Percolating That Pesky Problem

(Stormwater)

Bruce Wilson

Minnesota Pollution Control Agency
Zenith City (Duluth) 1870s

Photograph courtesy of Duluth Public Library
International Falls circa 1905
Wilson Steamship Company
Duluth circa 1890’s

“Mid-West’s San Francisco”
DULUTH 2010

MINNESOTA’S SECOND LARGEST CITY  87.3 SQ MILES
THIRD LARGEST POPULATION (2000 CENSUS)
~ 820 FOOT DROP IN ELEVATION
TROUT STREAMS
Expectations: High quality product drives the North Shore travel & tourism
Storm Sewer System in 2007

• 609 miles of road
• 300 miles of storm sewer
• 138 miles of ditch
• 16 sedimentation boxes
• 9000+ catch basins
• 43 named creeks/streams
• 10 Trout streams
• Wood pipe used until 2006

From Carlson, Todd (2007)
Fastest Population Growth Projected for Suburbs And North Central Counties – 2000 to 2030

Source: MN State Demographic Center

Minnesota Average 27.4%

-10.8% to 0%
0% to 10.0%
10.0% to 27.4%
27.4% to 50.0%
50.0% to 102.9%
Stormwater Analogies to Wastewater Treatment

• **Pretreatment**: ordinances, housekeeping, better site design, street sweeping

• **Primary Treatment**: removal of gross pollutants, coarse materials, screening and sedimentation + reduce rates

• **Secondary Treatment**: Removal of fines, nutrients, metals + additional reduction rates

• **Tertiary Treatment**: Advanced biological uptake of nutrients, removal of heavy metals + enhanced sedimentation, filtration + reduce rates and volumes
Municipal Wastewater Advances over ~40 years

- **Served by sewer system with tertiary treatment**
- **Served by sewer system with secondary treatment**
- **Served by sewer system with some treatment**
- **Served by sewer system with no treatment**
- **Not served by sewer system**
# Extremes Become More Ordinary?

<table>
<thead>
<tr>
<th>Event Type</th>
<th>Location</th>
<th>Duration</th>
<th>Details</th>
</tr>
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<tbody>
<tr>
<td>Extreme Drought</td>
<td>Sturgeon River; Sept. 2006</td>
<td>~ 300 years</td>
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<td>Grand Marais, June, 2008</td>
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Knife River after the 1999 Rain Event

(Photo courtesy of St. Paul Pioneer Press)
Duluth street after two intense storm events (August and September of 1972)

Photograph courtesy of Nancy Nelson, Skyline Planning and Preservation Alliance
Miller Creek Flooding

Photograph courtesy of Tim Larson, Skyline Planning and Preservation Alliance
2010: North Shore Advances

- Cook County: limit development, structures, and clearing on steep slopes and in bluff areas in shoreline protection zones. Engineered solutions to ravine area.
- Energy dissipation
- Minimize and mitigate delivery across the sensitive areas
- Site care and attention to building practices.
- Reduce impervious cover associated w/ roads, driveways.
Minimal Impact Design Standards

(c) The agency shall develop performance standards, design standards, or other tools to enable and promote the implementation of low-impact development and other stormwater management techniques. For the purposes of this section, "low-impact development" means an approach to storm water management that mimics a site's natural hydrology as the landscape is developed. Using the low-impact development approach, storm water is managed on-site and the rate and volume of predevelopment storm water reaching receiving waters is unchanged. The calculation of predevelopment hydrology is based on native soil and vegetation.

Minnesota Statutes 2009, section 115.03, subdivision 5c
Certain funding cuts, little chance of success, what are we waiting for? ...

adapted from Gimli, Lord of the Rings, New Line Cinema.
MIDS (Minimal Impact Design Standards)

- mimics a site's natural hydrology
- storm water is managed on-site and
- rate and volume of predevelopment storm water reaching receiving waters is unchanged
- predevelopment hydrology is based on native soil and vegetation.
Minimal Impact Design Standards

Community Ordinance Goals

Performance Goal

Calculation Methodologies for a Menu of Techniques
Minimal Impact Design Standards

Community Assistance

To implement credits and goals at the local level

Zoning

Erosion and Sediment Control

Tree, Slope, Protection

Stormwater Management

Subdivision

Community Programs
MIDS

- Performance goals (rate + volume)
- Credits: Volume, Rate, TP (TSS ?)
- Calculators: Volume, TP, TSS performance and credits
  - Scoping spreadsheet
  - As built spreadsheet
- Ordinance goals – St. Croix Basin
- Standardization of goals
MI DS

- Native soils
  - HSG (A, B, C, D)
- Native vegetation
  - Prairie/grass
  - Forest (deciduous, conifer)
- Incorporate regional differences
  - Slopes, clay, bedrock
Performance Goals

New Development Post = Pre

- Event Based Analyses (rate, volume)
  - Continuous XPSWMM for native soils and vegetation, for various IC. 10 acre new site rate and volume, varying soils for three performance goals.
  - Rate & volume plus rate for 1-100 year storms for new site & conditions.

- Create translator for antidegradation and TMDLs based on annual loads
  - P8 model continuous modeling of same variables & 30 years of storms.
MIDS Work Group: 24 Organizations
From: Andy Reese’s Infiltration for Volume Control
MIDS

- http://www.pca.state.mn.us
  Minimal Impact Design Standards
- Bruce.Wilson@state.mn.us
  651-757-2828
From: Andy Reese’s Infiltration for Volume Control
Fixing the Poplar River Mega Slump

- Bridge
- Keys
- Boulder Revetment
- Bendway Weir
- Pre-dug Scour Holes
- Mini Swale
- Transplanted Veg
Deeply planted willows oriented perpendicular to flow will act as a “Living Dike”, slowing near-bank flow velocities.
Looking US @ Bendway Weir #4 and stone revetment
Started at a campsite in May of 2007, the Ham Lake Fire burned over 100 structures and thousands of acres of forest.

Photographs courtesy of the US Forest Service.
It all comes down to our water!

Photograph courtesy of former MPCA Regional Manager, John Pegors
**Climate variability: drought**

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<th>Stream &amp; Date</th>
<th>Drought Recurrence Interval (years)</th>
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## Extreme 24 hour rainfall events exceeding 4 inches

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Note – a 6” 24 hour rain storm is approximately a 1 in a 100 year event.
Tourism, Development, and Water Quality on the North Shore

• Population, Tourism, Development Steadily Increasing

• Tourism a major sector of our economy
  - $275 Million spent (2000) in the North Shore Area

• Tourism Closely Tied to the Quality of the Natural Environment (Lake Superior, Streams, Inland Lakes)

From Anderson, Evenson, Estabrooks and Wilson, 2003
Native Vegetation

Minnesota Early Settlement Vegetation

Legend
- Aspen-birch (eventually succeed to hardwoods)
- Aspen-birch (eventually succeed to conifers)
- Aspen-oak land
- Big woods - oaks, elm, basswood, ash, maple, etc.
- Brush prairie
- Conifer and bog swamps
- Jack pine barrens
- Lakes
- Prairie
- Mixed hardwood and pine
- Mixed white pine and Norway pine
- Oak opening and barrens
- Open muskeg
- Pine flats (hemlock, spruce, fir, cedar, & white pine
- River bottom forest
- Wet prairie
- White pine

Vegetative cover map was derived from notes and maps from General Land Office surveys conducted in Minnesota (1847-1907). Map was digitized by the Minnesota DNR.
Fastest Population Growth Projected for Suburbs and North Central Counties - 2000 to 2030

Source: MN State Demographic Center

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MIDS Adjusted Timeline

Performance Goals: regional, runoff/storm design, antideg, TMDLs

Credits & Calculators
Q, TP, TSS

Ordinance Goals St. Croix MIDS
Specs, Fact Sheets

Work Group Review, Updating
Phase II

Antidegradation Rule Schedule

Due Date Products

Development begins

Alternatives Analysis, Socio-Economic Analysis

Draft Rule & Sonar May 2011
A diagram comparing the evapotranspiration and runoff for different percentages of impervious surfaces.

- **40% evapotranspiration**
  - 10% runoff
  - Natural Ground Cover: 25% shallow infiltration, 25% deep infiltration

- **38% evapotranspiration**
  - 20% runoff
  - 10%-20% Impervious Surface: 21% shallow infiltration, 21% deep infiltration

- **35% evapotranspiration**
  - 30% runoff
  - 35%-50% Impervious Surface: 20% shallow infiltration, 15% deep infiltration

- **30% evapotranspiration**
  - 55% runoff
  - 75%-100% Impervious Surface: 10% shallow infiltration, 5% deep infiltration
Early Settlement Vegetation in Northern Great Lakes Ecoregions
Bruce Wilson
Minnesota Pollution Control Agency
Looking down on Rice’s Point in Duluth, 1880s
MIDS
Miller Creek Brook Trout

Photograph courtesy of Tom Estabrooks, MPCA
Increasingly variable climate

• Changes in Northland since 1990’s
• Fewer & larger storms
• More dry periods
• Wetlands & trout streams
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  – $275 Million spent (2000) in the North Shore Area (~$355 in 2010$ by CPI)

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From Anderson, Evenson, Estabrooks and Wilson, 2003
Mimimal Impact Design Standardization (MIDS)

- Performance Goals: pre and post development based on native soils and vegetation
- Credits: volume control + phosphorus (total suspended solids)
- Calculator: standard method for credits
- Ordinance Goals: St. Croix MIDS Project
Conventional Stormwater Treatment

• **Primary:** catch basins, wet ponds, dry ponds, screening, oil/water separators, hydrodynamic separators.

• **Secondary:** Extended storage, filtration devices, sand filters

• **Tertiary:** Catch basin inserts, media filters, chemical additives (iron)
Low Impact Development: Rate + Volume Control

• **Primary treatment** via sedimentation: grass swales, reuse, buffers, filter strips

• **Secondary treatment** via bioretention, permeable pavement, infiltration trenches & basins, infiltration in swales, filter strips

• **Tertiary:** Enhanced filters, swales, basins to remove dissolved pollutants (P).