures of success (cisco lake progress bar chart)
- Using watershed condition information to target conservation easements and land acquisitions (LLAWF – Paula)
- Measures of success (LaSalle Lake, other?)
- Applying regulatory programs and oversight authority to sustain water quality (DNR – Mike)
- Measures of success

Concurrent Session II 1:15 p.m. – 2:45 p.m.

Track D: Sustainability *(continued)*

Addressing TMDLs: Lessons Learned from the Perspective of MS4 Cities
Randy Neprash (randy.neprash@stantec.com), Stantec & Minnesota Cities Stormwater Coalition

This presentation will be by Randy Neprash, PE, the sole staff for the Minnesota Cities Stormwater Coalition (MCSC). MCSC is a coalition of approximately 120 cities in Minnesota that are regulated under the MS4 stormwater permitting program. MCSC has been in a unique role of reviewing and commenting on numerous TMDL studies and reports from the perspective of regulated MS4 cities.

This presentation will present and discuss significant lessons learned by MCSC during this review process. These lessons include:

- It is essential to review multiple TMDLs in order to understand variation and context.
- It is useful to understand and exercise all the administrative and statutory processes available if one wishes to effectively challenge portions of a TMDL.
- There are actually two opportunities to submit formal comments on most TMDLs.
- TMDLs include cost estimates for compliance. These estimates are frequently rough and inaccurate and can be challenged.
- Implementation sections in TMDL reports should be general and relatively brief.
- Modeling information in TMDLs should be checked for calibration and sensitivity testing.
- The baseline year provided in a TMDL is very important and should be reviewed carefully.
- WLAs for MS4 permittees can be expressed in multiple formats.
- WLAs based on high flow conditions present unique challenges.
- The boundaries of the areas covered under the MS4 permit are important and rarely included in TMDL studies.
- The robustness of stakeholder processes for TMDLs is highly variable.

Concurrent Session III 3:15 p.m. – 4:45 p.m.

Track A: LiDAR & Spatial Analysis

Using LIDAR to Assess Watershed Influence on In-channel Stream Condition for North Shore Tributaries

John Jereczek (john.jereczek@state.mn.us), Minnesota Department of Natural Resources

Hydrologist with the US Forest Service have demonstrated the impacts of land use changes, particularly additional open lands and young forest (< 15 yrs) on bank full flows and in-channel erosion. Mapping these impacts has been difficult due to challenges associated with mapping forest stand age and the lack of detailed terrain data. Fortunately with available LIDAR data we now have the tools to map forest stand age, proportion of canopy cover and high resolution terrain data to explicitly map these impacts. We used LIDAR return data, classed into low, medium and high forest canopy, to assess the percent canopy cover or mature forest, and inversely open lands (including developed lands and agricultural lands) and young forest lands effects on MN streams flowing to the north shore of Lake Superior. We used a LIDAR derived DEM to populate an ESRI ArcHydro data model. This was then used to create continuous accumulation grids of percent open lands, contributing area and slope. With simple rule sets, these grids were then used to identify stream locations likely to have increased peak flows that might then increase the likely hood of prolonged in-channel stream erosion and sedimentation. In addition we will look at shading impacts and development of a topographic riparian delineation.

High-Resolution Maps of Forest-Urban Watersheds Present an Opportunity for Ecologists and Managers

Kirk M. Stueve (kstueve@biogeography.us), Lucinda B. Johnson (ljohnson@d.umn.edu), and George E. Host (ghost@d.umn.edu), University of Minnesota Duluth, Natural Resources Research Institute; Tom P. Hollenhorst and John R. Kelly, United States Environmental Protection Agency, Mid-Continent Ecology Division

Dense populations of people and abundant impervious surfaces contribute to poor water quality and increased flooding in forest-urban watersheds. Green infrastructure mitigates these effects, but precisely quantifying benefits is difficult because most land cover maps rely on coarse-resolution data. Hence, important questions concerning the effects of green infrastructure on water quality and quantity at different spatial scales remain unanswered. We used object-based image analysis to create high-resolution land cover maps and detect tree canopy overlapping impervious surfaces in a forest-urban watershed. Mapping accuracies approached or exceeded 90%. Impervious surfaces comprised ~24% of the watershed, tree canopy overlapped ~6% of impervious surfaces, and tree extent greatly exceeded baseline estimates. High-resolution land cover products provide ecologists an unprecedented opportunity to (1) quantify benefits of green infrastructure at different spatial scales and (2) model where future installations of green infrastructure and development are feasible, which could greatly improve the decision-making abilities of managers.

Minnesota Statewide Potential Recharge Estimation (1997-2011) Utilizing the Soil-Water Balance Model

Erik A. Smith (easmith@usgs.gov), Stephen M. Westenbroek (smwesten@usgs.gov), and Melinda L. Erickson (merickso@usgs.gov), U.S. Geological Survey

The U.S. Geological Survey, in cooperation with the Minnesota Pollution Control Agency, used the Soil-Water-Balance (SWB) model to calculate monthly and annual gridded potential groundwater recharge estimates across Minnesota for the period 1997-2011 at a one-kilometer resolution. Potential groundwater recharge is defined as infiltration past the bottom of the root zone. The SWB model utilizes land use, soil properties, and climate data to partition water inputs using a Thornthwaite-Mather soil-water-balance approach. Average recharge estimates across the state for the modeled period (1997-2011) ranged from <1 inch per year to 22 inches per year. For the period 1997 through 2011, April had the greatest average recharge compared to all other months. The highest average recharge across the state occurred in 2001 and the lowest average recharge occurred in 2003. Spatially, the highest recharge rates occurred in northeastern and southeastern Minnesota, and in the central sand-plains.

Concurrent Session III 3:15 p.m. – 4:45 p.m.

Track B: Rethinking and Reinventing Water Infrastructure

Reducing the Impacts of Extreme Precipitation Using Green Infrastructure: What's the Cost? An Economic Assessment

Hilarie Sorensen (soren360@d.umn.edu) and Brent Schleck (bschleck@d.umn.edu), Minnesota Sea Grant College Program

During the past 50 years, the largest increases in heavy precipitation occurred in the Northeast and Midwest regions (U.S. Global Change Research Program, 2009). Communities are interested in using green infrastructure to help reduce flooding impacts from these events, but first, they need answers to several questions:

- What are the options?
- What do they cost?
- What benefits do they provide that conventional techniques do not?
- What data and information are available to help answer these questions?

The objective of this project, led by the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center, is to help communities understand the costs and benefits of green infrastructure options for reducing flood impacts.

This economic assessment method builds on a NOAA-funded study, *The Role of Land Use in Adaptation to Increased Precipitation and Flooding: A Case Study in Wisconsin's Lower Fox River Basin*, by Kousky and others, 2011. Enhancements to this existing study include using climate projections for future extreme rainfall, calculating the costs of a variety of green infrastructure options, and working with the pilot communities to implement the results. This project is being funded by the U.S. Environmental Protection Agency's Great Lakes Restoration Initiative.

Study results in the Duluth's Chester Creek Watershed showed that approximately $1.65 million in benefits could be accrued over the next 20 years through reduced building damages, increased recreational use, reduced land restoration costs and reduced stormwater infrastructure replacement costs from flood events.

Reduce, Reuse, Replenish: The Three R's Of Hugo's Stormwater Management Plan

Pete Willenbring (pwillenbring@wsbeng.com), WSB & Associates, Inc.; Bryan Bear (bbear@ci.hugo.mn.us), City of Hugo

As a result of development, the City of Hugo is faced with managing: 1) reduced infiltration and increased runoff volumes, 2) increased groundwater pumping for potable and irrigation uses and reduced water levels in the aquifer and in White Bear Lake, and 3) the need to reduce phosphorus load to address downstream TMDL requirements for downstream lakes.

Innovative Comprehensive Approach

The City has developed a plan that will, in addition to providing a potable water system, will add to it a storm water system in selected areas of the community. This system will capture and store runoff that otherwise would leave the City, and allow this water to be re-used to: 1) actively infiltrate this water to the extent needed to fully replenish that taken out by pumping municipal wells as well as cover the reduced infiltration that is occurring as a result of development in the City. 2) provide a municipal source of stormwater to many city residents that can or in some cases must be re-used for irrigation instead of water that is pumped from wells. The City will create regional storage and distribution systems to facilitate the above activities.

Concurrent Session III 3:15 p.m. – 4:45 p.m.

Track B: Rethinking and Reinventing Water Infrastructure *(continued)*

Rainwater, Stormwater, Wastewater and Industrial Water Reuse: Interdisciplinary Solutions to Water Management and Supply Problems

Erin Anderson Wenz (eandersonwenz@barr.com), Barr Engineering Company

For many cities and industries, water is high on the list of current concerns. For some, hot summers and declining groundwater levels cast doubts on the future availability of water for everyday needs. For others, recent storms have created flooding problems that require more intensive management. For others, declining water quality due to stormwater runoff is of utmost concern. Or, the problem may be a combination of all of these. Solutions to these multi-faceted problems lie in linking water sources to water needs, turning one area's excess into another's supply. This presentation will highlight several constructed Midwestern projects- their costs, benefits and lessons learned- that have accomplished this goal for a variety of clients with differing motivations for embarking on "water reuse" projects. Useful tools that are available to aid in project decisions, such as water balance calculators and the EnvisionTM Sustainable Infrastructure Rating System will also be discussed.

Concurrent Session III 3:15 p.m. – 4:45 p.m.

Track C: Nutrients

Evaluating Agricultural Pesticides and Nitrogen Fertilizer Use in Minnesota

Thomas Bolas (thomas.bolas@state.mn.us) and Denton Bruening (denton.bruening@state.mn.us), Minnesota Department of Agriculture

Since 2003, the Minnesota Department of Agriculture (MDA) and the USDA National Agricultural Statistics Service (USDA-NASS) have collaborated to collect information on pesticide use from farmers via phone surveys. This partnership evolved in 2010 to include gathering additional nitrogen fertilizer information. Surveys are designed cooperatively, and MDA staff provides training and troubleshooting for NASS phone enumerators. This technique allows thousands of Minnesota farmers to easily share valuable information about the use of chemicals on their farm fields each year.

The pesticide and fertilizer survey data provides important feedback to MDA's programs, including the ground and surface water monitoring programs and associated laboratory analysis. The pesticide information is critical since the rapidly evolving product chemistry often requires new sampling/ handling methods and laboratory procedures. The survey data demonstrates pesticide usage trends, including the rise and fall of glyphosate and premix tank mixtures. Nitrogen fertilizer management is strongly influenced by regional conditions, so it is imperative that the survey links the state's regional BMPs. We will share some significant observations from three statewide Nitrogen fertilizer surveys conducted between 2009 and 2011. Knowledge about nitrogen and pesticide use is paramount to understanding the relationship between their applications and the presence in the environment. The survey data could be utilized by watersheds planners as they design TMDL implementation plans. Future decisions related to agricultural chemical education and policy can be informed by this survey program.

Minnesota's Nutrient Reduction Strategy

Wayne Anderson (wayne.anderson@state.mn.us) and Dave Wall (david.wall@state.mn.us), Minnesota Pollution Control Agency; Jennifer Olson (jennifer.olson@tetratech.com), Tetra Tech

After a public review process, Minnesota has completed its state-level nutrient reduction strategy to achieve and track meaningful and achievable progress for reducing point and nonpoint nutrient losses to waters. The strategy is driven by a need to reduce excess nutrients in Minnesota's waters as well as Minnesota's contribution of nitrogen and phosphorus to downstream waters such as the Gulf of Mexico, Lake Winnipeg and Lake Superior. The questions addressed in the strategy include:

1. Goals - What are the needed levels of reductions?
2. Sources - What nitrogen and phosphorus sources should we focus on?
3. Priority areas - What parts of the state are most critical for reductions?
4. BMPs - What level of BMP adoption is needed to achieve goals?
5. Stepping up - How can we increase BMP adoption?
6. Research - What new/improved BMPs are needed to ensure long term goals are achieved?

Building from scientific findings about nutrient levels, sources, trends and solutions, Minnesota has proposed ways to make progress toward milestone nutrient reduction targets. The strategy identifies existing and new state program initiatives which can further our progress in reducing nutrient losses to waters. The strategy is designed to be a unifying and organizing step to align goals, identify the most promising strategies, and ensure that collective activities around the state are working to achieve our goals.

Concurrent Session III 3:15 p.m. – 4:45 p.m.

Track C: Nutrients *(continued)*

P Speciation in Sediments of the Minnesota River Basin

Ashley Grundtner (grun0128@umn.edu) and Satish C. Gupta (gupta002@umn.edu), University of Minnesota

Sediments are a dominant P reservoir in a variety of aquatic ecosystems and play a critical role in governing dissolved P concentrations. We assess how P properties of the sediments change as they move downstream from the Greater Blue Earth River Basin to the Minnesota/Mississippi confluence. In this study, we analyzed bed load and suspended sediments for equilibrium phosphorus concentration (EPC0), their potential to desorb soluble P, and P sequential extraction fractions. Results showed that sediment samples have higher total P concentration than the P concentration in soils from the surrounding area, thus indicating some P adsorption from river waters. After correcting for particle enrichment, some sediment samples showed higher concentrations of inorganic P downstream than upstream of the WWTPs. Sequential fractionation showed a predominance of calcium-bound P in bed load sediments. Finally, a comparison of the EPC0 values showed that the majority of sediments are acting as a source of P, particularly during low flow periods. We synthesize these results in the context of historical sediment P in Lake Pepin and how sediments from various sources in the Minnesota River Basin may have contributed to this P.

Concurrent Session III 3:15 p.m. – 4:45 p.m.

Track D: Understanding and Managing Contaminants in Water

Presence of Pharmaceuticals in Select St. Croix River Tributaries

Sarah Elliott (selliott@usgs.gov), Kathy Lee (klee@usgs.gov), and Edward T. Furlong (efurlong@usgs.gov), U.S. Geological Survey; Byron Karns (Byronkarns@nps.gov), National Park Service

In 2011, the U.S. Geological Survey, in cooperation with the National Park Service, collected wastewater effluent and surface-water samples upstream and downstream from effluent discharge at five locations in the St. Croix River basin to characterize the occurrence of pharmaceuticals. Filtered water samples were analyzed for 110 pharmaceuticals. Among all samples, 67 pharmaceuticals were detected at concentrations up to 5,110 nanograms per liter. Antidepressants, anticonvulsants, and analgesics were some of the most commonly detected pharmaceutical types. Concentrations and numbers of pharmaceuticals detected were greatest in effluent and greater downstream compared to upstream. Fish and crayfish tissues from select sites also were analyzed for 55 pharmaceuticals (35 of which were common to those analyzed in water). Diphenhydramine, diltiazem, and sertraline were detected in both tissue and water. Results indicate that wastewater effluent is a source of pharmaceuticals to St. Croix River tributaries and that some pharmaceuticals accumulate in aquatic organism tissue.

Groundwater and Surface-Water Interactions Down-Gradient from a Decades Old Crude Oil Spill

Brent E. Mason (bmason@usgs.gov) and Jared Trost (jtrost@usgs.gov), U.S. Geological Survey; Joseph A. Magner (magne027@umn.edu) and John L. Nieber (nieber@umn.edu), University of Minnesota

In 1979 a crude oil pipeline near Bemidji, MN, burst and released 10,700 barrels of oil into sandy, surficial glacial deposits. After initial clean-up efforts, approximately 2,500 barrels of oil remained in the subsurface. The U.S. Geological Survey conducted a groundwater and surface-water interaction study in 2012 to determine if low dissolved oxygen groundwater (DO, less than 1 mg/L) from microbial degradation of crude oil, is discharging into Unnamed Lake approximately 380 m down-gradient from the spill site. Water chemistry indicates that the dissolved-phase chemical contaminants have migrated only meters down-gradient. Interactions between Unnamed Lake and the aquifer were quantified through measurements of hydraulic gradients, seepage rates, temperature differences, oxygen-16/oxygen-18 and deuterium/protium isotopic ratios, and water quality characteristics across the lake/sediment interface. These data indicate that low DO groundwater discharges into the lake from the aquifer, and that a zone of low DO water extends from the spill site to the lake.

Managing Chloride Sources to the Alexandria Area Sanitary District's Wastewater Treatment Facility

Ian J. Peterson (ipeterson@wenck.com) and Joseph M. Bischoff (jbischoff@wenck.com), Wenck Associates Inc.; Bruce Nelson (alasd1@rea-alp.com), Alexandria Lake Area Sanitary District

The State of Minnesota is currently focusing on chloride sources to surface waters as more water resources are impacted by chloride. Wastewater treatment facilities (WWTF) are one potential source due to the prevalent use of water softeners. Because of the limited treatment options for chloride, the best option for controlling discharges to surface waters is to evaluate and limit chloride loading to the wastewater treatment facility. To that end, the Alexandria Lakes Area Sanitary District (ALASD) developed a chloride source assessment for their WWTF. Residences almost exclusively soften their potable water which contributes nearly 80% of the total chloride to the WWTF with the remaining coming from industrial dischargers and background chloride concentrations. Centralized softening, metered home softeners, state performance standards, discharge regulation, and other options were evaluated to reduce chloride contributions. Only a combination of central softening and demand based softeners demonstrated the ability to achieve target chloride concentrations. These results suggest that WWTFs that serve predominantly rural populations where central softening is not an option may have difficulties meeting permitted discharge concentrations.

Plenary Session II 8:10 a.m. – 9:30 a.m.

Carp: Biology and Politics

Peter Sorensen, Department of Fisheries and Wildlife, founder and researcher at the Minnesota Aquatic Invasive Species Research Center, University of Minnesota

Concurrent Session IV 10:00 a.m. – 11:30 a.m.

Track A: Wetlands

Wetlands for Water Quality: Lessons from Field Studies and Mesocosm Experiments

Christian Lenhart (lenh0010@umn.edu), Dean Current (curre002@umn.edu), Nikol Ross (nikol.biermaier@gmail.com), and Ken Brooks (brook007@umn.edu), University of Minnesota

Wetlands are often restored or constructed for water quality treatment yet the effectiveness of different types in Minnesota is poorly documented. Three different wetland types were restored or constructed in southern Minnesota since 2004: a prairie pothole, an oxbow, and a 3-cell treatment wetland to reduce outflow and nutrient load. Field studies were from 2005 and are ongoing, while wetland mesocosm experiments have been done since 2013 to study the effect of different soil and vegetation types on nitrate removal rates. The pothole wetland stored the most water and had the greatest nutrient removal. The oxbow had rapid sediment removal rates and provided water storage. Constructed wetlands stored little water and had lower denitrification rates. Wetland mesocosm studies showed that higher rates of denitrification occurred in natural wetland soil than in the treatment wetland soil. The results suggest that improved planning and design is needed to optimize wetland benefit.

Status and Trends of Wetlands in Minnesota: Statewide Vegetation Quality Baseline

Michael Bourdaghs (michael.bourdaghs@state.mn.us), John Genet (john.genet@state.mn.us), Mark Gernes (mark.gernes@state.mn.us), and Emily Peters (emily.peters@state.mn.us), Minnesota Pollution Control Agency

The Minnesota Pollution Control Agency has initiated a probabilistic survey to track the overall status and trends of wetland quality—building off of the ongoing MN Department of Natural Resources wetland quantity survey—to more comprehensively assess whether no-net-loss policy goals are being achieved. Vegetation community condition—as expressed by the Floristic Quality Assessment—was the primary indicator for the survey. A total of 150 randomly selected wetland sites were sampled in 2011-12 to generate unbiased vegetation condition estimates at statewide and major ecoregion (i.e., northern forest/hardwood forest/prairie) scales. Wetland vegetation condition statewide is high—with 67% having intact/natural vegetation communities. This was driven by the extensive wetland acreage in the northern forest region (75% of Minnesota's wetlands) where conditions are exceptional/good at 84%. Vegetation condition was dramatically lower in the hardwood forest and prairie regions—with 82% being moderately to severely-impacted. Non-native invasive plants were the predominant stressor.

Addressing the Nutrient Driver Paradigm for Dissolved Oxygen in Small, Low Gradient Streams

Jeffrey Strom (jstrom@wenck.com) and Joseph Bischoff (jbischoff@wenck.com), Wenck Associates, Inc.; Diane Sander (diane.sander@mn.nacdnet.net), Crow River Organization of Waters

The common understanding of dissolved oxygen (DO) in streams is that nutrients and resultant algal production drives DO dynamics. According to this paradigm, increased nutrients lead to increased algal growth and decay, resulting in large daily DO swings. This paradigm is further supported by the development of nutrient criteria for the State of Minnesota which include several eutrophication response variables such as DO swing. While this paradigm likely applies well to larger rivers, Wenck's experience in developing DO TMDLs for small, low gradient streams suggests that sediment oxygen demand (SOD), wetlands, and headwater DO are the primary drivers of low DO. Wenck hypothesizes that the residence time for nutrients in low-gradient streams is too low to cause excessive algae growth. While these conditions may not apply to all low gradient streams, they are common enough to suggest that the nutrient driver paradigm is not applicable in all systems. Wenck will present several case studies for low-gradient streams in the Crow River watershed where low DO concentrations were a result of SOD, flow-through wetlands, channel form, and headwater conditions rather than high nutrient concentrations.

Concurrent Session IV 10:00 a.m. – 11:30 a.m.

Track B: Fish/Trout 1

Common Carp Removal in a Shallow Urban Lake

Bill Bartodziej (bill@rwmwd.org), Ramsey-Washington Metro Watershed District; Justine Koch (kochx174@umn.edu) and Peter Sorenson (soren003@umn.edu), University of Minnesota, Department of Fisheries, Wildlife, and Conservation Biology; Eric Korte (eric@rwmwd.org), Ramsey-Washington Metro Watershed District

Casey Lake is a small (7 ha), shallow (1.3 m) water body that serves as the focal point of a popular park in North St. Paul. Casey has had a history of poor water quality. In 2010, a common carp (Cyprinus carpio) research study on the connecting Phalen Chain of Lakes identified Casey as a carp nursery. Carp biomass was estimated at 486 kg/ha. A winter drawdown in 2012-13 was successful in eliminating the carp population. The ensuing changes in water quality were dramatic. Chlorophyll-a dropped from 84 mg/m3 to 7 mg/m3. Without carp, seven native submersed plant species appeared and covered 97% of the lake bottom. Bluegill (Lepomis macrochirus) and bass (Micropterus salmoides) were stocked in the spring of 2013. Managing small lakes like Casey can result in immediate local neighborhood benefits as well as reducing sources of invasive species to connecting lake systems.

Diagnostic Applications of a Fish Community-Based Stressor Index

John Sandberg (john.sandberg@state.mn.us), Minnesota Pollution Control Agency

The Minnesota Pollution Control Agency uses community-based biological indicators and water chemistry parameters to assess whether rivers and streams are meeting aquatic life standards. Because biological communities reflect environmental conditions, they can serve as reliable, diagnostic indicators for water quality parameters that may be otherwise difficult and/or expensive to monitor. Using concurrently-collected fish community and water quality data, species-level Tolerance Indicator Values (TIVs) were developed for individual water quality parameters. Species-level TIVs were aggregated to derive community-level Stressor Index Values (SIVs). SIVs were used to predict the probability of meeting water quality standards for specific parameters. This approach has demonstrated utility for identifying both: a) locations of potential (but unmonitored) water quality impairments, and b) causal diagnosis of biological impairments. TIV/SIV models have been developed for dissolved oxygen and total suspended solids and are being used to evaluate these parameters as potential causes of biological impairments.

Minnesota Super-Sentinel Lakes Program: Using Predictive Modeling to Assess Habitat Shifts for Cold-Water Fish

Richard Kiesling (kiesling@usgs.gov) and Erik Smith (easmith@usgs.gov), U.S. Geological Survey

The U.S Geological Survey Minnesota Water Science Center, in partnership with the Minnesota Department of Natural Resources, developed mechanistic, bio-physical lake models that simulate trophic dynamics and track changes in oxy-thermal habitat gradients for three deep, cold-water lakes. In all three lakes, calibrated models captured the trajectories of water temperature and dissolved oxygen concentrations over time at multiple depths. Calibrated models were used to evaluate changes in cold-water fish habitat under changing productivity and meteorological stressor gradients. Model simulations indicate that lethal oxy-thermal habitat developed from complex interactions between lake stratification, primary production in the upper mixed layer of the lake, and water column oxygen demand below the photic zone. The dynamic, mechanistic models can be used to simultaneously evaluate the influence of these three factors on whole-lake metabolism and predict changes in oxy-thermal habitat along stressor gradients.

Concurrent Session IV 10:00 a.m. – 11:30 a.m.

Track C: Making a Difference through Education and Outreach

Skills for Local Water Resource Management: The Watershed Specialist Training Program

Ann M. Lewandowski (alewand@umn.edu) and Faye Sleeper (fsleeper@umn.edu), University of Minnesota Water Resources Center

The objective of the ongoing Minnesota Watershed Specialist Training program is to build the proficiency of local staff who implement water protection and restoration. Course content helps participants integrate policy, natural resource sciences, administration, communication, and engagement to solve resource problems; and build their capacity for continued learning. The two 14-week sessions presented in 2013-2014 were attended by 38 people – primarily staff from local governments. Feedback from participants is an integral part of the course. According to participants, the training will have the most impact on their civic engagement and project management activities. They anticipate being more intentional at the beginning of projects to assess situations, understand the community, and write actionable goals and work plans. The skills they most want to develop relate to modeling/assessment tools, civic engagement, and project management. These observations are consistent with a survey of participants in similar training programs in Indiana, Ohio, and Michigan. The online format was effective for the training goals, providing interaction and feedback from a variety of colleagues, work on real life examples, and resources for future use.

Concurrent Session IV 10:00 a.m. – 11:30 a.m.

Track C: Making a Difference through Education and Outreach *(continued)*

Master Water Stewards: Community Leadership for Clean Water

Peggy Knapp (pknapp@freshwater.org), Freshwater Society

- Objectives and results of the research, policy, or project.
- Engineering approaches or techniques of project implementation.
- Brief summary of methodologies used in the study or project.
- Results of the project (project completed or expected completion date).
- Abstracts without project results will not be considered.

Objectives: The Freshwater Society partnered with the Minnehaha Creek Watershed District in 2012 to launch the Master Water Stewards program. Funded by a Clean Water Fund Grant, the program trains, certifies and supports community leaders to install pollution prevention projects on residential and commercial properties that educate community members, reduce pollutants from urban runoff, and allow more water to soak into the ground. The goals of the program are to certify 20 Stewards annually, install a minumum of 12 stormwater reduction projects, and design and implement a minimum of 12 education and outreach projects in each of three years of the three-year pilot.

Beyond the technical goals, by mobilizing leadership at the neighborhood level the Master Water Stewards program will create a new model of community engagement and leadership, and develop a new community-based education, outreach and action resource team that natural resource agencies, watershed districts and municipalities can deploy to meet water quality, education and outreach goals.

Techniques of Implementation: The program was created to fill a crucial niche in stormwater education and outreach, and address specific recommendations in the 2013 Municipal Separate Storm Sewer System (MS4) permit. In the Education and Outreach Minimum Control Measures, MS4s are required to focus on actions residents can take to reduce pollutants:

- Change local business practices
- Encourage installation of residential BMPs
- Manage pet waste, yard waste, deicing chemicals
- Work with lake associations to improve lakes
- Other small scale storm water management measures

Cities and other MS4s have limited capacity to conduct one-on-one outreach to property owners. Master Water Stewards make use of social relationships and social capital in community-based organizations to reach out to neighbors in ways city governments never could. Stewards teach, influence and lead neighbors to adopt more water-friendly practices.

Results: The program certified 19 Stewards in 2013, the first year of a three-year pilot, and has 29 candidates pursuing certification in 2014. Stewards have installed 14 stormwater projects on private property, and conducted 12 education and outreach campaigns, reaching over 200 individuals. New partnership models for long-term volunteer work are being developed with cities, private businesses, congregations, and Park Boards.

The three-year pilot phase concludes in 2015. The Freshwater Society is laying the foundation to expand the program to cities, counties, and watershed districts statewide.

Concurrent Session IV 10:00 a.m. – 11:30 a.m.

Track C: Making a Difference through Education and Outreach *(continued)*

Making Research More Accessible: Updates to the Minnesota Water Research Digital Library

Christine Yaeger (christine.yaeger@state.mn.us), Minnesota Department of Agriculture; Erik Anderson (erik.anderson@mnwcd.org), Washington Conservation District; Adam Birr (abirr@mncorn.org), Minnesota Corn Growers Association; Ann Lewandowski (alewand@umn.edu), Water Resources Center

You can now search for water research articles relevant to your needs from a single website- the Minnesota Water Research Digital Library (www.mn.gov/water-research-library). This Clean Water Fund supported tool includes Minnesota-focused research publications on all water topics with over 1,200 articles and growing. For this presentation, we will do a live, audience driven demonstration of the search functionality and filtering options to showcase the current Library contents. We will also hear from a panel of current contributors and present some of the opportunities to add your expertise to grow the Library: providing feedback through the stakeholder liaison group, discovering and collecting new research as a topic curator, or entering research records as a data entry partner.

Concurrent Session IV 10:00 a.m.-11:30 a.m.

Track D: WRAPS

The Applicability of Using HSPF in WRAPS/TMDL Projects

Timothy Erickson (terickson@houstoneng.com) and Mark Duetschman (mduetschman@houstoneng.com), Houston Engineering, Inc.

Over a ten year period, the Minnesota Pollution Control Agency (MPCA) is developing Hydrologic Simulation Program Fortran (HSPF) models for the 81 major watersheds in Minnesota. These HSPF models are being developed to inform the Watershed Restoration and Protection Strategy (WRAPS) Plans and assist in the development of watershed-wide Total Maximum Daily Loads (TMDL) Projects also being completed for each of the 81 watersheds. This presentation will be a lessons learned discussion on the use of HSPF in WRAPS and TMDL projects in the Sand Hill River Watershed and how the models can be used to meet requirements within the Clean Water Accountability Act, passed by the Minnesota Legislature in 2013. The Sand Hill River HSPF model was used to develop load-duration curves, estimate loading capacities, inform lake models, prioritize sub-watersheds for Best Management Practice implementation, and help develop implementation strategies. The benefits and limitations of using the HSPF model in the WRAPS and TMDL projects will be highlighted.

Predicting Pollutant Reductions for Watershed Implementation Strategies with SAM, an HSPF User Interface

Emily Javens (emily.javens@respec.com) and Julie Blackburn (jason.love@respec.com), Respec Consulting & Services

A major challenge facing decision makers within watersheds is how to select the best combination of water quality management practices to implement among the many options available that result in the most cost-effective, achievable, and practical management strategy possible. A decision-support tool was developed to facilitate prioritization and placement of best management practices (BMPs) on a watershed scale to achieve goals identified in Total Maximum Daily Load Studies (TMDLs), Watershed Restoration and Protection Strategies (WRAPs), or One Watershed One Plans (1W1Ps). Various individual and/or a suite of BMPs can be set up in the Scenario Application Manager (SAM) program that informs development of a custom implementation plan that optimizes pollutant reductions with costs. The decision-support framework consists of an ArcGIS map interface for site selection, Hydrologic Simulation Program – Fortran (HSPF) model application to simulate the transport and fate of pollutants, and a BMP database to estimate pollutant removals and costs.

Evaluation of Resource Management and Climate Change Scenarios Using HSPF Model Applications, Pine River and Leech Lake River Wraps

Andrea Plevan (aplevan@gmail.com), Respec Consulting & Services

Development of the Watershed Restoration and Protection Strategies (WRAPS) for the Pine and Leech Lake River Watersheds is underway by MPCA, Crow Wing SWCD, Cass County, and other local partners. A watershed hydrologic and water-quality model was developed with Hydrological Simulation Program–FORTRAN (HSPF). This model application was used to evaluate phosphorus loads to surface waters under resource management scenarios, which were based on water quality threats that were identified at stakeholder meetings. Land changes including conversion of forests to agriculture, shoreline development, and full build-out of cities led to watershed-wide phosphorus increases of up to 80%. The retention of 1.1 inches of runoff from impervious surfaces was not enough to mitigate the projected phosphorus load increases. Changes in precipitation projected by climate change models led to a 20% increase in annual watershed phosphorus loads. The scenario results will inform the implementation strategies selected for the WRAPS.

Concurrent Session IV 10:00 a.m.-11:30 a.m.

Low Impact Development and Stormwater Management Workshop

A Miscellany of Thoughts, Considerations, and Lessons Learned about Planning, Design, Construction, and Maintenance of LID Stormwater Control Measures

Scott Struck, Senior Professional at Geosyntec ConsultantsPast-Chair of Urban Water Resources Research Council; ASCE-EWRI Governing Board

This presentation will share experiences on shifting approaches and community responses to implementation of LID in an environment of changing stormwater and other relevant regulations. Locations that will be covered include the Pacific Northwest, Southern California, Colorado, Northeast Atlantic States, and several national efforts to gain a perspective on the ever-evolving understanding and application of low impact development stormwater management systems at a multitude of scales and in variety of land use and climate settings. The presentation will put into perspective the forward thinking of LID research and project implementation in Minnesota (given by other session speakers) in relation to regional and national efforts.

Luncheon Presentation 12:15 p.m. – 1:00 p.m.

Farming and Clean Water: Still Such a Long Way to Go

Craig Cox, senior vice president for agriculture and Natural Resources, Environmental Working Group

Concurrent Session V 1:15 p.m. – 2:45 p.m.

Track A: Sulfate, Mercury, and Wild Rice

Sulfate Enrichment and Water-Level Fluctuations Increase Methylmercury Production in a Northern Minnesota Peatland

Jill Coleman Wasik (Jill.Colemanwasik@Uwrf.Edu), University of Wisconsin River Falls; Carl P.J. Mitchell (Carl.Mitchell@Utoronto.Ca), University of Toronto; Daniel Engstrom (Dre@Smm.Org), St. Croix Watershed Research Station; Edward B. Swain (Edward.Swain@ State.Mn.Us) and Bruce A. Monson (Bruce.Monson@ State.Mn.Us), Minnesota Pollution Control Agency; Steven J. Balogh (Steve.Balogh@Metc.State.Mn.Us), Metropolitan Council Environmental Services; Jeff D. Jeremiason (Jjeremia@Gustavus.Edu), Gustavus Adolphus College

Mercury contamination of fisheries is a wide-spread issue of concern across Minnesota. Microbially-mediated methylation of inorganic mercury in wetlands is an important source of bioaccumulative methylmercury (MeHg) to food webs in downstream aquatic systems. Because sulfate-reducing bacteria are important mercury methylating organisms the amount of sulfate entering wetland systems can directly affect in situ MeHg production. Experimentally raising atmospheric sulfate deposition by 4X ambient rates across a 2.5-ha peatland in the Marcell Experimental Forest of northern Minnesota caused 2-10X increases in porewater MeHg concentrations, 5-6X increases in solid-phase MeHg, and 2-4X increases in mosquito larvae mercury burdens relative to the control. While added sulfate was consumed quickly by microbial activity hydrologic variability caused recently sequestered sulfate to recycle and stimulate further mercury methylation. These results indicate that controlling sulfate inputs to wetlands can be an important management strategy for reducing mercury burdens in aquatic foodwebs connected to peatlands.

The Impact of Sulfate Releases on Methylmercury in the St Louis River Watershed

Jeff Jeremiason (jjeremia@gustavus.edu), Kris Reiser (treiser@gustavus.edu), and Rachel Weitz (rweitz@gustavus.edu), Gustavus Adolphus College; Michael Berndt (mike.berndt@state.mn.us), Megan Kelly (megan.j.kelly@state.mn.us), and Travis Bavin (travis.bavin@state.mn.us), Minnesota Department of Natural Resources

The St. Louis River watershed is the site of a large iron mining district where water containing between 50 and 1000 mg/l sulfate is pumped continuously into the headwater regions of a river that eventually feeds into Lake Superior. In this study water samples were collected from multiple sites on the St. Louis River and in multiple tributaries spanning a wide sulfate concentration range during the 2012 and 2013 spring and summer seasons, which covered a range of high and low flow conditions. Dragonfly larvae were also collected from each site in both 2012 andn 2013 and analyzed for MeHg.

Principal component analysis on samples from the St Louis River revealed that THg, MeHg, Fe, and DOC were essentually unrelated to magnesium and sulfate concentrations in 2012. While magnesium and sulfate were derived mostly from the mines, THg, MeHg, and Fe were principally transported along with DOC from non-mining portions of the watershed. MeHg concentrations indragonfly larvae were positively correlated to peak MeHg concentrations in the dissolved phase measured during June and July. MeHg in dragonfly larvae were not elevated at the highest sulfate sites. MeHg in the water was the best predictor of MeHg in dragonfly larvae leading to the conclusion that MeHg in water is a reasonable indicator of methylmercury contamination in biota in these systems.

Concurrent Session V 1:15 p.m. – 2:45 p.m.

Track A: Sulfate, Mercury, and Wild Rice *(continued)*

Methylmercury Production and Transport in Sulfate-Impacted Lakes and Wetlands

Nathan Johnson (nwjohnso@d.umn.edu), University of Minnesota Duluth; Logan Bailey (baile324@umn.edu), University of Minnesota; Daniel Engstrom (dre@smm.org) and Jill Coleman-Wasik (jcoleman@smm.org), St. Croix Watershed Research Station; Carl Mitchell (carl.mitchell@utoronto.ca), University of Toronto-Scarborough; Michael Berndt (mike.berndt@state.mn.us), Minnesota Department of Natural Resources

The production and transport of methylmercury (MeHg) was quantified in several lakes and wetlands historically impacted by sulfate in NE Minnesota. Sediment and water from water bodies having between 5 and 800 mg/L sulfate were analyzed for MeHg and other geochemical parameters. Consistent with previous research, results from aquatic sediments showed that sulfate is related to MeHg production at low concentrations, but may inhibit MeHg production at higher concentrations. In wetlands, most MeHg appeared to be bound to dissolved organic carbon and exported during an early-summer hydrologic event. Little MeHg was released from wetlands following inundation by high sulfate (>600 mg/L) mine water. Results from lakes suggested that MeHg produced in anoxic bottom waters and sediments was isolated from the surface waters until fall turnover. Collectively, results indicated that MeHg production is related to sulfate in some situations, and hydrologic transport is important in mobilizing MeHg to downstream waters.

Hydroponic and Mesocosm Studies on the Effects of Sulfate and Sulfide on Wild Rice Growth and Seed Production

John Pastor (jpastor@d.umn.edu), Brad Dewey (bdewey@d.umn.edu), and Nathan Johnson (nwjohnso@d.umn.edu), University of Minnesota Duluth; Phil Monson (phil.monson@state.mn.us), Ed Swain (edward.swain@state.mn.us), and Emily Peters (emily.peters@state.mn.us), Minnesota Pollution Control Agency

The effects of sulfate and sulfide on wild rice growth and seed production were studied in hydroponic experiments and, for three consecutive years, in stock tank mesocosms where wild rice populations were grown in wild rice sediment. In aerobic hydroponic experiments, sulfate concentrations up to 1600 mg/L had no effect on wild rice seed germination and growth. In anaerobic hydroponic experiments, sulfide significantly depressed seedling growth at concentrations between 300 and 700 µg/L. In mesocosm experiments, sulfide production within the wild rice rooting zone increased with additions of sulfate to overlying water at 10 (background), 50, 100, 150, and 300 mg/L concentrations. Seedling survival declined with increased sulfide, consistent with the hydroponic experiments. Iron sulfide precipitated on wild rice roots at all levels of amended sulfate, reducing viable seed production and seed mass. The reduced number and mass of viable seeds resulted in reduced seedling emergence the following year.

Concurrent Session V 1:15 p.m. – 2:45 p.m.

Track B: Fish/Trout 2

Overwinter Invertebrate Community Dynamics in Groundwater-Fed Streams of Southeastern Minnesota

Jane E. Mazack (louws002@umn.edu) and Leonard C. Ferrington, Jr. (ferri016@umn.edu), University of Minnesota; Bruce Vondracek (bvondrac@umn.edu) U.S. Geological Survey, Minnesota Cooperative Fish and Wildlife Research Unit

Groundwater-fed streams, which remain ice-free in winter, provide ideal habitat for winter-active insects. Previous studies of these insects have focused on their thermal tolerance limits; however, their relationships to groundwater input and the invertebrate community are not well-established. We documented invertebrate community composition and emergence in 36 groundwater-fed streams in southeastern Minnesota during the winte n rs of 2010-2013. Hess samples were used to evaluate winter invertebrate community composition and surface-floating pupal exuviae collections were used to study the emergence patterns of cold-adapted chironomidae (Insecta: Diptera). Average invertebrate abundance was positively related to groundwater input, with early-winter average abundances ranging from 855 to 7874 individuals per square meter of riffle habitat. Additionally, 30 genera of emerging chironomids were collected. Over 60% were only found in late-winter samples; mid-winter emergence was dominated by the species *Diamesa mendotae*. We conclude that groundwater inputs significantly influence winter invertebrate dynamics in southeastern Minnesota streams.

Evaluation of Trout Stream Standards: Preserving and Enhancing the Vermillion River

Bruce Wilson (bwilson@eorinc.com), Emmons & Olivier Resources, Inc.; Travis Thiel (travis.thiel@co.dakota.mn.us), Dakota County Department of Environmental Resources

A detailed review of trout stream standards including thermal management aspects was conducted to guide the Vermillion River Watershed JPO's review of standards in preparation for its second generation watershed plan. Standards from several states and Minnesota watershed districts were summarized for: (1) protecting groundwater resources in general and specifically those that recharge of the Vermillion River trout stream reaches; and (2) reducing sediment losses from lands and stream banks resulting from peak flows. Six rule categories were evaluated with a range of potential changes proposed to address challenges facing the watershed including intensive agriculture, development pressures and variable climate.

Recruitment Dynamics of the Invasive Common Carp at a Watershed Scale

Justine D. Koch (kochx174@umn.edu) and Peter Sorensen (soren003@umn.edu), University of Minnesota; Loren M. Miller (mille075@umn.edu), Minnesota Department of Natural Resources

Recent research suggests the common carp (*Cyprinus carpio*) is often invasive due to its propensity to exploit shallow, predator-free basins for reproduction. Such basins often support extremely high abundances of young carp, but the fate of these carp is unknown. To determine whether these putative nurseries serve as a source of carp to connected waters, we used mark-recapture and genetic assignment methods to investigate carp recruitment in the Phalen Chain of Lakes. Microsatellite analysis of carp tissue samples (n=954) revealed 2 genetically distinct strains of carp. The distribution and movements of genetically distinct carp across the watershed revealed patterns in dispersal and colonization consistent with the carp nursery hypothesis. Additionally, there was evidence of reproductive homing by adult common carp. Ongoing research on carp recruitment dynamics will aid in the development of population models and integrated pest management strategies to combat this highly invasive and destructive species.

Concurrent Session V 1:15 p.m. – 2:45 p.m.

Track C: Stormwater Management

Webber Natural Swimming Pool-First Public Natural Swimming Pool in North America

Robert G. Schunicht (rschunicht@landform.net) Landform Professional Services, LLC; Clifton Swenson (cswenson@minneapolisparks.org) Minneapolis Park and Recreation Board

The Webber Natural Swimming Pool fulfills a Minneapolis Park Commissioner's vision for a lake-type experience for his North Minneapolis constituents by returning Webber Park's aquatic facilities to their original, natural concept. Natural Swimming Pools (NSP) use an engineered wetland and other natural processes to clean pool water to pristine lake conditions as opposed to traditional chemical pools which kill everything but the swimmers. Acquiring approval for a NSP—a unique and healthy alternate to chemical pools—was a challenge as it violates current State Health Codes. We will explore the process followed to realize a community's vision for a 2014 NSP grand opening vision.

Learning objectives include:

- Understand the engineered wetland and other concepts of a Natural Swimming Pool.
- How to introduce a new concept into a neighborhood engagement process
- How to get legislative approval for a pilot project
- Understand the steps necessary to implement a concept that has never been done in North America.

Re-creating Trout Brook

Kathleen Anglo (kathleen.anglo@ci.stpaul.mn.us), City of Saint Paul; Bob Fossum (bob@capitolregionwd.org), Capitol Region Watershed District

The City of St. Paul is completing construction on the Trout Brook Nature Sanctuary which is being developed in a 41-acre brownfield. The proposed Nature Sanctuary includes over a ½ mile re-creation of Trout Brook, which was placed in a storm sewer below grade in the late 1800s. The site will also include three iron-sand filter enhanced ponds and three new wetlands to manage stormwater from adjacent urban areas to provide stormwater treatment. The stream will be fed from the Trout Brook Interceptor and the new pond/wetland system. The project is identified within the CRWD Watershed Management Plan, which prioritizes "Bringing Water Back to St. Paul". Upon completion, the Trout Brook Segment will represent the largest open channel stream segment in the City of St. Paul. The project will accomplish the goals of stormwater management, habitat creation, demonstration, and education to effectively "Bring Water Back to St. Paul."

Concurrent Session V 1:15 p.m. – 2:45 p.m.

Track C: Stormwater Management

Implementation of Floating Weir System for Surface Skimming of Temporary Stormwater Ponds

Dwayne Stenlund (dwayne.stenlund@state.mn.us), Minnesota Department of Transportation; Joel Toso (jtoso@wenck.com), Wenck Associates, Inc.

This study provides design information for temporary stormwater ponds with floating head skimmers. The purpose of the temporary ponds is to trap and remove suspended sediment and nutrient loads from stormwater runoff on active construction sites. The design information is directed at meeting the standards in the National Pollution Discharge Elimination System (NPDES) general permit which includes storing runoff from the 2-year, 24-hour rainfall event or providing the equivalent sediment control systems. The goal of the floating head skimmer is reduce re-suspension of the trapped sediments and provide clear evidence of meeting maintenance and cleanout requirements that maximize temporary sediment trap performance efficiency.

The study results include:

- Research of currently available floating head skimmers,
- Estimation of runoff hydrology and hydraulics from active constructions sites using HydroCAD,
- Estimation of water quality improvements using P8, and
- Design details for project implementation.

The study shows several available technologies for pond skimming. The pond and skimmer design manages a 2-year, 24-hour rainfall event while removing an average of 80 percent of total suspended solids (TSS) from runoff. Smaller systems do not operate equivalently without additional treatment such as adding flocculants. Product detail sheets, plan setup, maintenance requirements, and special provisions discussions are included.

Concurrent Session V 1:15 p.m. – 2:45 p.m.

Track D: Stormwater 2

A 10-Year Commitment to Water Quality: Adopting Stormwater Techniques into a Linear Roadway Project

Chantill A. Kahler-Royer (chantillka@bolton-menk.com) and Lanol L. Leichty (lanile@bolton-menk.com), Bolton & Menk, Inc.

A road project doesn't often last 10 years or more. CSAH 12 was a divide between Spring Lake and Upper Prior Lake with no treatment of roadway storm water prior to flowing into the adjacent lakes. Scott County selected Bolton & Menk, Inc. to design a 2.5 mile reconstruction project, in four phases, to treat all road runoff, benefitting the water quality of both lakes.

In phases 1 and 2, private development was adjacent to the roadway corridor. Regional ponds were constructed that served the rate and water quality needs for the development and roadway.

The challenge was to provide water quality and volume treatment in a narrow linear corridor, meeting agency requirements. A series of three wetlands with a trail and interpretive signage will be a community recreational amenity as well as a water quality system. New stormwater treatment methods, including an iron enhanced sand filter to remove phosphorus, were incorporated as new technology became available. The proposed system exceeds agency requirements for storm water rate control and water quality standards. The overall proposed rates of runoff are significantly less than the existing rates for the 1, 2, 10 and 100-year storm events.

The project was initiated summer 2003, with estimated completion in fall 2014.

Life Cycle Assessment (LCA) for Lower-Impact Infrastructure Design in Minnesota

Matt Metzger (mmetzger@barr.com) and Louise Segroves (lsegroves@barr.com), Barr Engineering Company

Many cities, watershed districts and industries are seeking to understand big-picture costs and consider multiple benefits when making decisions. This is driving increased awareness of life cycle impacts and tradeoffs for projects, products and services. Life Cycle Assessment (LCA) is one analytical tool that can be leveraged to implement internal sustainability programs, decision making or pursue project credentials under such frameworks as LEED®, ISI Envision® and MPCA Green and Sustainable Remediation guidelines. LCA is a "cradle-to-grave" assessment method that considers how energy and materials are utilized across the interdependent stages of a product's life from raw material extraction through end of life. Managing environmental performance can be enhanced through targeting contributing factors that add to greenhouse gas, pollutants, embodied energy and water footprints. This presentation will present an overview of LCA methodology and discuss several infrastructure case studies (including Maplewood Living Streets) where LCA demonstrated impact reductions.

Targeting Properties for Stormwater BMP Retrofits

Matt Kumka (mkumka@barr.com), Barr Engineering Company; Paige Ahlborg (paige.ahlborg@rwmwd.org), Ramsey-Washington Metro Watershed District

RWMWD received a FY2013 Community Partners Clean Water Legacy grant to partner with churches in high priority areas in a watershed stewardship initiative to improve water quality. The goals of the program include reducing stormwater runoff from parking lots and rooftops, reducing phosphorus levels and other pollution going into impaired lakes, and foster relationships with congregations to encourage them to work together to help protect and improve local lakes through educational activities. This talk will focus on the implementation process including initial contact with each church, project construction, and finally ongoing stewardship activities with congregations. As of fall 2013, two churches installed a total of eight rain gardens, and four more churches are prepared to retrofit their sites fall 2014. The church project success lead raised interest in assessing retrofit possibilities on other land use areas. The District received a FY2014 Accelerated Implementation Clean Water Legacy grant to focus on determining priority stormwater retrofit projects at schools and commercial properties. The process will highlight how priority sites were selected, how property owners were approached, and plans for future BMP installation.

Concurrent Session V 1:15 p.m. – 2:45 p.m.

Low Impact Development and Stormwater Management Workshop

Case Study #1: Riverside Avenue Project LID and stormwater BMP implementation for streets and highways

Kurt Leuthhold, City of Minneapolis; Greg Wilson, Barr Engineering Company

In 2011 and 2012 the City of Minneapolis reconstructed Riverside Avenue and at the same time constructed a series of four distinctly different stormwater BMPs within the ROW. The area adjacent to Riverside Avenue is fully developed and ranges from single family homes to high density residential, commercial, and retail development. A major hospital and a college campus are also adjacent to the ROW. The adjacent land use, extensive above and below ground utilities, and the narrow ROW that needed to accommodate heavy traffic, pedestrians, and bicycles, made the installation of BMPs challenging.

At one reconstructed intersection, a small pedestrian park was constructed with a small plaza and benches. Incorporated within the park was an infiltration basin and a plaza with permeable pavers and an underlying tree trench. The infiltration basin includes trees and a simple selection of perennials to make maintenance as easy as possible.

At a second location, a long linear turf grass swale runs the full length of a block. Boulevard trees are planted in the swale. Stormwater is diverted from the street to the swale by inlet structures with sumps. Stormwater infiltrates through the turf grass and into an underground rock storage trench. Check dams in the swale increase the volume of infiltrated storm.

The last BMP is virtually all underground. A rock infiltration trench runs the full length of a block and a sidewalk was constructed on top of it. Stormwater from the street is diverted to several sand filters that are also under the sidewalk. The sand filters provide significant pretreatment prior to the stormwater entering the infiltration trench. The sand filters are covered with utility grates set flush with the sidewalk. This makes inspection and access for maintenance very easy.

This presentation will feature the aspects of this project from cradle to grave any may include the application and results of models, impacts, and the MIDS calculator.

Current and unfolding LID and stormwater BMP research

John Gulliver (gulli003@umn.edu) and Andy Erickson (eric0706@umn.edu), St. Anthony Falls Laboratory, University of Minnesota

What's next in stormwater research? This presentation will feature a summary of current stormwater research being undertaken by various groups at the University of Minnesota and how they relate to low impact development.

Concurrent Session VI 3:00 p.m. – 4:30 p.m.

Track A: Sulfate, Mercury, and Wild Rice

Field Studies of Physical and Chemical Characteristics of Wild Rice Habitat in Minnesota

Edward Swain (edward.swain@state.mn.us), Minnesota Pollution Control Agency; Amy Myrbo (amyrbo@umn.edu), Department of Earth Sciences, University of Minnesota; Daniel Engstrom (dre@smm.org), St. Croix Watershed Research Station, Science Museum of Minnesota

A major goal of Minnesota's Wild Rice Sulfate Standard Study, begun in 2011, is to help determine whether a revision of the State's sulfate standard is warranted. Minnesota has a sulfate standard of 10 mg/L for "water used for production of wild rice." Although sulfate is not directly toxic to wild rice, sulfate is converted by bacteria to sulfide, which can be toxic. The statewide survey of wild rice habitat at 268 sites included analysis of many physical and chemical parameters, including sulfate in surface water and sulfide in sediment porewater. Results from the field survey suggest a) that sites with elevated sulfide are unlikely to host wild rice, b) the observed sulfide concentrations are consistent with hydroponic and mesocosm experiments, two other components of the study, and c) that sulfide concentrations are affected by the availability of both sulfate and iron. When iron is available it precipitates sulfide, reducing toxicity.

Control of Hypolimnetic Mercury Methylation by Liquid Calcium Nitrate Amendment: Redox Thresholds for Sulfide Mobilization of Iron, Manganese, Phosphate, and Methylmercury

David Austin (david.austin@ch2m.com), CH2M Hill

Oxidation-reduction (redox) biogeochemistry in surficial sediments either retains monomethylmercury (HgCH3+) or causes its efflux into the water column. Within a hypolimnion, mere loss of dissolved oxygen (DO) does not cause efflux of HgCH3+. Rather, there is a phased process after loss of DO that ultimately causes HgCH3+ and PO43- efflux from sediments. The process is non-linear in a classic, positive feedback driven by sulfate (SO42-) reduction and consequent sulfide (H2S/HS-) dissolution of Mn and Fe as seen in data from Lake Ann (Chanhassen, MN). Data suggest that efflux of HgCH3+ into the water column, that was created by SO42--reduction in sediments, is driven by ion exchange as insoluble Mn(III/IV) and Fe(III) reduce to soluble Mn(II) and Fe(II) and replace HgCH3+ loosely bound to organic matter. Efflux of NH4+ from sediments is a model for this process.

These processes have clearly identifiable thresholds and strong functional relationships with measured redox values. The numeric value of the thresholds on a redox (millivolt) meter will vary by probe calibration point, probe equilibration monitoring protocol, and by the geochemistry of the water sampled. Nevertheless, the existence of thresholds is predictable and reproducible in a given lake using a given redox monitoring protocol.

In Round Lake (Eden Prairie, MN) addition of liquid calcium nitrate (LCN) in 2010 suppressed HgCH3+ formation in the anoxic hypolimnion by suppressing SO42--reduction, thus keeping redox well above the HgCH3+ efflux threshold value of +60 mV (standard hydrogen reference electrode scale, 3 to 5 minute equilibration). NO3- exerted control on redox from an initial 17 mg/L to approximately 0.5 mg/L NO3- (ion). NO3- oxidized H2S/HS- in Round Lake, raising the hypolimnion SO42- concentration from 1.0 to 5.5 mg/L at the NO3- depletion point. Thereafter, SO42--reduction began as redox dropped below +60 mV. HgCH3+ concentrations rose from 0.3 to 1.1 ng/L as SO42- fell to 2.5 mg/L. In contrast, in Lake Ann, serving as a control, SO42- concentrations dropped to near zero values over the same time and exhibited no interruption in HgCH3+ production. These findings are consistent with the Lake Onondaga (Syracuse, NY) project (2011 to present) that has successfully suppressed HgCH3+ formation with LCN injection into the hypolimnion.

Concurrent Session VI 3:00 p.m. – 4:30 p.m.

Track B: Chlorides on the Move

Chlorides in Minnesota's Groundwater

Sharon Kroening (sharon.kroening@state.mn.us), Minnesota Pollution Control Agency

Chloride contamination of lakes, streams, and groundwater has occurred in Minnesota and other states in the northern part of the nation, most likely due to the use of roadway de-icing chemicals. This presentation will describe how chloride affects drinking water and aquatic life, as well as the current status of chloride contamination, sources, and trends.

Twin Cities Metropolitan Area Chloride Management Plan

Brooke Asleson (brooke.asleson@state.mn.us), Minnesota Pollution Control Agency

In Minnesota we are faced with the challenge of balancing winter safety and water quality. Chloride concentrations in Minnesota waters are increasing, with salt from de-icing materials being the primary source in the Twin Cities Metropolitan Area (TCMA). To address this dilemma the Minnesota Pollution Control Agency has been collaborating with many partners since 2010 to develop the TCMA Chloride Management Plan (CMP). The goal of this plan is to assist local partners in managing this challenge by evaluating current water quality conditions, identifying sources of chloride, setting realistic goals and laying the foundation for a collaborative strategy to meet goals. A unique approach has been taken through this project to address protection and the Total Maximum Daily Load for the existing 40 chloride impairments in the TCMA. Many resources, tools and creative ideas to aid in managing this dilemma have been generated through the development of the CMP.

Winter Maintenance Assessment Tool: An Innovative Planning Tool for Public Works to Manage Salt Use

Connie Fortin (connie@fortinconsulting.com), Fortin Consulting Inc.; Brooke Asleson (brooke.asleson@state.mn.us), Minnesota Pollution Control Agency

A new automated assessment tool has been designed as part of the Minnesota Pollution Control Agency's (MPCA) Twin Cities Metropolitan Area (TCMA) Chloride Management Plan to enable winter maintenance organizations to evaluate their current practices and customize their own approach for reducing salt use in an accurate, easy to use and educational format. The Winter Maintenance Assessment tool (WMAt) is focused on salt used for de-icing (chloride), and on the industry of winter maintenance. After using the WMAt to inventory their current winter maintenance practices, users will be able to review their practices according to chloride reduction efficacy. This allows winter maintenance organizations to chart their best path forward within the goal of reducing chloride pollution. Several organizations have tested the tool and generated assessments of their past, present and future chloride use. The WMAt is scheduled to be ready for use by all organizations in early 2015.

Concurrent Session VI 3:00 p.m. – 4:30 p.m.

Track C: Innovative Technology

Lessons Learned During Woodchip Bioreactor Design and Install, Including First Year Monitoring Results

Lisa Odens (lodens@houstoneng.com) and Nancy Stowe (nstowe@houstoneng.com), Houston Engineering, Inc.; Margaret Peeters (margaret@mfcrow.org) and Mike Behan (mike@mfcrow.org), Middle Fork Crow River Watershed District

The Middle Fork Crow River Watershed District (MFCRWD) exists for the protection and preservation of water quality within the watershed. With funding from BWSR, a bioreactor was designed in the fall of 2012 and installed in November of 2013. The design was primarily based on research by Iowa State University, the University of Illinois, and discussions with BWSR. Water quality data collected in 2012 demonstrated that the site was a good candidate for the installation of a bioreactor. The presentation will describe site selection, problems encountered during design and installation, as well as the approaches used to find solutions and their degree of success (lessons learned). The presentation will also provide an assessment of the bioreactor's performance based on the first year monitoring results following installation.

High Performance Green Infrastructure: Distributed Real-time Monitoring and Control

Charlene Harper (charper@geosyntec.com) and Marcus Quigley (mquigley@geosyntec.com), Geosyntec Consultants, Inc.

The application of real-time, dynamic control and feedback systems to the management of stormwater infrastructure is changing the means and methods by which we understand and control our urban environments and reduce impacts to natural systems. Advanced systems that incorporate weather station connections and controlled release valves to maximize on-site detention of stormwater runoff during wet weather conditions were installed and monitored at pilot sites for a WERF High Performance Green Infrastructure Research Project. We will share the results, which demonstrate significant improvements in stormwater management when compared to conventional, passively controlled systems. Recent local projects utilizing advanced systems in the Capitol Region Watershed District will also be discussed. The inclusion of dynamic control systems as integral components of holistic stormwater management is particularly well suited to meeting increasingly complex environmental goals such as storm duration, peak control, volume reduction, use and reuse, and water quality improvements.

Matrix Riprap (aka Partially Grouted Riprap) for Spill-Through Bridge Abutments

Rita Weaver (rodr0097@umn.edu), University of Minnesota; Nicole Bartelt (nicole.bartelt@state.mn.us), Minnesota Department of Transportation

Side slopes on spill through abutments in MN are typically protected by riprap cover, and both non-grouted and fully grouted riprap systems have been well studied and documented. The Minnesota Department of Transportation funded the Saint Anthony Falls Laboratory (SAFL) to evaluate the strength of matrix riprap (aka partially grouted riprap) as an alternative to non-grouted or fully grouted riprap. Work at SAFL ranged from small scale modeling in two different flumes to out-of-flume tests to evaluate application methods. Test also considered how the shape of the stone affects shear stress and the importance of following MnDOT's guidelines for grout application. Results of the testing showed that the matrix riprap strength greatly exceeded non-grouted riprap. Our presentation will cover both the testing procedures and the results of our study. MnDOT also recently completed an implementation research project to demonstrate an installation of matrix riprap on a spill-through abutment in Minnesota. A summary of that project will also be presented.

Concurrent Session VI 3:00 p.m. – 4:30 p.m.

Track D: Water Resource Evaluation and Innovation

South Washington Conservation Corridor; Re-establishing Historic Watershed Connections

John Loomis (jloomis@ci.woodbury.mn.us) and Matt Moore (mmoore@ci.woodbury.mn.us), South Washington Watershed District

Historically, the South Washington Watershed District's 15,000 acre Northern Watershed (NWS) drained through what remains of an inter-glacial river valley to the Mississippi River. Settlement and development cut off that connection for all but the largest rainfall events. As a result, the NWS is currently landlocked and neighborhoods surrounding the southern edge of the NWS face an increasing flood risk. After 20 years of planning, SWWD is in the process of re-establishing that connection. The South Washington Conservation Corridor project, which will be complete by 2020, incorporates over 200 acres of restored prairie, provides nearly 1500 Ac-Ft of storage for flood control and regional infiltration, completes regional greenway and trail connections, and will restore the valley connecting the NWS to the Mississippi River. We will discuss the need for the project, watershed and geologic characteristics that make the project possible, and the many benefits of this unique combined use system.

Laying the Foundation for Characterizing the Long-Term Environmental Impact of Converting Pine Plantations to Modern Irrigated Cropping Systems

Luke Stuewe (luke.stuewe@state.mn.us), Minnesota Department of Agriculture; Joshua Stamper (jstamper@umn.edu), University of Minnesota Extension

The Potlatch Corporation is currently planning on selling its entire 320,000 acres of forest land within Minnesota with the goal of selling up to a third of the holdings by 2017. It is currently unknown how many acres will be suitable for agricultural production but there has been some substantial transformations already taking place in Wadena, Otter Tail and Cass Counties in the last five years.

One 1,400 acre development in Cass County has captured considerable legislative and media attention in the past year. This site, previously managed for commercial timber production and recreational hunting leases, has been converted to irrigated cropping systems that will include potatoes, corn, edible beans, and soybeans. Due to the coarse- textured soils, shallow groundwater, and close proximity to a trout stream, this site will pose some significant challenges. This site also poses the very unique scientific opportunity of monitoring natural conditions and then observing the transformations over the next several decades. Many partners, including the local producers, will introduce some novel crop rotations and crop covering systems. One irrigation pivot will be instrumented to monitor nitrate leaching losses.

This presentation will discuss partnerships, roles, the monitoring installation, and long term goals of the project.

Toward Effective Indicators of Animal Feeding Operation Contamination of Surface Water

Ed Brands (ebrands@umn.edu), University of Minnesota Morris

Animal feeding operations (AFOs) have been associated with many nutrient and bacteria surface water impairments in the United States. However, the presence of elevated nutrient and bacteria levels in surface waters does not specifically implicate AFOs as sources. The aim of this research is to identify and evaluate substances that may serve as specific indicators of AFO contamination of surface waters. Based on a review of recently published literature on efforts to characterize AFO-related contaminants such as antibiotics, insecticides, and natural and synthetic growth hormones in surface water, candidate indicators were identified by evaluating substances based on the following criteria: 1) known to be frequently used in AFOs, 2) unique to AFOs, 3) expected (based on laboratory or field studies) to be found in surface waters, 4) regularly detected in ambient waters, and 5) relatively inexpensive and accurate analytical methods exist for quantifying or determining presence/absence in water.

Concurrent Session VI 3:00 p.m. – 4:30 p.m.

Track D: Water Resource Evaluation and Innovation *(continued)*

Case Study #2: Cross Plains Wisconsin – A 38 Acre Private Residential LID Development
LID and Stormwater BMP Implementation for Private Property Development

James Bachhuber (jbachhuber@brwncald.com) and Caroline Burger (cburger@brwncald.com), Brown & Caldwell; Roger Bannerman (roger.bannerman@wisconsin.gov), Wisconsin Department of Natural Resources, retired

Engineering Approaches and Methodologies: The study area (38 acre single family residential subdivision with LID design principals) was about 80% fully developed by 2002. The subdivision's LID practices included: 1) narrower streets from standard design (36' versus 40'); 2) a single sidewalk instead of two sidewalks, 3) required disconnection of all roof drains, 4) grass swale roadside drainage, 5) wet detention basin, and 6) an infiltration basin. The USGS established long term automatic stormwater monitoring stations at the outlet of the 38 acre project site. The station was operational for the USGS Water Years (October 1 – September 30) 1999 – 2005. Runoff data collection included continuous recorded rainfall, surface flow and volume, and water quality parameters (sediment, and phosphorus series). Only data meeting the USGS QAPP requirements were retained for analysis and reporting.

Brief summary of methodologies used in the study or project: This study will compare monitored and modeled rainfall runoff volumes from the project site. A total of 309 rain events were monitored between 1999 – 2005, however only 91 rain events actually resulted in any measureable discharge that left the project site. Each event has a start /stop date and time; duration, precipitation depth, and intensity for 15, 30 and 60 minute time periods. A WinSLAMM file will be created to represent the developed project site conditions including the installed LID practices. The model accounts for numerous 8465 2 characteristics including: source areas, soil hydrologic groups, and conveyance systems The monitored rainfall data will be used as input to WinSLAMM model runs in order to compare event runoff volumes to monitored values.

Results of the project: The project site is fully developed and the LID practices have been in place since about 2000. The monitoring effort is complete and all data has been QC'd, and reviewed to meet USGS publication standards. The final comparison of WinSLAMM modeling to the monitored events will take place before August, 2014. The project site's source areas have been delineated in GIS and must be ground verified before inputting into WinSLAMM. Once that step is completed a final analysis will be conducted and the modeled events will be statistically compared to the monitoring results. The results of this analysis will be to identify strengths and limitations of this stormwater modeling tool to represent monitored conditions.

Poster Session 4:45 p.m. – 5:45 p.m.

1. Bald Eagle Lake Watershed Stormwater Re-use/Phosphorus Reduction Project

Kyle Axtell (kaxtell@ricecreek.org), Rice Creek Watershed District; Pete Willenbring (pwillenbring@wsbeng.com), WSB & Associates, Inc.

The Bald Eagle Lake TMDL identifies a thirty-eight percent reduction (809 pounds) in watershed phosphorus loading to meet state standards. Seventy-five percent of the average total annual phosphorus load to Bald Eagle Lake originates from the project subwatershed – making it the highest priority area for phosphorous reduction.

This project collects stormwater runoff from a 915 acre watershed upstream of Bald Eagle Lake to irrigate 116 acres of the Oneka Ridge Golf Course. Estimates indicate between 50 and 200 acre-feet of runoff volume will be re-used annually for irrigation and up to 100 acre-feet of additional infiltration will occur as a result of this project. This will lessen the golf course's dependency on groundwater for irrigation by up to 50% and reduce the phosphorus load to Bald Eagle Lake by between 75 and 225 pounds annually. The system recently began operation in July 2014

2. Improving the Sediment Budgets of Minnesota River Tributaries with Statistical Analyses of Reach-Averaged Variables

Martin Bevis (bevisma@gmail.com) and Karen Gran (kgran@d.umn.edu), Department of Geological Sciences, Univeristy of Minnesota Duluth

The Greater Blue Earth River (GBER) basin contributes more total suspended solids, by volume and per area, to the Minnesota River than any other tributary in the watershed. Previous work to identify sediment sources in the basin has focused on the "knickzone:" reaches below knickpoints where past base-level fall in the Minnesota River valley drives high erosion rates on near-channel features like bluffs. We extended those sediment budgets upstream throughout the entire GBER basin, and explored the effect of geologic history, fluvial parameters and bluff characteristics on bluff erosion rates. Historic aerial photos and lidar-derived DEMs were used in ArcGIS to create sediment budgets. To account for the episodic nature of bluff erosion in extrapolations, we compared measured erosion rates with reach-averaged parameters including vegetation cover, bluff slope and channel slope. Our techniques improve erosion rate extrapolations basin-wide and confirm the importance of bluffs in the knickzone as sediment sources.

3. Understanding Land Use Land Cover Effects on Water Quality in Human Dominated Watersheds

Evelyn Boardman (board054@umn.edu) and Jacques Finlay (jfinlay@umn.edu), University of Minnesota

Simple Land Use and Land Cover (LULC) metrics often do not explain the wide variability in water quality often observed among watersheds with similar characteristics. We sought to quantify the specific LULC factors influencing varied nitrogen, phosphorus and chloride loading in urban watersheds associated with varied relative to their overall level of development. This project brings together watershed hydrology, chemistry, and spatial data produced by the Metropolitan Council, University of Minnesota, and other environmental monitoring organizations to examine the relationship between land use and water quality. As expected, chloride yield increased with urban land cover. However, total phosphorus, total nitrogen, and runoff were highly variable. Greater watershed lake cover corresponds to overall lower nutrient yields, but some watersheds with low lake cover also have low yields. More specific metrics of development and hydrologic flow paths are helping us understand the drivers of water quality degradation in human dominated watersheds.

Poster Session 4:45 p.m. – 5:45 p.m.

4. Conservation Drainage for Agriculture

Chuck Brandel (chuck.brandel@is-grp.com), ISG; Craig Austinson (craig.austinson@blueearthcountymn.com), Blue Earth County

Inefficiencies in Blue Earth County Ditch 57 affected agricultural economics and reduced water quality due to flushing sediment and nutrients downstream. Project goal: To increase drainage capacity and water quality throughout system.

Surge basins, buffer strips, two-staged ditch, and weir and culvert structures were installed to control flow rates and allow sediment and nutrients to settle before continuing downstream. Buffer strips provide nutrient uptake and trap sediments prior to entering the ditch. Weir structures divert and dissipate the flow resulting in less sediment and nutrients traveling downstream.

During the 2013 rain season, storm events greater than 0.5" were analyzed for water quality. 2013 peak flow rates at the control weir at the outlet of the system were reduced by 55%. Average reductions for surge basin: peak flow 77%, TSS 47%, TP 63%, and TN 60%. Average reductions for two-stage ditch: TSS 10%, TP 8%, TN 19%.

5. Quantifying PAH Bioavailability During Habitat Restoration with Navigational Dredged Materials

Amanda Brennan (brenn411@umn.edu) and Nathan Johnson (nwjohnso@d.umn.edu), University of Minnesota Duluth

An ongoing pilot project in a high priority restoration area in Duluth, MN is utilizing navigational dredged materials from the Duluth-Superior harbor for restoring shallow water habitat with the goal of removing BUIs. Dredged material placement, in effect, acts to cover areas that are affected by moderate or low-levels of legacy sediment contamination in the proximity of urban streams. Utilizing solid-phase microextraction (SPME), the bioavailability of PAHs was quantified in sediments before dredged material placement and in navigational areas prior to dredging. We observed that (1) porewater concentrations were similar in the pre-placement sites and dredged material, (2) highest porewater concentrations were at the outfalls of two urban creeks, and (3) PAH concentrations in surface water were higher during placement (inside silt curtain) than in control sites (outside silt curtain). Current research includes quantifying the magnitude of ongoing contamination from the urban creeks and the risk posed by these contaminants.

6. Lacustrine Responses to Decreasing Wet Mercury Deposition Rates: Results from a Case Study in Voyageurs National Park, Northern Minnesota

Mark Brigham (mbrigham@usgs.gov), U.S. Geological Survey; David Gay (dgay@illinois.edu), Illinois Water Survey and National Park Service; David Krabbenhoft (dpkrabbe@usgs.gov), U.S. Geological Survey; Mark Sandheinrich (msandheinrich@uwlax.edu), University of Wisconsin-LaCrosse; James Wiener (jwiener@uwlax.edu), University of Wisconsin-LaCrosse; Ryan Maki (ryan_maki@nps.gov), National Park Service

Annual wet deposition rates of three pollutants important in aquatic mercury cycle, mercury, sulfate, and hydrogenion, have decreased considerably from 1998 to 2012 in northern Minnesota (mean decreases from two monitoring sites of 32, 48, and 66 percent, respectively). Consistent with these decreases, epilimnetic aqueous methylmercury and total mercury in yellow perch decreased in two of four study lakes in Voyageurs National Park (mean decreases of 47 and 35 percent, respectively, between 2001 and 2012). Counter to decreases in the atmospheric pollutants, epilimnetic methylmercury and mercury in yellow perch increased in a third lake (mean increases of 85 and 80 percent, respectively). The fourth lake had two disturbances in its watershed during the study period; this lake lacked overall trends in epilimnetic methylmercury and mercury in yellow perch. The diverging responses among the study lakes exemplify the complexity of ecosystem responses to decreased loads of atmospheric pollutants.

Poster Session 4:45 p.m. – 5:45 p.m.

7. Watershed Education in the Red River Basin, A Multi-State Analysis

David Demuth, Jr. (david.demuth@vcsu.edu) and Gregory D. Carlson (gregory.carlson@vcsu.edu), Valley City State University; Karen L. Terry (kterry@umn.edu), University of Minnesota Extension

University of Minnesota Extension, North Dakota State University Extension, the International Water Institute, and the Great Plains STEM Education Center at Valley City State University conducted a study using the Delphi method to inventory watershed education (WE) activities in the Red River Basin so as to forecast an effective and efficient framework to advance understanding of water issues affecting a variety of stakeholders. The survey queried seven audience groups: Teachers, Research/Extension Professionals, Natural Resource Professionals, Local Government Leaders, K-12 Students, General Public, and Agriculture Produces. Current and past education programming, gaps in education programming, the role demonstration sites, drainage, land reclamation, technical training, are among the topical points. Key results and recommendations will be presented.

8. A Watershed Management Framework for Minnesota Lakes

Michael Duval (michael.duval@state.mn.us), Timothy Cross (tim.cross@state.mn.us), and Peter Jacobson (peter.jacobson@state.mn.us), Minnesota Department of Natural Resources

Minnesota has a wide variety of lakes from deep, oligotrophic lakes to shallow, eutrophic lakes. Different lake management strategies are required for these diverse lake types. Lakes with good water quality need protection, while lakes with poor water quality need restoration. MNDNR Fisheries developed a statewide framework for identifying water quality changes and appropriate management strategies for several thousand managed fish lakes. We developed a simple, but direct watershed disturbance variable (percent of urban, agriculture, and mining land uses in a catchment) using the NLCD 2001 land use GIS dataset. We calculated the amount of protected land (publicly owned or protected by conservation easement) for each watershed using 2008 Minnesota DNR GAP Ownership GIS data. Plotting values of land use disturbance and protection status on separate axes allows for categorization of lakes into a protection vs. restoration framework. The framework establishes meaningful land use targets for lake management efforts.

9. Applying a Targeted Watershed Approach to Land Use Planning in North-Central Minnesota

Michael Duval (michael.duval@state.mn.us), Minnesota Department of Natural Resources; Mitch Brinks (mitch.brinks@crowwing.us), Crow Wing County Land Services Department

For Crow Wing County (CWC) and other counties in north-central Minnesota with an abundance of quality, natural resources and relatively low land values, a well-designed protection approach to local water management planning is much more efficient and cost-effective than a restoration approach. In 2013, CWC adopted a Local Comprehensive Water Management Plan that included the first-of-its-kind water protection model that assessed all 125 minor watersheds in the county to determine which watersheds are already in good condition, which could use more protection, and which would likely need restoration. The model used GIS technology to analyze the amount of land in a "protected" state (public lands, easements, and wetlands on private lands) along with land disturbance, and lake water quality trends to assign risk classifications and to suggest specific implementation strategies for each sub-watershed. Three examples illustrate how this model has subsequently directed "tool" selection and produced measurable protection outcomes.

Poster Session 4:45 p.m. – 5:45 p.m.

10. Applying a Targeted Watershed Approach to Protecting Water Quality and Other Priority Conservation Features in North-Central Minnesota

Michael Duval (michael.duval@state.mn.us), Minnesota Department of Natural Resources; Lindsey Ketchel and Paula West, Leech Lake Area Watershed Foundation

Cass and Crow Wing counties are in the heart of Minnesota's premier lakes region with high-quality waters, exceptional fisheries, pristine forests, thousands of miles of recreational trails, and healthy ecosystems. The region is also the source of drinking water for the Twin Cities. Local economies depend on the legacy of high-quality natural resources that draw people to live, work, and play in these counties. Yet, the future of these natural resources is uncertain. Population growth up to 30% is projected for these counties. Land development pressure to accommodate this growth, both on shorelands and second-tier development within watersheds of priority lakes, threatens the future quality of water and forest resources. Additionally, with climate change looming on the horizon, protection of high-quality resilient landscapes is ever more important. We applied a science-based watershed protection framework to implement targeted fee title and conservation easements acquisitions in north-central Minnesota.

11. Applying a Watershed Framework to Clean Water Program Implementation

Michael Duval (michael.duval@state.mn.us), Minnesota Department of Natural Resources; Jeff Hrubes (jeff.hrubes@state.mn.us) and Dan Steward (dan.steward@state.mn.us), Minnesota Board of Water & Soil Resources

Minnesota's Clean Water Land and Legacy Amendment has increased expectations of the Legislature and Minnesota citizens that BWSR and other granting agencies ensure that projects be Prioritized, Targeted and Measureable. We show how modest BWSR cost-share program funds were sufficient incentive for a collection of north-central Minnesota counties to conduct watershed assessments on a subset of their water resources and to align local water planning into a watershed context for targeted water quality protection and restoration. For example, cost-share funding for large lake screening projects from 2008-2014 began to provide LGU's with a more scientific basis for prioritizing resource needs. In 2013 Crow Wing County became the first county to screen all their minor watersheds using a similar approach. Scaling the analysis to the minor watershed level has strengthened local water management and is helping water quality protection activities compete for funding following the principles of Prioritizing, Targeting and Measuring.

12. Applying Established Forest Stewardship Approaches to Private Forest Land on Targeted Lakesheds of North-Central Minnesota

Michael Duval (michael.duval@state.mn.us) and Gary Michael (gary.michael@state.mn.us), Minnesota Department of Natural Resources

Cisco, a preferred prey fish for walleye, northern pike, lake trout and muskie, inhabit cold, oxygenated water of deep lakes. Division of Forestry (DOF), using an established Forest Stewardship Program, worked with partners to enhance protection of targeted private forestlands within lakesheds of strategically selected cisco lakes in north-central Minnesota. DOF provided local funding to develop forest management plans for willing landowners in targeted areas. Plans included recommendations to maintain a healthy forested landscape while managing their forests for personal goals (wildlife habitat, timber production, recreation). With a completed plan, landowners qualified for a cost-share incentive program to implement plan recommendations. The management plan also qualified landowners for a tax incentive program that prevents development on the property for a minimum of eight years. Landowners were informed of these programs and encouraged to enroll. Initial funding has already moved several priority lakes measurably closer to their targeted lakeshed protection threshold.

Poster Session 4:45 p.m. – 5:45 p.m.

13. The Presence of Contaminants of Emerging Concern in Minnesota Lakes Receiving Groundwater Influenced by Septic System Effluent

Sarah Elliott (selliott@usgs.gov) and Richard Kiesling (kiesling@usgs.gov), U.S. Geological Survey; Heiko Schoenfuss (hschoenfuss@stcloudstate.edu), St. Cloud State University

In 2012 and 2013, the U.S. Geological Survey conducted a survey of 20 Minnesota lakes to determine the occurrence of contaminants of emerging concern (CECs) and effects on bluegill sunfish. Lakes were chosen based on groundwater inputs, density of shoreline development and presence of septic systems. Interstitial or surface water was collected and analyzed for selected wastewater compounds, pharmaceuticals and/or pesticides. More compounds were detected in surface water compared to interstitial. Endocrine active compounds that were detected include nonylphenol, atrazine, and a flame retardant. Male bluegills were collected from nesting areas and analyzed for a variety of biomarkers indicative of endocrine disruption. Although results were highly variable, some intersex was observed at one lake with known sources of CECs. Results from this study highlight the complexity of determining major contributing sources of CECs to Minnesota lakes. Further investigation is warranted to more accurately determine sources and pathways.

14. Prioritizing Wetland Restoration and Conservation in Minnesota Using an Interactive GIS Web Tool: Phase II

Jeremy Erickson (eric0792@d.umn.edu), Valerie Brady (vbrady@d.umn.edu), and Terry Brown (tbrown2@d.umn.edu), Natural Resources Research Institute, University of Minnesota Duluth; Mark Gernes (mark.gernes@state.mn.us), Minnesota Pollution Control Agency; Lucinda Johnson (ljohnson@d.umn.edu), Natural Resources Research Institute, University of Minnesota Duluth

An NRRI-MPCA partnership has created an interactive GIS web tool that prioritizes Minnesota wetland restoration or protection to achieve improved water quality and/or habitat and that will result in high functioning sustainable wetlands. The model was developed using a multitude of statewide GIS data layers to account for immediate characteristics that would influence wetland viability, anthropogenic stress, and potential future benefits at possible restoration or conservation sites. The model was incorporated into a user friendly web interface to allow both GIS experts and non-users to prioritize locations based on their restoration goals. In 2013, the model was improved by adding recently completed GIS data layers, accounting for surrounding landscape influences, and improving the web interface. The tool was completed June 2014, has been the subject of several training workshops, and is available for use.

15. The Southeast Lake Huron Rural Stormwater Management Model

Ryan Fleming (rfleming@eorinc.com), Michael Talbot (mtalbot@eorinc.com), and Cecilio Olivier (colivier@eorinc.com), Emmons & Olivier Resources, Inc.

The Rural Storm Water Management Model (RSWMM) project required accurate simulation of hydrology, hydraulics and water quality for 500 sq. km draining to Lake Huron. Assessment of sediment, phosphorus and nitrogen load reduction due to agricultural and urban BMP implementation was also required. Since no existing model could fully meet these goals, a customized model was developed. Using PCSWMM as a base model, additional water quality routines were added to improve functionality in rural areas. Improvements include: addition of MUSLE for sediment yield estimation; components of SPARROW for in stream P and N processes; ability to represent agricultural BMPs; and seasonality in parameterization. Overall, the RSWMM provides a unique tool to examine hydrology and water quality in agricultural and urban catchments of Lake Huron. Given this new modeling flexibility for rural applications, it can serve as a state-of-the-science watershed assessment and decision making tool throughout North America.

Poster Session 4:45 p.m. – 5:45 p.m.

16. A Long Term Biological Monitoring Network for Understanding Variability of Aquatic Communities in Minnesota's Rivers and Streams

John Genet (john.genet@state.mn.us) and John Sandberg (john.sandberg@state.mn.us), Minnesota Pollution Control Agency

The Minnesota Pollution Control Agency uses fish and macroinvertebrate community data in conjunction with water chemistry data to assess the ecological condition of rivers and streams throughout the state. Climate change can deteriorate the effectiveness of biological indicators to make such assessments by disrupting the stressor-response relationship between watershed disturbance and aquatic communities. For example, a cold water stream may experience degradation due to increased air temperature and frequency of intense precipitation events even if the watershed lacks significant anthropogenic disturbance. To account for such effects in our biological indicators we initiated a network of long term monitoring sites in least-disturbed, reference watersheds across the state. Monitoring began in 2013 with the establishment of approximately half of the 60 sites in the network that will be sampled biennially. Collaborations with other water resource entities are being sought to increase the amount of data collected at each site as well as the utility of this data set for others.

17. Smart Bioremediation Technology to Achieve High Sulfate Reduction in Mining Waters of NE Minnesota

David W. Hendrickson (dhendric@nrri.umn.edu), University of Minnesota Duluth- Natural Resources Research Institute; Jeffery J. Hanson (jeffhanson@clearwaterlayline.com), Clearwater Layline, LLC

Objectives: The objective of the project was to create an efficient, low cost, smart bioremediation technology which could achieve high sulfate reduction in mining waters of NE Minnesota in an environmentally sound manner. Pilot scale floating bioreactor modules installed in an iron mine pit lake in 2013 reduced sulfate concentrations from 1250 ppm sulfate to as low as 184 ppm sulfate.

Engineering approaches of project implementation: Modular engineering design concepts were utilized to produce a technology capable of being scaled up.

Methodologies used in the project: Solar panels were incorporated in the design to power embedded sensors and flow controls to provide remote monitoring capabilities.

Results of the project: Phase I of the project was completed with four bioreactor modules installed and operated successfully in the pit lake during the summer of 2013. Phase II is proceeding with units operating successfully over the winter and into 2014.

Project completion: 2015

18. Conditioning Digital Elevation Models (DEM) in the Red River Basin - Methods and Lessons Learned

Zach Herrmann (zherrmann@houstoneng.com), Houston Engineering, Inc.; Grit May (grit@iwinst.org), International Water Institute; Henry Van Offelen (henry.van.offelen@state.mn.us), Minnesota Department of Natural Resources

Light detecting and ranging (LiDAR) data is the most powerful data available to assess the hydrologic features of Minnesota's landscape. Conditioning digital elevation models (DEM) is essential for accurate hydrologic modeling and development of many Lidar-derived data products for decision making. A 5 meter conditioned DEM was created for the entire Red River basin (38,000 square miles) in 2011 and 2012 using standardized methods. This conditioned DEM has been used to developed hydrologic models and to derive a variety of terrain analysis data products. A 3 meter conditioned DEM has also been produced for several watersheds in the basin using more intensive methods including a complete culvert inventory. The techniques developed in these efforts and a comparison of terrain analysis data produced from these DEMs with different levels of conditioning provide guidance for future conditioning efforts.

Poster Session 4:45 p.m. – 5:45 p.m.

19. Climate Change Effects on Coldwater Fisheries and Water Quality of Northern Minnesota Lakes

Meghan Jacobson (mjacobson@eorinc.com), Emmons & Olivier Resources Inc.

This presentation will address the science and management implications of climate change on lake water quality and coldwater fisheries in northern Minnesota. Northern Minnesota is dominated by high water quality lakes that support sensitive coldwater fish species, including tullibee and trout. Climate change in northern Minnesota is predicted to result in a longer summer stratified period and extended dry periods punctuated by large rain events. Greater variability in wet-dry cycles increases the decomposition of soil organic matter, especially in wetland and peat soils, and ultimately the export of soluble reactive phosphorus to lakes and streams. The combination of longer summers and flashy precipitation will likely increase oxygen consumption in lake waters due to higher soluble reactive phosphorus loading, with corresponding negative impacts on coldwater fisheries and internal recycling of sediment phosphorus. One major lake management implication that will be address in this presentation is that the targeting of the soluble fraction of phosphorus will become an increasingly important component of successful lake best management practices in the future.

20. Subsurface Filtration Fish Barriers as an Innovative Carp Management Tool: Bone Lake Case Study

Meghan Jacobson (mjacobson@eorinc.com) and Greg Graske (ggraske@eorinc.com), Emmons & Olivier Resources Inc.

A growing number of Minnesota lakes have degraded water quality due to overabundant carp populations. High densities of carp can cause severe algae blooms in lakes resulting from their rooting feeding behaviors which stir up nutrient rich lake sediments. Despite these strong relationships between carp density and poor water quality, management of carp populations is difficult due to carp's high reproductive success and high tolerance to low dissolved oxygen and turbid water conditions. Complete elimination of an established carp population through chemical treatments or physical removal are not always successful. One known successful management strategy is to prevent carp movement between lakes using physical fish barriers. EOR developed an innovative rough fish barrier in response to interest from MN/DNR staff in a subsurface filtration lake inlet/ outlet that eliminates the passage of Aquatic Invasive Species (AIS) and reduces maintenance requirements. This low velocity fish barrier maintains water flow and lake levels while limiting upstream and downstream carp movement. Barrier were installed at the inlet and outlet of Bone Lake, located near Forest Lake, MN. These subsurface inlet/outlets will prevent the upstream migration of carp into Bone Lake, as well as preventing the carp's downstream migration after spawning. The Bone Lake fish barrier is the first installation of this innovative design and will limit lake and wetland disturbance by rough fish, resulting in both water quality and habitat improvements.

Poster Session 4:45 p.m. – 5:45 p.m.

21. Neighborhood Drainage Infrastructure Improvements Using Green Initiatives in the Village of Hinsdale, Illinois

Ajay Jain (tmathews@hrgreen.com) and Phil Stuepfert (tmathews@hrgreen.com), HR Green

Narrative: The Woodlands neighborhood in Hinsdale, Illinois has a long history of problems related to surface water management resulting in damages to homes and personal property. Affected also are roads which become impassable during and sometimes long after significant rainfall events. Additionally, the roadway conditions and ongoing maintenance within the Woodlands neighborhood has been poor and problematic due to the lack of adequate storm water management over the past thirty years. Traditional stormwater management was cost prohibitive. The objective of the project was to manage the stormwater by maximizing the use of "green initiatives". Use of "green initiatives" resulted in approximately 55% reduction in peak runoff for up to a 50-year storm and savings of approximately 40% over traditional stormwater management systems. The presentation will discuss the design approach, results, lessons learned, public coordination and costs associated with the project.

Objectives and results of the research, policy or project: Implement stormwater management in a residential neighborhood using "green initiatives."

Engineering approaches or techniques of project implementation: Approximately 28 rain gardens, 17 bio-swales and 29,121 CF of Underground Stormwater Detention were installed.

Brief summary of methodologies used in the study or project: Combination of green and gray infrastructure to provide a cost effective stormwater management.

Results of the project (project completed or expected completion date): Project was completed in June 2013. Modeling shows approximately 55% reduction in peak runoff for up to a 50-year storm and costs savings of approximately 40% over traditional stormwater management.

22. Empire Wastewater Treatment Plant Volume Reduction System: A Tour of On-Site Best Management Practices

Karen Jensen (karen.jensen@metc.state.mn.us), Jen Kostrzewski (jennifer.kostrzewski@metc.state.mn.us), Cammy Johnson (camille.johnson@metc.state.mn.us), Pat Oates, Metropolitan Council Environmental Services

In 2007, Metropolitan Council Environmental Services (MCES) completed an expansion of the Empire Wastewater Treatment Plant (WWTP), doubling its capacity from 12 million gallons per day (mgd) to 24 mgd. As a part of this project, MCES implemented stormwater volume reduction best management practices (BMPs). The system includes bioinfiltration basins, permeable pavers, a restored wetland, vegetated swales, a demonstration green roof, and prairie plantings. The BMPs helped to reduce the amount of stormwater runoff from the WWTP and its impact on the Vermillion River, a sensitive, trout stream.

Now, the BMPs are well-established, and MCES has initiated a monitoring program in 2014 to determine the system-wide performance. In the coming years, MCES will monitor groundwater levels, quantify infiltration capacities, identify the efficiency of the green roof, and perform plant and animal surveys in the green roof and the restored wetland. This research and monitoring will outline metrics in order to assess the true cost/benefit of the BMPs for the WWTP and the greater watershed.

Poster Session 4:45 p.m. – 5:45 p.m.

23. A Method to Quantify the Impact of Seepage on River Bank Erosion

Andrew C. Kessler (dkessler@houstoneng.com), Houston Engineering, Inc.; Satish C. Gupta (gupta002@umn.edu), University of Minnesota

Within Minnesota, the impact of seepage on bank erosion and sediment loading in rivers is often overlooked. The objective of this study was to assess if thermal imagery could be used to detect seepage locations on river banks and if these seepage locations relate to the extent of bank erosion calculated from multi-temporal lidar change detection. The above concept was tested in South-central Minnesota on one river bank with terrestrial lidar acquired in 2012 and 2013 and on a second bank with airborne lidar collected in 2009 and 2012. The results indicate that thermal imagery can be used to identify the location of seepage on river banks and, in combination with lidar measured elevation change, provides a means to quantify seepage induced bank erosion.

24. Economic Comparison of Borehole and River Sourced Water Supply System through Life Cycle Costing: Case Study of Ethiopia

Atekelt Abebe Ketema (atekelt.ketema@students.boku.ac.at) and Guenter Langergraber (guenter.langergraber@boku.ac.at), Institute of Sanitary Engineering and Water Pollution Control, University of Natural Resources and Life Sciences, Vienna

To utilize spatially and timely variable water resource potentials in optimal and sustainable way, it is important to examine economic life time cost and benefit of water related systems. Such approach can address all one time investment cost, annual operation and maintenance cost, reinvestment cost, residual value and revenue/benefit gained from the system.

This study analyzed life cycle cost (LCC) of borehole and river sourced water supply systems using CLARA-simplifying planning tool. The tool calculates cost for different water supply and sanitation systems based on bill of quantities of technologies. Both systems are planned to serve 50,000 populations for 25 years of service. Cost functions developed from implemented water supply projects in Ethiopia from 2011-2014 were used to validate the tool result. The result shows that LCC of intermittent-river sourced water supply system is cheaper than borehole sourced system. This can be explained by greater annual operation cost of the later system that is mainly caused by larger pumping cost. However initial investment cost of the former system costly than the later one.

25. Empire Wastewater Treatment Plant Green Roof: A Study to Determine Performance Efficiency of a Small Green Roof

Jennifer Kostrzewski (jennifer.kostrzewski@metc.state.mn.us), Karen Jensen (karen.jensen@metc.state.mn.us), Cammy Johnson (camille.johnson@metc.state.mn.us), Pat Oates, Judy Sventek (judy.sventek@metc.state.mn.us), Kent Johnson (kent.johnson@metc.state.mn.us), Scott Schellhaass (scott.schellhaass@metc.state.mn.us), and Stephen Labuz, Metropolitan Council Environmental Services

This study was designed to assess performance metrics to determine the effectiveness of the seven-year old, 1,800 ft2 green roof installed at the Empire Wastewater Treatment Plant (WWTP), near Empire, MN. Metropolitan Council Environmental Services (MCES) instrumented the roof with soil moisture/temperature sensors and installed a meteorological station on site in June 2014. Soil moisture, soil temperature, precipitation, air temperature, relative humidity, wind speed, wind direction, and solar radiation were recorded at 15 minute intervals. Additionally, the daily volume of water discharged from the green roof was monitored. Data were analyzed for individual storm events and cumulatively over the study period.

The hydrologic balance identified the volume of stormwater captured by the WWTP green roof, thereby reducing the surface runoff. This roof is one component of a multi-faceted stormwater volume reduction system that has been implemented at the WWTP. Further research and monitoring will continue to outline and determine system-wide performance metrics.

Poster Session 4:45 p.m. – 5:45 p.m.

26. South Washington Conservation Corridor: Stabilizing East Ravine

Michael Lawrence (mlawrence@houstoneng.com), Houston Engineering, Inc.

East Ravine is located in southern Washington County and is a major part of the Cottage Grove Ravine Regional Park. The ravine has the potential for substantial erosion under both existing and future conditions; future conditions include both development and construction of the Central Draw Storage Facility project. Stabilizing the ravine is a priority of the larger South Washington Conservation Corridor project. A shear stress analysis on the ravine was completed using multiple modeling techniques; from this analysis a range of stabilization options were identified. Working with a variety of stakeholders, stabilization options were selected. The outlet to Ravine Lake has presented an ongoing flooding issue for the park; a solution to this problem was also identified. This presentation will discuss the need for the project under existing and future conditions, the analyses that were completed, and how the stabilization component was incorporated into the greater Conservation Corridor project.

27. Comparison of In-Stream and Laboratory Procedures to Establish Relation Between Turbidity and Suspended-Sediment Concentration

Gustavo Merten (00091236@.ufrgs.br), Department of Civil Engineering, University of Minnesota; Paul Capel (capel@usgs.gov) and Christopher Ellison (cellison@usgs.gov), U.S. Geological Survey

Suspended- sediment concentrations (SSC) in surface waters are often estimated using in situ turbidity meters. Establishing a proper relation between the turbidity and SSC is critical for computing SSC time-series. Concurrent instantaneous in-stream measurements of turbidity and sampled SSC using depth-integrated isokinetic equipment from the specific waterway is ideal, but expensive and labor-intensive. In this study, two laboratory-based procedures using sediment collected manually from the stream or sediment collected with a passive, integrated in-stream sampler tube were tested and compared with in-stream procedure. Results showed that the relation between laboratory-based turbidity and SSC overestimated the computed SSC as compared with the in-stream procedure. Sediment grain size differences between SSC-samples used in laboratory and in-stream are associated with this result.

28. Wind Farms and Water

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The prairie-pothole region of Minnesota and the Dakotas is an area that is known for wind and water. Over the last 15 years the area has seen an increase in both rising water levels and new wind energy projects. These large infrastructure projects will be examined from a hydrologic perspective to shed light on the opportunities and potential risks of building in a complex hydrologic area. Using historic aerial photography, two-dimensional hydrologic modeling, and statistical analysis we show the changes that have occurred and predict future conditions of rising water levels. This presentation will highlight several renewable energy projects with complex hydrologic issues across the upper Midwest and the techniques used to mitigate risk and protect infrastructure.

Poster Session 4:45 p.m. – 5:45 p.m.

29. Modeling the Hydrological Effects of Wetland Restoration in the Le Sueur Watershed with SWAT

Nathaniel Mitchell (mitc0388@d.umn.edu) and Karen Gran (kgran@d.umn.edu), Department of Geological Sciences, University of Minnesota Duluth; Brent Dalzell (bdalzell@umn.edu), University of Minnesota; Karthik Kumarasamy (karthik.k@aggiemail.usu.edu), Utah State University

Stream flow increases and high turbidity levels observed within the Le Sueur Watershed (LSW) have motivated the discussion of potential management options including wetland restoration. This study uses the Soil and Water Assessment Tool (SWAT) to demonstrate the flow reductions offered by wetland restoration scenarios with different extents and placements in the LSW. Sites are selected based on their hydrologic isolation (i.e., depressions), compound topographic index values, agricultural productivity (from USDA NASS Crop Database Layers), and land use (from NLCD data). Results to date show that the derivation of certain SWAT parameters, such as the fraction of discharge input to wetlands (WET_FR) and the hydraulic conductivity of the wetlands' bottoms (WET_K), are critically important to modeling results and their interpretation. Findings with different scenarios may help determine the potential success of implementing distributed stream flow management systems capable of reducing stream flows, erosion of near-channel features, and resulting turbidity levels.

30. Robart's Creek Box Culvert Repair within a Detailed Flood Insurance Study Area

Scott Morgan (scott.morgan@state.mn.us), Nicole Bartelet (nicole.bartelt@state.mn.us), and Shanna Kent (shanna.kent@state.mn.us), Minnestoa Department of Transportation

Bridge 4014 is a double 10'x10' Reinforced Concrete Box Culvert in severe disrepair. Large cracks, severely crumbling floors and broken flumes required repair. This structure is located in a low point on Minnesota Highway 22 on Robart's Creek under 15 feet of fill in narrow right-of-way making replacement costly and difficult. As an alternative, MnDOT was planning a lining repair, however this stream is part of a Detailed Flood Insurance Study which pulled in additional coordination with Landowners and FEMA leading to a unique solution.

31. Southern Minnesota Stream Bank Repairs

Scott Morgan (scott.morgan@state.mn.us), and Shanna Kent (shanna.kent@state.mn.us), Minnestoa Department of Transportation

The Minnesota and Le Sueur Rivers in Southern Minnesota are very winding and constantly changing. Occasionally, this mobility threatens existing infrastructure and the safety of the traveling public. Minnesota Highway 22 and US Highway 169 are two routes running parallel to segments of these rivers that recently required repairs. Due to right-of-way, flood plain restrictions and steep slopes, space is limited. Coordinating with the Minnesota DNR, MnDOT installed bendway weirs and riprap to protect and maintain the roadway surfaces.

32. Developing the Framework for the One Watershed, One Plan

Rachel Olm (olmxx001@umn.edu), University of Minnesota; Melissa Lewis (melissa.k.lewis@state.mn.us), Minnesota Board of Water and Soil Resources; Joseph Magner (magne027@umn.edu), University of Minnesota; Doug Thomas (doug.thomas@state.mn.us), Minnesota Board of Water and Soil Resources

The vision of One Watershed, One Plan (1W1P) is to align local water planning on major watershed boundaries with state strategies towards prioritized, targeted and measurable implementation plans. In June of 2014, five planning boundaries, based on major watersheds, were chosen to pilot the 1W1P campaign in Minnesota. Through the pilot watershed program, a framework will be developed for moving current local water plans toward prioritizing, targeting, and measuring implementation actions. An in-depth inventory identified technical and social tools capable of prioritizing sub-watersheds for restoration and/or protection activities; along with targeting landscapes within the sub-watershed for installation of best management practices (BMPs). This effort will require the use of watershed models and biophysical tools along with a menu of BMPs tailored to gain landowner buy-in. Measurable results must demonstrate achievement of restoration and/or protection goals over time. Feedback and lessons learned from this framework will be used to guide full development and implementation of the 1W1P program.

Poster Session 4:45 p.m. – 5:45 p.m.

33. Statewide Riparian Buffer Inventory of Minnesota's Rivers and Streams

Andrew Petersen (andrew.petersen@state.mn.us) and John Sandberg (john.sandberg@state.mn.us) Minnesota Pollution Control Agency

No accurate and precise statewide inventory of riparian land-use/land-cover (R-LULC) currently exists for Minnesota's rivers and streams. Obstacles to such an evaluation include: a) the spatial resolution and accuracy of algorithmically-classified LULC data, and b) the time required to complete detailed, comprehensive R-LULC classification using "improved" methods such as visual interpretation of high-resolution aerial photography. The MPCA's Environmental Monitoring and Assessment Protocol (EMAP) design offers an opportunity to estimate statewide R-LULC statistics by carrying out detailed GIS air photo interpretation at a limited number of stream locations. The stratified random design of the EMAP program allows extrapolation of these results to the full population of Minnesota's rivers and streams. While this method cannot be used to evaluate R-LULC at specific locations outside of the EMAP design, it can provide accurate estimates of statewide and ecoregional riparian condition. Expected completion date November, 2014.

34. South Washington Conservation Corridor Project: Design and Construction of a Storm Sewer Pipeline with 40+ Foot Bury Depths

Matt Redington (matthew.redington@hdrinc.com), HDR Engineering, Inc.

Development slated in the Northern Watershed of the South Washington Watershed District would increase runoff volumes such that the capacity of a non-draining storage area adjacent to CSAH-22 would be overwhelmed, causing overtopping of the street and flooding of downstream residential areas. The landlocked and fragmented nature of the watershed is due to past development, and the South Washington Watershed District is interested in restoring a flow path through the watershed and allowing future development. A storm water basin (the Central Draw Storage Facility) and a 72" diameter storm sewer pipe are being constructed to allow discharge of water from this landlocked area adjacent to CSAH-22.

The first phase of construction, grading of the Central Draw Storage Facility and installation of 5,800 feet of pipe is complete. Portions of the installed diversion pipe alignment are buried up to 44 feet deep. Subsequent phases of construction will include open channel improvements to the downstream East Ravine and an additional 5,900 feet of pipe.

This poster will include discussion on the control structure for the pipeline. In addition to controlling inflows to the pipeline, it diverts water to the Central Draw Storage Facility from an adjacent residential neighborhood providing relief to an under-capacity storm sewer system, provides an emergency overflow for the Central Draw Storage Facility, and lowers flooding elevations within a neighborhood pond.

Poster Session 4:45 p.m. – 5:45 p.m.

35. Results of a Comprehensive Water Quality Assessment of Select Metropolitan Area Streams

Emily Resseger (emily.resseger@metc.state.mn.us), Jennifer Kostrzewski (jennifer.kostrzewski@metc.state.mn.us), Karen Jensen (karen.jensen@metc.state.mn.us), Joe Mulcahy (joe.mulcahy@metc.state.mn.us), and Hong Wang, Metropolitan Council Environmental Services

Metropolitan Council Environmental Services (MCES) and its partners monitor metropolitan area streams to assess compliance with water quality standards, extent of nonpoint source pollution, and progress towards improving water quality. MCES has continuously monitored flow and regularly sampled base flow and storm events at each site for a period of record ranging from 11 to 23 years.

During 2014, MCES completed its first comprehensive study of 22 streams in its program. Annual pollutant loads were calculated using the Flux32 load estimation program. Water quality was assessed through intra- and inter-annual comparison of concentration and loads, load duration curves, biological assessment, and trend analysis using the USGS QWTREND statistical method. Load and concentration statistics for all 22 streams were compared to understand relative water quality and contributions to the region's major rivers.

This poster provides supplemental information to last year's oral presentation and will provide a general overview of the study results, with a focus on trend analysis and stream-to-stream comparisons of assessment metrics.

36. The Legacy of Civil Engineering on Riverine Management and Restoration

Marty Rye, Superior National Forest

Civil engineering has a long and storied history. It generally involves the manipulation of the natural world to provide services to humans. Human service demands require reliability, efficiency, and optimization. These demands are expressed as elements of successfully engineered systems that include identifiable boundaries, static form, and a specific design life generally on a human temporal scale. Natural systems are characterized by multiple temporal and spatial scales that are often non-linear and dynamic. Traditional riverine engineering and management have approached problems from this human services perspective. Resultant riverine management and stream restorations used conventional design methods to account for uncertainty and were evaluated based on successfully engineered system criteria. A better understanding and communication of the characteristics of service demands, uncertainty, and ecological needs yield different management perspectives and designs that are more informed and sustainable.

37. Contribution-Based Fees for Water Management Units in the Sauk River Watershed District

Paul Senne, Respec Consulting & Services; Tara Ostendorf (tara@srwdmn.org), Sauk River Watershed District; Emily Javens and Seth Kenner, Respec Consulting & Services

Watershed districts have the authority to fund projects based on benefits or contributions to water quality issues through the development of water management units. The SRWD is developing the framework to fund best management practices within ten management units established in their watershed management plan. Runoff coefficients were developed with a Hydrological Simulation Program—FORTRAN (HSPF) model application that take into account land use, soils, and slope. The coefficients were applied to parcels to determine the relative contribution of each parcel to surface water runoff and phosphorus loads within a management unit. Costs for a volume or phosphorus reduction practice can be distributed based on this relative contribution. A coefficient generator and fee calculation tool allows the user to define project cost, assessment area, base fee, years of assessment, and interest rate. Changes to parcel boundaries or land cover can be incorporated into the approach without rerunning the HSPF model.

Poster Session 4:45 p.m. – 5:45 p.m.

38. Iowa Watersheds Project: Planning and Assessment of Distributed Flood Mitigation Strategies in Agricultural Watersheds

Nicholas Thomas (nicholas-thomas@uiowa.edu), Chad Drake (chad-drake@uiowa.edu), Larry Weber (larry-weber@uiowa.edu), and Keith Schilling (keith-schilling@uiowa.edu), IIHR Hydroscience & Engineering, The University of Iowa

Since European settlement the majority of the Midwest's native prairie, woodland, and wetlands have been replaced by annual corn and soybean crops. Landscape changes coupled with recent increasing trends in frequency and intensity of heavy rainfall have produced several severe floods. Following the devastating 2008 Iowa flooding, the Iowa Flood Center (IFC) received funding to investigate basin-scale flood mitigation strategies. Hydrologic simulations were developed for the Upper Cedar River basin contained in Iowa and Minnesota, to identify regions where mitigation practices will provide the most benefit. The IFC is coordinating with local agencies to locate sub catchments for construction of pilot projects, monitoring, and a more detailed modeling effort. Based upon monitored data, numerical models will be used to predict potential cumulative benefits of numerous similar projects distributed throughout the watershed. Project results will provide guidance for effectively implementing distributed flood mitigation strategies to provide cumulative benefit for downstream communities.

39. Comprehensive Natural Resource Planning in Red River Basin Watersheds – Simplifying a Complex Process to Essential Objectives and Strategies Needed to Improve Watershed Health

Henry Van Offelen (henry.van.offelen@state.mn.us), Minnesota Department of Natural Resources

Natural resource professionals have spent millions of dollars developing natural resource and water quality plans at the state, regional, watershed, and local scale. These plans often provide duplicative information to describe the landscape and identify problems priority concerns, goals, and objectives yet they rarely prescribe specific actions at the appropriate spatial scale needed to achieve "healthy watersheds". The objective of this project was to provide natural resource professionals in the Red River basin with the LiDAR-derived data, hydrologic and water quality models, and innovative geospatial tools to build on past plans and streamline the natural resource planning process in basin watersheds. This natural resource planning process has results in the rapid development of strategic goals and objectives and prescribes prioritized, targeted, and measurable actions for landowners and local government implementers to improve watershed conditions.

40. Red River Basin Watershed Planning Tool - Applying Light Detecting and Ranging (LiDAR) Data, Emerging GIS Technologies, and Established Practices to Strategically Plan Projects to Improve Watershed Health

Henry Van Offelen (henry.van.offelen@state.mn.us), Minnestoa Department of Natural Resources; Charles Fritz (charles@iwinst.org) and Grit May (grit@iwinst.org), International Water Institute

The International Water Institute in collaboration with the Red River Water Management Board and Minnesota Department of Natural Resource has developed an online decision support tool to help watershed-based teams to projects to improve watershed health within the Red River Basin in Minnesota. The tool guides the user through a planning process from problem identification through alternative evaluation. A suite of LiDAR-derived data is integrating into the system through mapping applications for problem identification, watershed delineation, estimating existing hydrologic conditions, and identifying, selecting, and evaluating effectiveness of water retention projects. The planning tool also provides an assessment of the permit complexity of a potential project and provides the user with the ability to print a series of reports that document the planning process to facilitate completion of needed permit applications. The planning tool readily provides essential data and tools to streamline project planning and permitting.

Poster Session 4:45 p.m. – 5:45 p.m.

41. Water Quality Trading Considering Flow Pollution and Stock Pollution

Zhiyu Wang (wang2689@umn.edu) and Jay Coggins (jcoggins@umn.edu), University of Minnesota

Water quality problems have long been a serious environmental concern. In 1972 the United States passed the Clean Water Act, which became the primary federal law on water pollution. Based on time length of influence, water pollution can be further divided into flow pollution (or stream pollution) and stock pollution. Flow pollution causes immediate damage to the environment, most often in a river system, but because of downstream current it does not extend to future if no more emission is added. Stock pollution may lead to damage in a short period, but most importantly its effect is sustained into the future. In general, river pollution is commonly regarded as flow pollution or stream pollution, and lake pollution or pollution in a water reservoir is considered as stock pollution. This is because stream flows take pollutants all the way to the downstream and limit their future concentration in the river. In contrast, pollutant concentration decreases at a much slower rate in a lake or a water reservoir due to stratification and relatively stable aggregate water in the reservoir. In order to control water pollution, water quality trading is a promising approach and has been implemented in several watersheds. Farrow, Schultz, Celikkol and Houtven (2005) and Hung and Shaw (2005) show that water quality trading is a socially cost-effective policy for solving water pollution problems.

However, most studies on water quality trading only focus on river pollution, neglecting damages caused by stock pollution at the same time. Even though some consider stock pollution like lake eutrophication in water quality trading, the dynamic process of stock pollution and its influence on trading scheme has not been taken into account (e.g. Obropta & Rusciano, 2007; Zhang, Zhang and Bi, 2012). On the other hand, for studies which notice dynamic characteristics of stock pollution, they mostly focus on the optimal management path, and do not seriously consider water quality trading as an implement instrument to solve the problem (e.g. Iwasa, Uchida and Yokomizo, 2007; Laukkanen & Huhtala, 2007; Hediger, 2009; Dechert and O'Donnell, 2006). In fact, little if any effort has been devoted to ascertaining whether water quality trading is still socially cost-effective when the goal is to solve both flow pollution and stock pollution simultaneously. In reality, people do care about pollution that affects both a river and a downstream lake. Therefore, especially when our scope is extended to a larger water system, it is neither appropriate nor persuasive to simply neglect the influence of pollutants from a river on a lake or a water reservoir, as is typical in the existing literature. In this sense, a question arises as to whether previous work on water quality trading is still socially cost-effective as a means of solving both river and lake pollution problem at the same time. In this paper we attempt to answer this question.

This paper focuses on a water quality trading scheme developed by Farrow et al. (2005) One of the important assumptions in the paper is that all environmental damages are measured in money and are linear functions of emissions or pollutant load. For example, damage due to river pollution is a linear function of pollutant emission, while damage due to lake pollution is linear in pollutant load. In the first part of our analysis, the social cost-effectiveness problem and the socially optimal problem are developed. The only difference between the two problems is whether the goals on water quality of the water system are determined exogenously or endogenously. Since the problems involve dynamic optimization, optimal control theory is applied here in order to figure out the steady state. Moreover, an augmented Hamiltonian approach is introduced in the first problem to solve the constraints on both control and state variables in each period. Spence and Starrett (1975) prove that the most rapid approach path to the steady state is optimal. Hence, once the steady state is known, the optimal path is obvious. In the second part of our analysis, the Damage Trading Ratio System (DTRS) defined by Farrow et al. (2005) is calculated to make water quality trading applicable. A static cost minimization problem is established correspondingly for each source of pollution. Lagrange equations are created in order to obtain the equilibrium of water quality trading. Comparing the results of the social cost-effectiveness problem and the equilibrium resulting from water quality trading, we are able to determine whether the trading scheme is cost-effective or not.

Poster Session 4:45 p.m. – 5:45 p.m.

41. Water Quality Trading Considering Flow Pollution and Stock Pollution *(continued)*

The primary goal of the paper is to figure out whether water quality trading is socially cost-effective in dealing with flow pollution and stock pollution at the same time. The answer is no and yes. When stock pollution is introduced, the problem faced by a social planner becomes dynamic and the social planner will discount time value. However, each point polluter faces the same cost minimization problem as before and therefore ignores the accumulation of pollution over time in the downstream reservoir. This divergence in problems they are dealing with makes DTRS in previous trading scheme fail to be cost-effective. In fact, compared with the socially cost-effective results, the only difference of water quality trading equilibrium results is the discount rate. Only under very rare scenarios is the Farrow et al. water quality trading scheme cost-effective. However, this does not mean that water quality trading can never achieve social cost-effectiveness as before. The Farrow et al. trading scheme is still able to solve both flow pollution and stock pollution simultaneously. We show how to modify the DTRS by adjusting the damage coefficient on to account for the accumulation of a stock of pollution in the downstream reservoir. A modified DTRS and established and the corresponding permit prices can be computed. Based on this modified DTRS and the resulting permit prices, our water quality trading scheme still achieves the socially cost-effective outcome in the face of both flow pollution and stock pollution. The method has promise in the study of large-scale problems such as the control of water quality in the Mississippi watershed and, at the same time, in the Gulf of Mexico.

42. Mapping Undocumented Levees Using LiDAR Data and GIS

Terry Zien (terry.r.zien@usace.army.mil), U.S. Army Corps of Engineers; Christiana Czuba (cczuba@usgs.gov) , U.S. Geological Survey

The goal of this study was to develop a GIS methodology to identify undocumented levees from remotely-sensed, high-resolution LiDAR (Light Detection and Ranging) topographic data.

Two methodologies were developed to identify potential levee features from high-resolution topography data. Two communities were identified as having levees not documented in the National Levee Database. The City of Delano, on the South Fork Crow River, and the City of Springfield, located on the Cottonwood River; both have levee features that were constructed or raised during past flood threats to reduce flood risk for residents and infrastructure.

The first methodology involves the use of hillshades and manual exploration of the data to highlight potential levee features. The second methodology involves the application of wavelets to the topography data, by which topographic signatures are highlighted. By presenting these methodologies, future efforts for identifying levees in other and larger areas can be streamlined.

The USACE manipulated topography data for the City of Delano to visually identify potential levee features and then performed a detailed site visit to assess the validity of those potential features. The USGS used wavelet analysis to identify potential levee features in Springfield. These two methodologies were then compared for the city of Delano.

The two methodologies explored in this study are complementary for future applications, creating a three-step procedure for identifying potential levee features from high-resolution topography data. The automated wavelet analysis can be used as a first cut over a large area to highlight features in the landscape that are potential levee structures. Then a smaller area can be more closely investigated in the wavelet analysis results and in looking at the bare-earth topography and resulting hillshade layers. This allows the development of a map of potential levee features. This dataset can then be used for further analysis in the field and talking to local officials to determine the characteristics, function, and condition of the potential levee features.