

***DuluthStreams.org*: Community partnerships for
understanding urban stormwater and water quality
issues at the head of the Great Lakes**



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I. EXECUTIVE (PROJECT) SUMMARY

This final report summarizes the accomplishments of the *Duluth Streams* Partnership from its inception through an EPA Environmental Monitoring for Public Access and Community Tracking (EMPACT) Program grant in January 2002 through September 2004. Duluth, Minnesota lies at the westernmost end of Lake Superior, the source and headwaters of the entire Laurentian Great Lakes ecosystem. Although perhaps better known for its extremely cold winters, Duluth residents and visitors know it as a city of forested hills, wetlands and trout streams with 42 named creeks and streams moving through the City in 30 subwatersheds. Duluth's park system is one of the most extensive in the nation, and the City owns and maintains 11,000 acres, including 125 municipal parks. Streams form the fabric of the aesthetic appeal and character of Duluth (Duluth Vision 2000), but are also the core of the City's stormwater runoff system, with 250 miles of storm sewer, 93 miles of creek, 4,716 manholes, 2 lift stations, 13 sediment boxes, and over 138 miles of roadway ditches.

Urbanization and rural development have placed increased pressure on the region's coastal communities and on Duluth's urban streams, in particular, on the 12 (with 2 more pending) that are designated as Trout Streams and 14 that are classified as Protected Waters. In addition, since the early 1990s, over 50 new lodging establishments were constructed along Lake Superior's North Shore. One county located along the North Shore of Lake Superior (Cook) experienced a 24% population increase during that time. Stream communities of fish and amphibians and the invertebrates that sustain them are being adversely impacted by increased temperature, excessive turbidity and suspended solids, road salts, organic matter, and nutrients. Some of these streams have been placed on the Minnesota List of Impaired Waters, and several have been targeted for Total Maximum Daily Load (TMDL) development. Further, all of these streams discharge either directly into ultra-oligotrophic Lake Superior or indirectly via the St. Louis River Estuary-Duluth Superior Harbor. This is particularly important because Lake Superior has been designated as a zero-discharge demonstration project by the International Joint Commission for eliminating inputs of persistent toxic chemicals to the Great Lakes system. Second, the lake's nearshore zone, the source of much of its biological productivity, is extremely nutrient deficient and sensitive to increased inputs of nutrients, suspended solids, turbidity, and organic matter. Lastly, the Harbor itself is one of the 43 Great Lakes Areas of Concern (AOCs) because of serious impairments to its beneficial uses. There are also significant social and economic impacts associated with this region – the Minnesota DNR reports that angling in North Shore streams and Lake Superior produces \$63 million in direct sales and income and over 1,200 jobs. For North Shore streams alone, the numbers are over \$33 million direct sales and income, and over 435 jobs.

Stormwater issues have become increasingly important to resource and regulatory agencies and to the general public. In 1998 the City of Duluth established a stormwater utility to address the quality and quantity of surface water moving through the City and in 2003 was issued a Stormwater Permit under Phase II of the federal Clean Water Act's National Pollution Discharge Elimination System (NPDES). Beginning in January 2002, under funding through EPA EMPACT in combination with in-kind effort from various agencies, the Natural Resources Research Institute (NRRI) and Minnesota Sea Grant formed a partnership with the City of Duluth, the Minnesota Pollution Control Agency (MPCA), the Great Lakes Aquarium, and the

Western Lake Superior Sanitary District (WLSSD) to create *Duluth Streams*. Additional partners have since joined together to form a Regional Stormwater Protection Team (RSPT). The Partnership's chief goal is to enhance the general public's understanding of aquatic ecosystems and their connections to watershed land use to provide both economic and environmental sustainability.

The project's major objectives were to: 1) link real-time remote sensing of water quality in four urban streams and GIS technology to current and historical water quality and biological databases (all 42 Duluth streams) using advanced data visualization tools in World Wide Web and information kiosk formats; 2) incorporate visually engaging interpretive text, animations and videos into the *Duluth Streams* website to illustrate the nature and consequences of degraded stormwater and the real costs to society; and 3) engage the public in the stormwater issue via programmatic activities such as establishing high school directed neighborhood stewardship and/or monitoring of 3 streams, developing curricula for high school and college students for inclusion in our *Water on the Web* curriculum, hosting a *Duluth Streams* Congress as a community forum for presenting all project results, and adapting the Nonpoint Education for Municipal Officials (NEMO) program to the greater Duluth Metropolitan Area.

This final report summarizes the accomplishments of the *Duluth Streams* Partnership from its inception in January 2002 through September 2004. The website at <http://duluthstreams.org> is the focus of the project and offers water quality, biological, and GIS data in the context of a variety of school- and community-oriented educational material.

II. BACKGROUND AND OBJECTIVES

Duluth, Minnesota lies at the westernmost end of Lake Superior, the source and headwaters of the entire Laurentian Great Lakes ecosystem. Although perhaps better known for its extremely cold winters, Duluth residents and visitors know it as a city of forested hills, wetlands and trout streams. With 42 named creeks and streams moving through the City in 30 subwatersheds, Duluth has one of the highest densities of stream corridors of any of the >150 eligible EMPACT metropolitan areas. Duluth's park system is one of the most extensive in the nation, and the City owns and maintains 11,000 acres, including 125 municipal parks. Streams form the fabric of the aesthetic appeal and character of Duluth (Duluth Vision 2000), but are also the core of the City's stormwater runoff system, with 250 miles of storm sewer, 93 miles of creek, 4,716 manholes, 2 lift stations, 13 sediment boxes, and over 138 miles of roadway ditches.

Urbanization and rural development have placed increased pressure on the region's coastal communities and on Duluth's urban streams, in particular on the 12 (with 2 more pending) that are designated as Trout Streams and 14 that are classified as Protected Waters (MPCA 1999). In the early 1990s, over 50 new lodging establishments were constructed along Lake Superior's North Shore, and from 1990 to 1996 one Lake Superior county (Cook) experienced a 24% population increase (Anderson et al. 2003; MPCA 2000a,b). Stream communities of fish and amphibians and the invertebrates that sustain them are being adversely impacted by increased temperature, excessive turbidity and suspended solids, road salts, organic matter, and nutrients. Some have been placed on the Minnesota List of Impaired Waters (MPCA 2004), and several have been targeted for TMDL development (www.pca.state.mn.us/water/tmdl/index.html#tmdl).

Further, all of these streams discharge either directly into ultra-oligotrophic Lake Superior or indirectly via the St. Louis River-Duluth Superior Harbor. This is particularly important because Lake Superior has been designated as a zero-discharge demonstration project by the International Joint Commission for eliminating inputs of persistent toxic chemicals to the Great Lakes system (IJC 1999; MPCA 2000a,b). Second, the lake's nearshore zone is the source of much of its biological productivity and is extremely nutrient deficient and sensitive to increased inputs of nutrients, suspended solids, turbidity, and organic matter. And lastly, the Harbor itself is one of the 43 Great Lakes Areas of Concern (AOCs) because of serious impairments to its beneficial uses (MPCA 1992; IJC 1999). There are also significant social and economic impacts associated with this region – the MN DNR reports that angling in North Shore streams and Lake Superior produces \$63 million in direct sales and income and over 1,200 jobs. For North Shore streams alone, the numbers are over \$33 million direct sales and income, and over 435 jobs (MPCA 2000a).

The federal Clean Water Act (CWA) of 1972 addressed both point (permitted discharges primarily from municipal wastewater treatment plants and industrial effluents) and nonpoint sources (primarily runoff and groundwater impacted by diffuse urban, agricultural and forestry land uses). Efforts over the first 20 years of the CWA focused primarily on identifying point sources and implementing Best Available Technologies to control their impacts. In the past decade, water quality regulatory efforts have increasingly focused on nonpoint sources both by encouraging the use of Best Management Practices (BMPs) and, perhaps more importantly, by identifying polluted water bodies and establishing schedules for cleaning up these waters. Central to this effort is implementation of the TMDL program for limiting allowable amounts of pollutants for all sources, both point and nonpoint, to ensure that impaired waters achieve water quality standards protective of their designated beneficial uses (EPA 1999c, Jarrell 1999). The process is watershed-based and requires states to establish TMDLs that specify pollutant load allocations for point and nonpoint sources, including natural background, a margin of safety (MOS), and consideration of seasonal variations.

Stormwater has been cited as a significant source of nonpoint pollution to numerous bodies of water (e.g., Deely and Fergusson 1994; Crawford et al. 1995; Graves et al. 1998; Meybeck 1998). The first major assessment of stormwater contamination was conducted in the 1980s by the EPA Nationwide Urban Runoff Program (NURP: EPA 1983), which looked at pollutants in stormwater from large urban areas across the United States. Other researchers have focused on specific sources, such as parking lots, rooftops, lawns, and high and low-density roadways (Daub et al. 1994; Sansalone and Buchberger 1997; Steuer et al. 1997; Andral et al. 1999), specific events, such as snowmelt (Daub et al. 1994; Sansalone and Buchberger 1996; Novotny et al. 1998) or specific land use types (Matraw et al. 1978; Miller et al. 1979). Numerous studies have also addressed the effects of stormwater pollution on water quality in receiving bodies such as streams, lakes, or wetlands (Ellis and Marsalek 1996; Borchardt and Sperling 1997; EPA 1997; Graves et al. 1998; EPA 1999b). The results of these studies suggest that urban areas have numerous deleterious effects on the quality of stormwater, including increased levels of sediment, organic matter, nitrogen, phosphorus, heavy metals, pesticides, chloride, and persistent polycyclic aromatic hydrocarbons. Effects on water volume and flow rate are strongly related to the amount of impervious area in the watershed, with higher percentages of impervious surfaces

associated with greater flashiness, higher peak flows, lower base flows, and more total runoff. In addition, the amount of drainage ponds and impervious areas in a watershed control water temperature, which if increased can adversely affect stream organisms, including fish.

To address pollution concerns from stormwater runoff, EPA enacted new regulations in October of 1999 to implement Section 319 of the 1972 Clean Water Act. Known as the EPA Phase II Stormwater rule, these regulations require communities with populations under 100,000 to implement a municipal stormwater management program. The program must address water quality and quantity issues. Cities with populations under 100,000, such as Duluth, were required to apply for an NPDES Phase II Stormwater Permit by March 2003. The permit required several measures related to the original EPA-EMPACT initiatives, including illicit discharge detection, public involvement and participation, and public education and outreach.

In 1998 the City of Duluth established a Stormwater Utility to address the quality and quantity of surface water moving through the City. One of the first acts of the Utility was to conduct a needs assessment of the City's surface water system (CDM 2000a,b). Based on this assessment, the process of developing a Surface Water Management Plan began in October 2000. Two streams were selected for pilot watershed studies to determine future needs for more extensive stream studies. Although the Utility planned to eventually have adequate information on all the creeks in the City, it lacked funding to do so. In addition the Utility began to increase public involvement by helping residents to learn about and identify with their local sub-watershed.

Beginning in January 2002, under funding through EPA-EMPACT in combination with in-kind effort from various agencies, the Natural Resources Research Institute (NRRI) and Minnesota Sea Grant formed a partnership with the City of Duluth, the Minnesota Pollution Control Agency (MPCA), the Great Lakes Aquarium, and the Western Lake Superior Sanitary District (WLSSD). WLSSD operates the region's primary wastewater treatment plant but also coordinates closely with the City's Stormwater Utility and is involved in most issues related to environmental quality in the Duluth-Superior region. The regional MPCA office in Duluth coordinates monitoring data programs for the region. Additional partners have since joined with *Duluth Streams* to form a Regional Stormwater Protection Team (RSPT; <http://duluthstreams.org/stormwater/rspt.html>) which is described in detail in Section V.3.

The *Duluth Streams* Partnership's chief goal is to enhance the general public's understanding of aquatic ecosystems and their connections to watershed land use in order to provide both economic and environmental sustainability. This is being accomplished by linking state-of-the-art real-time remote sensing of three urban streams and the St. Louis River Harbor to current and historical databases in a website. The website is designed to deliver stream water quality data, GIS-based maps, and interpretive information to citizens of Duluth and the surrounding region. A further goal is to develop computerized information kiosks in several venues in Duluth and the surrounding region.

Duluth Streams actually evolved from a series of EPA-EMPACT and NSF-ATE (Advanced Technology Education) funded projects developed by a team of U. of Minnesota-Duluth research, education and outreach professionals since 1997. *WaterontheWeb.org* (WOW), *LakeAccess.org* and *DuluthStreams.org* form a set of interlinked web-based water science

education sites built upon a central core of intensive, remotely sensed, time-relevant data. The ambitious technology included in WOW and the multi-disciplinary high school/college basic and water resource management curriculum, necessitated strong interdisciplinary collaboration first within the university community (aquatic and landscape ecology, formal science education, extension and outreach, and advanced engineering, computer science, and telecommunications skills) and later with resource agencies for help in maintaining the robotic sensors. It is hoped that this broad base of data, visualization tools and interpretive text and curricula will enable *Duluth Streams* to remain a dynamic website with a central core of intensive water quality and GIS data.

The project is well-timed because of the newness of the regulations and concerns regarding how to address maintenance of infrastructure and streams on private property; how to clean and maintain natural waterways without causing damage to trout breeding areas; what to do with nuisance ponding, and how to control erosion during development and maintain holding ponds after development is complete. Controlling these sources requires working not just with large dischargers, but with individual homeowners and requires monetary resources, which must be generated by increased revenues from the public, such as through taxes. There has already been resistance in Duluth to an increased charge for the Stormwater Utility. The only way to overcome lack of understanding and resistance is through education. If people better understood the risks and impacts of stormwater inflows to their treasured natural waterways, they would be more inclined to take a proactive, positive role in solving the problem rather than seeing it as another government “taking.”

Duluth’s urban streams are treasured natural resources that make Duluth a unique city in the U.S. The quality of these streams directly relates to the cumulative actions of thousands of individual homeowners and hundreds of small businesses. Consequently, environmental impacts to these streams can best be reduced or eliminated with no or minimal adverse impacts on the economic health of the community by an improved understanding of how stream water quality and organisms respond to stormwater and what controls the nature of stormwater flows.

The major objectives of *Duluth Streams* are to:

- 1) link real-time remote sensing of water quality in four urban streams and GIS technology to current and historical water quality and biological databases (all 42 Duluth streams) using advanced data visualization tools in World Wide Web and information kiosk formats;
- 2) incorporate visually engaging interpretive text, animations and videos into the *Duluth Streams* website to illustrate the nature and consequences of degraded stormwater and the real costs to society; and
- 3) engage the public in the stormwater issue via programmatic activities such as establishing high school directed neighborhood stewardship/monitoring of 3 streams, developing curricula for high school and college students for inclusion in our *Water on the Web* curriculum, hosting a *Duluth Streams* Congress as a community forum for presenting all project results, and by adapting the Nonpoint Education for Municipal Officials (NEMO) program to the greater Duluth Metropolitan Area.

This final report summarizes the accomplishments of the *Duluth Streams* Partnership from its

inception upon EPA funding in January 2002 through September 2004. The website at <http://duluthstreams.org> is the focus of the project and offers water quality, biological and GIS data, and a variety of formal and community educational material (major sections shown in the attached image). Therefore, the various sections below rely heavily on reference to the relevant website sections.

III. METHODS

1. Background and QA/QC

This project evolved from two NSF-ATE and two EPA-EMPACT funded projects that allowed the creation of www.waterontheweb.org and www.lakeaccess.org for college/high school and community education. Real-time and time-relevant data acquisition, visualization, and dissemination are central to these lake and stream monitoring-based educational programs, including *Duluth Streams*. The primary QA/QC objective for all of these studies is to assure accurate and representative measurements of the biological, physical and chemical parameters that are monitored. The historical and current manual monitoring data, plus the intensive data collected by the stream monitoring units (SMUs) are intended for both public education and for inclusion in the City of Duluth (City), Western Lake Superior Sanitary District (WLSSD), Minnesota Pollution Control Agency (MPCA/STORET), and Minnesota Department of Natural Resources (MDNR) databases.

It is essential that these measurements comply with ANSI/ASQC E4, "Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs (EPA 1998)." Water quality data, from sampling to analysis to database entry followed previously established and documented QA/QC plans developed by NRRI, certified by the MN Dept of Health and the MPCA (Ameel et al. 1998), and used for previous EMPACT projects performed by our group. EPA used our *Lake Access* EMPACT project as the national model for technology transfer to other aquatic EMPACT projects (Peterson et al. (2000) and it includes detailed QA/QC information. Details may be found at:

- *Duluth Streams* at <http://duluthstreams.org/streams/aboutdata.html>
- *Lake Access* at <http://lakeaccess.org/QAQC.html>
- *Water on the Web* at <http://waterontheweb.org/under/instrumentation/qaqc.html>

2. Site selection

Manual water and flow sampling began during the spring runoff in April 2002 at three primary urban, designated trout streams – Chester, Tischer and Kingsbury Creeks. The streams were chosen on the basis of usage, geographic coverage of the city, and varieties of land-use in the watershed. Automated stream monitoring units (SMUs) with dataloggers, modems, and flow, temperature, EC25 (specific or temperature-compensated electrical conductivity) and turbidity sensors were deployed during summer 2002 at each stream. A rain event-triggered sampler was installed at Kingsbury Creek at a site within the Duluth Zoo (for security, telecommunications, and educational reasons). Additional water samples were collected manually at the Chester and Tischer Creek sites and analyzed for nutrients – nitrogen (N) and phosphorus (P) series, biochemical oxygen demand (BOD₅), total suspended solids (TSS), chloride (Cl) and fecal coliform bacteria to estimate seasonal water quality variations and loading. A fourth water

quality sonde was installed in the St. Louis River outflow to Lake Superior at the Duluth Inlet (Aerial Lift Bridge channel) where a flow gauge had been previously installed and is operated by the USGS. Data from both devices were logged and transmitted to the *Duluth Streams* server via a modem as per the other streams.

3. Field and water chemistry: Manual field measurements and laboratory procedures were performed by experienced staff at either the NRRI Central Analytical Laboratory, WLSSD's lab, or the MN Department of Health (MDH – they analyzed samples for MPCA) which have all been certified by MDH. These criteria follow EPA's protocols for data QA for the Safe Drinking Water Act and Clean Water Act (related to NPDES permitting and various Clean Lakes diagnostic, feasibility and restoration programs) and require performance audits using externally certified standards (e.g., APG). Analytical methods generally follow APHA (2003) or EPA (1989a,b) except where improvements have been made by NRRI (Ameel et al. 1998; revised annually).

4. Stream sampling – routine parameters and frequencies: "Routine" monitoring included measurements of temperature, DO, EC25, turbidity, micronutrients (nitrate+nitrite-N, ammonium-N, total N, total P), alkalinity, Cl, color, TSS, total volatile solids (TVS), total dissolved solids (TDS), and less frequently, BOD₅ and fecal coliform bacteria. Automated sensors, measuring temperature, EC25, turbidity, depth (for flow estimation) on the SMUs, are



checked ~weekly for cleaning and/or re-calibration by comparison to a YSI 85 or 556 multi-probe water quality analyzer and as per manufacturer's recommendations. Manual measurements include daily calibrations. The SMU control modules (CR10X and sensors) are programmed to collect temperature, EC25, turbidity, and stream elevation data at 5-15 minute intervals, which is relevant to the time-scale of storms. Flow-weighted water chemistry samples are collected at Kingsbury Creek in Duluth by an ISCO 6700 autosampler slaved to the CR10X stream elevation probe.

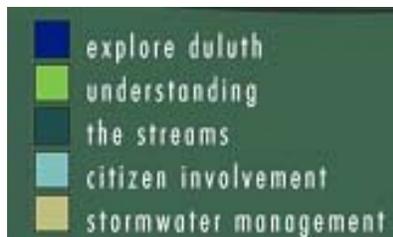
Ancillary water quality analyses were collected as per Anderson et al. (2003) in order to generate "defensible" estimates of annual nutrient and sediment loads – typically at least 20 discrete water samples per year collected during base-flow, spring snowmelt runoff and during summer rainstorm events. Field samplers followed protocols from the final QA/QC report (QAPP) and for MPCA as per Anderson et al. (2003). More detailed descriptions of all aspects of data collection, transmission, visualization, reduction, reporting and interpretation are found in the DATA section of the *Duluth Streams* website (http://duluthstreams.org/streams/QA_QC.html).

5. Sensor data transfer and visualization: Interactive data visualization applets are used to create interactive visual representations of the data. Through *Water on the Web* and our current and previous EMPACT projects, we developed a suite of JAVA applications and spreadsheet templates to process and summarize the data at different temporal and spatial scales (Host et al. 2000; Munson et al. 2003; Axler and Lonsdale 2003). A major product of our previous work was the development of the stream and lake Data Visualization Tools (DVT). These tools can be used to explore lake data as it varies with depth, or stream parameters over time with an animated ECG-type display of variables over time (see Figure 1 below). The applications are coded in the

Java programming language to allow the programs to run over the Internet on a wide variety of platforms, including Windows, Unix/Linux, and Macintosh. The stream data visualization tool allows comparison of multiple stream systems as they respond to similar storm events over different time scales. A recent new interactive animation has been developed to demonstrate the effect of different intensity precipitation events (0.5, 1 and 2 inches/day) and levels of impervious surface in the Miller Creek watershed on stream flow and sediment and phosphorus loading. The model was developed and calibrated previously and the animation was developed as a prototype teaching tool. The next phase of DVT expansion will be the ability to show how stream hydrographs respond to varying degrees of impervious surface within a watershed; this is a key issue facing coastal communities as they develop and evaluate build-out scenarios.

6. GIS data : The website features Internet Map Server, a technology designed to allow users to access and manipulate on-line GIS data, including the ability to query across data layers (e.g., calculate the area of forested wetlands within a 100 m riparian buffer of 2nd and higher order streams) and to create tabular and mapped summaries of the results. Spatial data analyses performed for this project in cooperation with other projects in the region included hydrography, transportation, landuse/landcover, geology and soils, ownership and administrative boundaries (see Figure 2 below).

IV. THE WEBSITE: www.duluthstreams.org



The website www.duluthstreams.org is the focus of the project and offers water quality, biological and GIS data, and a variety of school and community educational material (major sections shown in the image to the left). Each major section will be briefly described.

1. HOME PAGE

The home page offers the following introduction:

Welcome. In this website you will find easy access to most everything you might ever want to know about Duluth's 42 streams. You can learn about their history, geology, water quality, biology, recreation, human impacts, and management in this great city at the head of the greatest of the Great Lakes - Lake Superior.

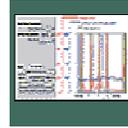
In addition to the major sections shown in the image above and described in detail in the following sections, the home page offers users immediate access to the following important sections:

(1) Highlights for New Users – These are seasonal pieces that explain the



most important features of the streams' ecology with practical information about what citizens can be doing at this time of year to help maintain or improve stream condition.

(2) View Real-Time Data – This is a direct link to the data visualization tool for viewing animations of water quality in 3 urban streams, the St. Louis River as it enters Lake Superior at the Aerial Lift Bridge, and the flow of Western Lake Superior Sanitary District's wastewater discharge into the St. Louis River Estuary. This also accesses water chemistry data collected for the three intensively monitored urban streams, and eventually for other intensive or long-term monitoring stream data.



(3) Local Beach Information – A direct link to the Lake Superior Beach Monitoring Program that the Minnesota Pollution Control Agency and various partners (including *Duluth Streams*) began in 2003. In 2004, *Duluth Streams* staff developed and continue to host a website specifically for this program (www.minnesotabeaches.org) to make it easier for the general public to access data and information about local beach closings.



The bottom of the Home Page provides additional links that appear on every page in the website. These include: HOME, ABOUT US, CONTACT US, DATA VIEWER, SEARCH, GLOSSARY, SITE MAP, DATA INDEX and WHAT'S NEW. The DATA VIEWER links to the same place as View Real-Time Data on the home page.



The DATA INDEX link opens the main index for water quality and other information about all of Duluth's streams. It provides a map that allows the user to link to a particular stream section via mouse-rollover and a comprehensive table that summarizes all information available for each stream, with appropriate links to that information.

mouse over stream number to see stream name and available information									
Data and information available for the <i>Duluth Streams</i>:									
Stream	Map location	Real time data	Trout stream	Storm data	Land use data	Photos	Historic Photos	GIS map utility	Reports

WHAT'S NEW is an important section because it provides a chronology of features as they are added (with a site updated notation on the home page), as well as notices about meetings and workshops relating to regional water resources and watersheds, links to relevant websites, and other water-related information of use to the general public, students, teachers, businesses, agency staff and decision-makers. In addition to the animated DATA VIEWER section it is the section that alerts users to the website's dynamic nature..

The GLOSSARY is largely compiled from glossaries available from the following websites: *Glossary of the Great Lakes* (Minnesota Sea Grant), *Natural Resources Defense Council*, and

MN DNR - Hydrologic Terms. The remaining links, ABOUT US, CONTACT US, SEARCH and SITE MAP are typical of other websites and require no further discussion.

2. EXPLORE DULUTH

This section provides the user with an overview of the natural and human environment in the region. It is a combination of “processed” information and links to major websites. The human environment section includes basic facts about the City, census information and historical



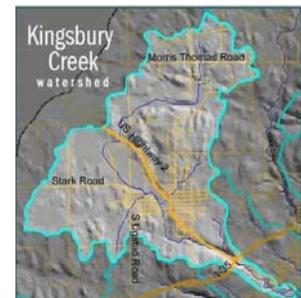
PHOTO BY PETER WOLTER, NATURAL RESOURCES RESEARCH INSTITUTE, UNIVERSITY OF MINNESOTA DULUTH

information including a number of unique websites that are relatively unknown to the general public containing a wealth of historical images and other information. The Natural Environment section contains information about the climate and geology of the region, organisms (both aquatic and terrestrial), photos and facts about the Lake Superior Basin and Lake Superior itself. We also are using this section to provide useful “tidbits” about natural

phenomena that are common, aesthetically interesting, but not well understood by the general public. This includes the foam that is produced naturally in copious amounts in some streams and the ice formations in Lake Superior and its tributaries. We anticipate this section growing to include more detailed information on climate trends and potential impacts of long-term climate change.

A final subsection is devoted to surrounding communities, with a common link as recent Stormwater Phase 2 NPDES stormwater permittees. These communities form the core of the Regional Stormwater Protection Team (RSPT) along with City of Duluth, NRRI, and Sea Grant staff. RSPT formed as a direct result of the *Duluth Streams* project. At present, these sections are simple links to their community websites, but they will be greatly expanded in the next year, using Minnesota’s Lake Superior Coastal Program funding. The RSPT has adopted the *Duluth Streams* website as their central tool for educating the public, agency staff, decision makers, private businesses and contractors about the consequences of degrading surface water quality and ways to reduce and mitigate such effects.

The individual Stream Data sections offer information about real time data (4 streams), water chemistry (5 streams in Excel or HTML format from current *Duluth Streams* and MPCA monitoring programs), the data viewer animation (DVT) for the intensively monitored streams, storm graphs (again, from the intensively monitored streams) and slope. There is also a summary of watershed data (area, stream density, road density, landuse, land cover, impervious surface), available fish survey data, photographs, summaries of illicit discharge inspection sites if appropriate, and a GIS map utility. The GIS utility features the ARC Internet Map Server (ArcIMS), a program for displaying and querying maps over the Internet. The maps are interactive – a user can zoom in and out of maps, with different amounts of detail being presented at different spatial scales. IMS allows different kinds of map layers (roads, land



use, water bodies) to be turned on or off, so customized maps may be created. A user can also perform interactive queries to collect information about different items on the map. It is thus a fairly powerful way to distribute GIS data over the Internet.

A Quick Start Primer is offered that covers the basics of using IMS – such as how to get and retrieve information. Clicking on the link for a GIS map causes many things to happen - it wakes up a copy of ARCVIEW residing on our map server, loads all the appropriate data, and delivers the data over the Internet to the web browser on a user's computer. Available data layers include: roads, lakes and streams, land use, wetlands, soils, population density, and others. GIS tools allow the user to make various geographical calculations, and a zoom feature includes aerial photographs of the watershed taken with infrared film that accentuates vegetation and hard surfaces. In the future we hope to offer limited areas with high resolution (< 1m) black and white photos.

3. UNDERSTANDING

This section is primarily intended to provide a set of detailed “Primers” that describe the basics of: (1) how stream ecosystems work; (2) the key water quality parameters needed to characterize Duluth's streams; (3) the major types of water quality impacts most relevant to the condition of streams in Duluth, and more generally, in the Lake Superior Basin; (4) the organisms that inhabit the streams and their watersheds; and (5) regional hydrology; and (6) drinking water, wastewater, and related issues.

A central feature of most of these sections is the integration of real data from our instrumented streams into the explanatory materials, including the use of animated “gif” graphic sequences to illustrate certain points and to simulate how relevant data may be viewed using *Duluth Streams's* data visualization tool (easily accessed via the “DATAVIEWER” at the bottom of each page).

Stream Ecology Primer – This section has gone through a number of revisions and is near completion. Users are referred to several websites, one of which was developed through the Water Resources Center at the University of Minnesota-Twin Cities. Users are also referred to the more comprehensive set of slide modules viewable or downloadable from our companion website, *Water on the Web* (www.waterontheweb.org).

Water Quality Primer – This includes parameter descriptions and explanatory material that are accessed via two drop-down menus, one for manually sampled parameters and the other for automated sensors and sampling. Each section is designed to explain what the parameter is estimating, why it is important, how it varies naturally, and how it can impact aquatic organisms and other beneficial uses of water. There are many cross linkages to the Water Quality Impacts section (see below), to other sections of the website, and to other websites. Links to other websites are chosen carefully because of their potential for being discontinued suddenly, so there is an emphasis on federal and state agencies and larger non-profit organizations. A new browser is always opened when a user is taken “off-site” to make it easy to return home.

Water Quality Impacts – This section highlights the nature of the major water quality impacts in the Duluth urban area including: bacteria, temperature, erosion, impervious surfaces, lawn care, motor oil, pet waste and road salt. The stream monitoring units (SMUs) have now been operating for three years, and, because of their high-frequency (15 minute) data collection, have revealed a number of interesting phenomena on the behavior of these urban streams, including extended conductivity spikes from salt-laden snowmelt, the identification of unauthorized sediment releases from urban construction activities, and sudden increases in water temperature from rain running across sun-warmed parking lots and roads to levels exceeding EPA water quality criteria for trout. The Impacts list is not all inclusive but emphasizes impacts which can be mitigated in the near-term by changes in citizen habits, management and training for city staff, contractors, and local policy decision-makers. Each section is closely tied to data, either EPA-EMPACT funded real-time data or current and historical traditional monitoring data. Examples include:

(1) data remotely sensed by our SMUs, e.g., turbidity caused by erosion off a road construction site adjacent to Tischer Creek in September 2003; road salt runoff captured by dramatic increases in EC25 in the creeks each spring; or sharp thermal increases from summer rainstorms on hot days (see Appendix 6).

(2) related intensive monitoring programs, such as our ongoing EPA-EMPACT project, *Lake Access* (www.lakeaccess.org) that involves a sub-watershed scale phosphorus fertilizer experiment linked to intensive stormwater monitoring for flow and phosphorus.

(3) related Duluth area manual sampling programs such as the Lake Superior Beach Monitoring Program that began in 2003 (www.minnesotabeaches.org). In fact, *Duluth Streams* staff participated in the design of this fecal bacteria monitoring program since its inception, helped develop and review website materials and sampling methods and design, and most recently has collaborated with the MN Pollution Control Agency to design a new website, hosted by NRRI for the purpose of making the health risk advisories and data more easily and rapidly available to the public and to other agencies. This website also is designed to accommodate non-beach sources of microbial data from the Lake Superior region in addition to having the potential to be developed into a state-wide information and data clearinghouse for all recreational waters that are monitored for pathogen indicators.



Pet waste impacts

All these examples help explain and make real the importance of the water quality impacts discussed in this section of the website.

The Minnesota Pollution Control Agency, other agencies, and municipalities have expressed interest in expanding the website to include the North Shore of Lake Superior. If funding is secured, forest practices would be added to the list of water quality impacts. It is hoped that funding can be secured to install water quality sensors in several North Shore streams that already have USGS flow gauges as part of such an effort. This would build on an ongoing effort

by the MPCA to monitor a set of North Shore streams, although water quality sampling has been restricted to manual sampling (Anderson et al. 2003).

Organisms – This section provides detailed information about the aquatic organisms that inhabit regional streams, from microbes to fish to mammals and birds, both directly on the website and through links to other sites. There is a particular emphasis on aquatic invertebrates because of their expanding use as bioindicators of stream condition in addition to their widespread use by K-12 science classes. One unanticipated highlight is the inclusion of a very detailed list of aquatic invertebrates, with detailed ecological information that was developed by Dr. Valerie Brady, now at NRRI. She conducted the sampling and developed the information while a post-doctoral researcher at the US EPA Mid-Continent Ecological Research Laboratory in Duluth and lacked an appropriate venue for it. This section also provides a link to a cutting edge research study of lynx in northeastern Minnesota and a new invasive aquatic plant guide for Minnesota that is being developed by Co-PI Cynthia Hagley and others.

Water and Wastewater – This section focuses on hydrology – the movement and transport of water, but with an urban focus. It explains where drinking water comes from, whether it be municipal or rural, and where wastewater is treated, whether onsite or by a publicly owned sewage treatment plant. Users can find explanatory material and links to find out more about their own systems and the quality of their drinking water and wastewater.

4. STREAMS

This section serves as the main data repository with subsections devoted to each of Duluth’s 42 streams, a separate grouping of the 12 designated trout streams, a metadata section that describes the type of data and the monitoring instrumentation, a detailed Quality Assurance/Quality Control section, and an annotated index of reports and websites where other relevant data can be found. Current data from the 4 intensively monitored streams, as well as maps, graphs, and charts can be viewed by selecting a stream from a menu or by visiting a Data Availability Table. This table summarizes all known data and is organized into the subcategories: map location; real-time data; trout stream (an identifier); storm data (illustrative data vignettes taken from the intensive dataloggers); land use data; photographs (current); historic photographs; GIS map utility; and reports.

Several options exist for viewing Current Data:

1. Animated graphs of stream monitoring unit data can be viewed and manipulated with the Data Visualization Tool (DVT). This may also be accessed from the “Data Viewer” option at the bottom of every page on the website (Figure 1, Appendix 6,7);
2. Data collected with stream monitoring units, including

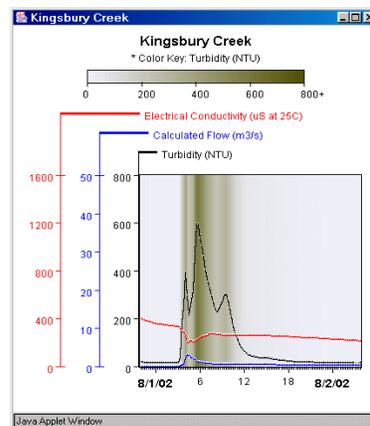


Figure 1. Stream data visualization tool (DVT)

temperature, turbidity, electrical conductivity and water depth (real time data) is available in both HTML tables and Excel tables;

3. Water chemistry data for water samples collected periodically by *Duluth Streams* staff and MPCA staff (for Amity Creek), including nitrogen, phosphorus, pH, and more is available in Excel tables;
4. Real time data viewed in Excel can be easily graphed using a simple Excel graphing utility.

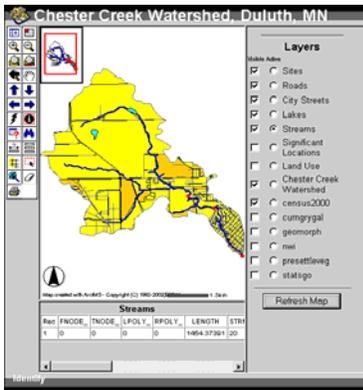


Figure 2. Example of the output from the Internet Map Server GIS utility

The GIS utility, Internet Map Server (IMS), allows the user to zoom in on maps (Figure 2) and at maximum zoom converts to infrared aerial photographs with a resolution of ~ 2-3 m (Figure 8). This tool has been well received by middle and high school science classes. The City of Duluth now has higher resolution (<1 m) aerial photographs of the entire City, and we are seeking funding to develop lessons that integrate scenes from these photos with GIS layers describing sanitary and storm sewer lines, allowing users to trace the flow of water from the headwaters of three streams, down through the three City high schools, and then into WLSSD for treatment or into the St. Louis River Estuary or Lake Superior, in the case of stormwater. Additional description of the IMS tool is located in Section III.6, METHODS.

The Archives section of Current Data includes a compilation of reports and websites that are briefly annotated to indicate sources of other relevant stream data. Presently, there is no comprehensive index of these data and the current listing is only the initial version of what we expect to be an ongoing library effort.

The Quality Assurance/Quality Control section provides specific information about our QA/QC protocols, including: data types; sensor resolution and reporting limits; SMU placement; flow calibration; sample collection; sensor calibration; other continuous water monitoring data; data transmission and initial QA screening; final data review and posting; water sample analyses; and references. This information was included in the Quality Assurance Project Plan (QAPP) for the project at its inception in order to ensure that the data collected would be of a quality at least as high as that used for regulatory permitting.



5. CITIZENS and SCHOOLS

The focus in this section is on activities and tools that homeowners and schools can pursue to become better informed and better stewards of our streams. Guidance and curricula are provided that are oriented toward reducing the amount of runoff leaving their property, and reducing the amount of soil, nutrients, leaves and grass, and salts in that runoff. The Citizen

and Stormwater Management sections in particular are intended to educate citizens and also to provide detailed guidance to help them reduce their impacts on stormwater, to take action as volunteers, or to become active politically (see Figure 3 and Appendix 3). The website serves as a clearinghouse for water-related information – emphasizing streams, stormwater, and stormwater mitigation. This information has been scattered over numerous agency websites. Compiling the information in one organized location benefits resource and regulatory agencies (county, region, state and federal), the private sector (engineering and consulting firms, contractors, vendors), and private citizens and students.

CITIZENS and SCHOOLS is divided into: Volunteer Activities; Curricula; Home and Garden ; Local School Stewardship; FAQs; and Resources. Volunteer Activities includes information and activities specifically designed for local programs.

The St. Louis River Riverwatch program is part of the national River Watch program funded by USDA, a citizen-based water quality monitoring program. St. Louis Riverwatch includes >32 high schools and middle schools. The program is directed by aquatic ecologists at the Fond du Lac Tribal and Community College in Cloquet, MN, ~30 miles south of Duluth. It focuses on a single spring sampling of aquatic invertebrates plus some ancillary field and test-kit chemistry data at sites along the St. Louis River or its tributaries. There is an annual meeting with talks and posters. The project promotes and inspires stewardship of this valuable natural resource among youth and teachers throughout the watershed. The St. Louis River *Riverwatch* program has the following objectives:



(1) provide environmental education opportunities to students and teachers by offering a hands-on approach to learning about the cultural and natural history of the St. Louis River watershed;

(2) cultivate a life-long sense of stewardship toward the river and the river communities;

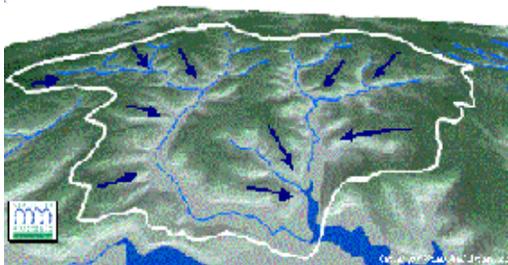


Figure 3. *Everyone lives in a watershed*

(3) collect and interpret baseline water quality data using sound scientific techniques;

(4) share water quality information with state and local communities in a variety of ways, such as the media, brochures, and public presentations;

(5) encourage citizen participation in reaching the long-range management goals for the river;

(6) collaborate with other agencies and groups on watershed-related studies.

The program lacked the resources to fully develop its website and so *Duluth Streams* has developed and hosted an interim website that includes information about the River Watchers, the participating schools, field and lab data sheets, and interactive GIS maps and field and lab worksheets. This also provided an opportunity for us to promote a more intensive monitoring program patterned after the MPCA's Volunteer Citizen Stream Monitoring Program (CSMP). Streams such as those in the Duluth Area are flashy, with dramatic increases in flow and changes in nutrient and sediment concentrations and other pollutants occurring in association with rainstorms and spring snowmelt. The CSMP asks volunteer to sample throughout the ice free seasons; primarily for optical clarity as estimated using GLOBE program transparency tubes (Globe Program 2004). Ancillary measurements of temperature, estimated flow, and visual observations of condition are also included. *Duluth Streams* has recommended that schools follow CSMP protocols, adding EC25 as a measure of total dissolved salts (TDS) and roadsalt, in addition to their more intensive biological and chemical sampling survey each Spring.

Storm Drain Marking information is included in support of a major elementary school program around the state. The message is simply that storm drains do not flow to water treatment facilities and that debris and other waste materials should never be dumped into them because they flow into our streams.

Water Quality Monitoring Day began in 2002 with an interagency program led by the USGS and USEPA in order to provide a "snapshot" of some simple water quality parameters in the nations streams each October. Perhaps more importantly, it was an attempt to excite students and teachers about the need to protect and monitor our surface waters. The program became international in 2003. *Duluth Streams* helped a middle schools and two high schools to participate in October 2002 and has since worked with the middle school to implement an intensive monitoring program of Tischer Creek, about a mile upstream from our SMU, using the CSMP transparency tube and a pocket EC25 meter. A PowerPoint slide show was developed and is viewable and downloadable from the website (Appendix 7). The slide show provides background for the monitoring effort. It then compares local schools' data to the intensive data stream collected by the automated SMUs to show that student-collected data can provide essentially the same information and conclusions.

The Environmental Youth Leadership project was made possible in-part through funding from Minnesota's Lake Superior Coastal Program. Over the course of two years, educators from the University of Minnesota Extension Service worked in collaboration with staff from the Northern Pines Girl Scout Council and Duluth Independent School District 709 to engage high school students in model service-learning projects. It targets energetic middle or high school teachers or student group leaders. Students in these groups learn the foundations of good leadership through discussion, reflection, team and mission building. Student groups selected and completed environmental restoration projects within the St. Louis River estuary in northern Minnesota. In programs ranging from a few weeks to three months, groups successfully tackled the following projects:

- Miles of beach cleanup on Minnesota Point
- Removal of litter from the St. Louis River shoreline
- Planting of 300 saplings to control St. Louis River shoreline erosion

- Construction of 10 herbivory exclosures to protect cedar saplings on Grassy Point
- Insect control of the invasive plant, purple loosestrife, in riverine wetlands
- Removal of buckthorn, another invasive plant, from the St. Louis River shoreline

Twenty five lessons from the program were compiled into the curriculum guide "Building Environmental Youth Leadership: A High-School Service-learning curriculum" that can be downloaded from the website. The first part of the guide defines key components of the service-learning process. Part 2 is comprised of narrative lesson plans focused on team/mission building and action planning. When combined with existing studies or additional curricula, these lessons provide teachers, youth leaders and families an effective means for cultivating environmental service.

The Curriculum section focuses on locally developed lessons and instructional materials while also providing web links to curricula developed by large federal and state agencies and NGOs that are likely to remain accessible via their current web addresses. There is a wealth of information readily available via the Internet, so our section focuses on hosting locally relevant information. The Stowe School Curriculum is an example of such a curriculum, with 31 elementary school lessons that relate to Lake Superior and local waters. It was developed by graduate students in education at the University of Minnesota-Duluth and then revised under the direction of *Duluth Streams* Co-PI Bruce Munson and University of Minnesota Extension Service Extension Educator Nate Meyers before it was made available via the website.

The Home and Garden section provides a variety of useful information for homeowners, landscaping businesses, and developers to reduce the amount and improve the quality of runoff (e.g., Figure 4). It includes:



Figure 4. Residential rain garden

- (1) Frequently asked questions – these include the most common questions asked of city stormwater utility staff;
- (2) Lawn and garden “tools” – e.g., water gardens, rain barrels, spring cleanup, how to reduce runoff;
- (3) Home care and construction – pervious building materials; electronics recycling;
- (4) Fact sheets – 10 steps you can take today; “everyone lives in a watershed” explanatory material

Local School Stewardship is a work in progress. Presently, it only includes materials derived from intensive interaction with the Washburn-Edison Middle School’s stream elective program. However, there has been direct collaboration with three area high schools as well as more indirectly through the St. Louis River Watch program, and it is hoped that there will eventually be high school stewardship of several creeks in the form of routine transparency, temperature, flow, and EC25, coupled with spring biomonitoring.

Resources was created to provide the public with easy access to agencies, elected officials and public utilities staff to have their questions answered, to get information, or to report potential stream impairments. It includes contact information for local, state, and federal decision makers (including e-mail addresses, telephone numbers and mailing addresses), the Regional Stormwater Protection Team (RSPT), information for selected individuals from local agencies such as the City of Duluth Planning Department, the Minnesota Department of Natural Resources – Division of Waters, the Minnesota Pollution Control Agency, the St. Louis County Land Department, the South St. Louis Soil and Water Conservation District, the U.S. Environmental Protection Agency (EPA), the Western Lake Superior Sanitary District, the St. Louis River Citizens Action Committee, the Minnesota Office of Environmental Assistance, and a number of relevant water-related links such as www.waterontheweb.org, www.minnesotashorelandmanagement.org, and www.lakeaccess.org, the Lake Superior Decision Support System (www.nrri.umn.edu/lsgis), and the Coastal GIS website (www.nrri.umn.edu/coastalgis). This section also links back to Education Links sections on the website concerned with classroom curricular issues and to the Stormwater Management section (see below).

Kiosks with interactive computerized displays were originally intended to be installed at the Duluth Zoo and the Great Lakes Aquarium. They were intended to describe the project, the sampling equipment, and the related educational resources and would be used by Zoo and Great Lakes Aquarium staff for their programmatic activities. Unfortunately, although an existing kiosk at the Great Lakes Aquarium contains earlier versions of the *Water on the Web* Basic Science curriculum and the *Lake Access* website, financial difficulties at the GLA precluded updating the kiosk. Similarly, there were insufficient resources for a “high tech” kiosk at the Zoo, although several displays were set up there in addition to contributing a booth and staff for several environmental events that it hosted. Opportunities for funding a dedicated computer kiosk will be sought for the Zoo site and we will seek additional collaboration with the Aquarium in the future

6. STORMWATER MANAGEMENT

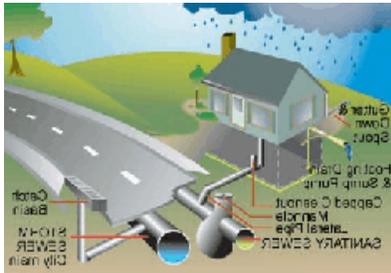
Information in this section includes: (1) actions the cities and other MS4 (Municipal Separate Stormwater Sewer System) permittees in the region are required to take to comply with current stormwater regulations; (2) key compliance issues related to inflow and infiltration; and (3) actions homeowners, businesses, developers, and contractors can take to minimize stormwater impacts. Additional features about street sweeping and pet waste clean-up are planned.

EPA Phase II Minimum Measures are summarized and the 2003 and the 2004 City of Duluth General Stormwater Permit Applications are downloadable as PDF files. There are also links to further City of Duluth information on the City’s website and to EPA fact sheets.



Stream and Storm Sewer Maintenance – Stream clean-up and maintenance requires a continuous effort by the City of Duluth and Youth Employment Services (YES), combined. YES assists the City Utilities Operations Department with the annual stream cleaning of Duluth’s streams. The Utility Operations department addresses specific maintenance problems, removes large debris such as household appliances sometimes dumped in the streams and does routine cleaning of sediment traps, catch basins, and culverts. This section describes these mandatory “good housekeeping” activities in detail and provides pictorial narratives of two specific examples: the annual Spring snowmelt maintenance (which was enormously difficult in 2003 due to poor snow cover that resulted in deeply frozen streams forcing the City to thaw and clean culverts); and a summer 2004 clean-up of nearly a hundred tires and other materials from the Buckingham Creek channel.

Inflow and Infiltration (I&I) – I&I is the process by which clear water leaks into the sanitary sewer system causing periodic overloading of the wastewater treatment plant and the efflux of millions of gallons of untreated sewage into receiving waters. In Duluth and in other cities in the western Lake Superior basin, this is a major problem with no simple solution. The City of Duluth’s I&I program has sought to remove clear water through the disconnection of footing drains from the sanitary sewer system. The City also has a maintenance program to ensure that the City of Duluth’s sewer pipes are in good condition. These efforts should eventually stop overflows.



I&I is one of the major water-related environmental issues in the region because of sewer bypasses, overflows and spills that have occurred following heavy rainstorms. In addition, a Lake Superior beach monitoring program for fecal coliforms and *E. coli* that began in 2003 led to a number of beach advisories warning against water contact recreation. Although only a few of the advisories were likely due to either sewer line spills or I&I events in 2003 (and fewer in 2004), they brought increased public and regulatory attention to bear on the issue, including an administrative order by the US EPA to take immediate steps towards solving the problem.



Because of public confusion over the complexity of the issue and its close, yet distinct relationship to the stormwater runoff issue, we decided that it would be helpful if *DuluthStreams* could present explanatory materials about the issue (www.duluthstreams.org/stormwater/inflow.html). Fortuitously, we subsequently discovered that the regional sewage treatment plant (WLSSD) had a continuous on-line discharge gauge and effluent turbidity monitor plus a city-wide network of precipitation gauges. These data are now routinely downloaded through the Data Visualization Tools on the DS website and provide striking examples of the surge in discharge at WLSSD caused by inflow from rainstorm-induced stormwater runoff and spring snowmelt runoff. As noted previously, the *Duluth Streams* home page has a Beach Advisory icon linked to the MPCA Beach Monitoring website to help advertise such health risk warnings. The Minnesota Beaches web site is a cooperative effort with the MPCA to deliver warnings on potentially hazardous beach conditions and beach closures due to high fecal coliform counts. The site covers issues related to water

quality, public health, and land use planning and is tightly cross-linked to *Duluth Streams*.

Site Design Toolkit – The Stormwater Management section is currently being re-structured to add a major unit with information relevant to construction activities for both homeowners and contractors. This will include fact sheets illustrating the use of specific types of materials and



designs to minimize and clean runoff and illustrated local case studies. The project recently benefitted from a small cooperative grant from the MPCA to assist their Pollution Prevention Program by developing a North Shore (of Lake Superior) Conservation Design Toolkit. This web-based "toolkit" is being designed for developers and local governments to provide information and resources on environmentally sustainable development approaches and best management practices. The toolkit will highlight practical strategies and techniques for design and

implementation in areas such as alternative storm water management systems, site design options (e.g., clustered development), centralized and decentralized wastewater treatment systems, and alternatives to impervious pavement (e.g., Figure 5). Specific toolkit components will include:

- (1) Case studies and/or fact sheets comprising a "Showcase of Ideas"
- (2) Catalog of images/specs illustrating development practices from a "problems & solutions" and/or "before & after" perspective
- (3) Guidance on tailoring BMP applications for specific site conditions and circumstances in the North Shore Region
- (4) Links to BMP performance data and evaluations of BMP effectiveness
- (5) Model local ordinances for stormwater management, erosion and sediment control, subdivision design, etc.
- (6) Concept design worksheet(s) and resources for developers targeting pollution prevention opportunities
- (7) Checklist for municipal officials conducting concept design or site plan review and approval
- (8) List of contacts for technical assistance providers affiliated with various state, local, federal, and nonprofit resource organizations.
- (9) Links to technology information and guidance material
- (10) Links to existing guides and resources for implementing land management strategies, such as performance-based zoning



Figure 5. Example of a pervious surface

(11) Frequently asked questions related to low impact development practices and applications

This effort is a collaboration between Minnesota Office of Environmental Assistance (OEA) staff, MPCA's North Shore Team and Stormwater Staff in St. Paul and Duluth, *Duluth Streams* staff from NRRI and Minnesota Sea Grant, and the RSPT. The toolkit will be located within the STORMWATER MANAGEMENT section of *DuluthStreams.org* and will augment the existing stormwater and surface water education information on the site.

Specifically, the toolkit will be tailored for industries, governmental entities, and individuals engaged in development and construction activities and/or oversight. Some target audiences for the toolkit include:

- Private developers/builders/contractors
- Designers/architects/landscape architects/planners/engineers
- Local units of government, with an emphasis on new MS4 permittees
- Homeowners/homebuyers/realtors

Regional Stormwater Protection Team (RSPT) – Development of the initial EPA-EMPACT project necessitated a formal partnership with a variety of governmental agencies and non-profit organizations to accomplish project goals. One important outcome of the *Duluth Streams* Partnership has been its expansion to create a broader partnership called the Regional Stormwater Protection Team (RSPT; see agency list and Memorandum of Understanding, MOU in Appendix 8). This team has brought together regional communities and institutions faced with common education and training requirements for their new federal/state nonpoint source pollution permits (MS4s). The RSPT, formed in 2002, includes *Duluth Streams*, other governmental units, agencies, nonprofit groups, and educational organizations and is working to develop a unified watershed approach for educating the public on nonpoint source pollution issues and protection of the region's waters. Since all stormwater in the Duluth area ultimately ends up in Lake Superior, all citizens have an added responsibility to protect this pristine water body and in doing so, protect our source of drinking water.



DuluthStreams.org is a logical focal point for RSPT, which continues to focus on stormwater issues in particular, but does this within the context of the broader area of surface water quality and the ecological health of streams and lakes in the region, including, of course, Lake Superior. Our ultimate goal is for all of the surface water "relevant" agencies in the region to actively contribute to this effort. Because of similar stormwater and/or growth issues along the north and south shores of Lake Superior, we hope to further expand the website to encompass all of the watersheds in western Lake Superior.

V. PROJECT IMPACTS

1. Website use – Website usage has grown steadily since the site was unveiled and is now > 200,000 hits/month and >20,000 page requests/month excluding City and University members of the *Duluth Streams* Partnership (Figures 6 and 7). Based on how use patterns of our first EPA-

EMPACT website tracked usage of our WOW website, we expect its use to continue to grow. It is also noteworthy that the troughs and crests in the curves appear to generally track the school

year. As yet we have not attempted to estimate specifically where the *Duluth Streams* “hits” come from. WOW now has received page requests from >120 countries so we suspect some of the *Duluth Streams* use is broader than the western Lake Superior region.

Website use will also grow as the Regional Stormwater Protection Team continues to rely on *Duluth Streams* while developing more media materials, flyers and bookmarks, technical workshops, public water festivals, and school activities (Examples in Appendix 3). *Duluth Streams* staff also developed a separate marketing plan in February 2004 that calls for increased media stories, presentations at local, state and national conferences and journal and trade magazine articles.

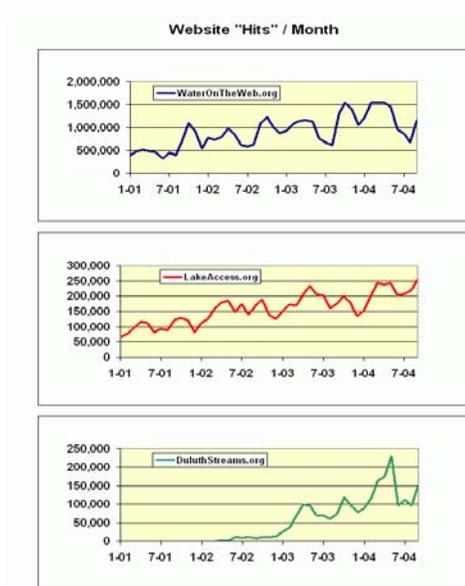


Figure 6. Hits/month for *Duluth Streams*, also showing usage from “parent” sites *Water on the Web* and *Lake Access*.

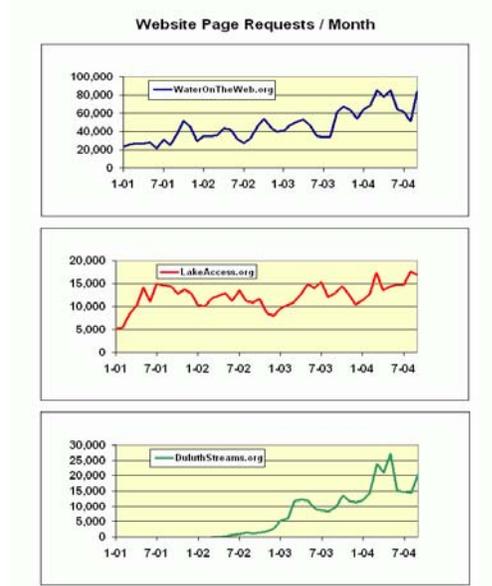


Figure 7. Page requests/month for *Duluth Streams*, *Water on the Web*, and *Lake Access*.

2. School curricula – While not originally intended to include school curricula, it soon became apparent that helping to establish school stewardship and volunteer monitoring programs was important. In addition there appeared to be relatively little coordination of water-related activities among schools. Although the St. Louis River *Riverwatch* program began in 1997 and had expanded to include >32 schools, it lacked the resources for a comprehensive website. Therefore, we developed a website for *Riverwatch* to use in late 2002 (it is still their main website) and included its field and lab worksheets, list of participating schools, and site maps and linked it to aquatic invertebrate keys on the *Duluth Streams* website. The website also has provided a home for the *Environmental Youth Leadership* curriculum which includes 25 lessons of which seven involve high school level water and watershed learning activities.

The Stowe School Watershed Curriculum that is downloadable from the site was developed via a state collaborative educational grant to the City of Duluth in partnership with the Stowe Elementary School (K-6). They then contracted with the Education Department at the University of Minnesota-Duluth to have graduate students refine the curriculum. Its 31 lessons are linked to local streams and Lake Superior whenever possible. Co-PI Bruce Munson and graduate student Nate Meyers edited and revised the set of lesson plans to make them more technically accurate and to include the various “messages” of *Duluth Streams* whenever possible.

Pilot projects were developed for one middle school and three high schools that introduced flow-related spring and fall sampling for clarity (via the transparency tubes used in the Minnesota volunteer Citizens Stream Monitoring Program-CSMP), EC25, and estimates of relative flow to be integrated into the existing monitoring program – a once a year aquatic invertebrate survey. Results from their fall samplings, which included water chemistry test kit measurements plus additional measurements made by *Duluth Streams* staff were submitted to the database developed for National/International Monitoring Day (URLs:

www.yearofcleanwater.org/events/volunteer.htm and www.green.org/sites/). A section entitled **Water in the Classroom** was created to assist teachers in creating water-based curriculum for elementary and high school students.

The website is also tightly linked to the high school science and college level water science curricula in www.waterontheweb.org. Locally, it is being used in all of the environmental classes at Lake Superior Community College in Duluth and in a number of classes in the Biology, Geology, Environmental Education and Science Education departments/programs at the University of Minnesota-Duluth.

The *Duluth Streams* group would also like to provide further opportunities for informal and extracurricular student education by developing kiosk exhibits at the Duluth Zoo, the Great Lakes Aquarium and the Hartley Nature Center. While some interaction has taken place with each of these groups directly or indirectly, particularly the Zoo where the Kingsbury Creek stream monitoring unit and automated sampler is located, kiosk construction will require additional grant funding. As noted previously, the Great Lakes Aquarium, in particular, is only recently emerging from a fiscal crisis that temporarily closed its doors.

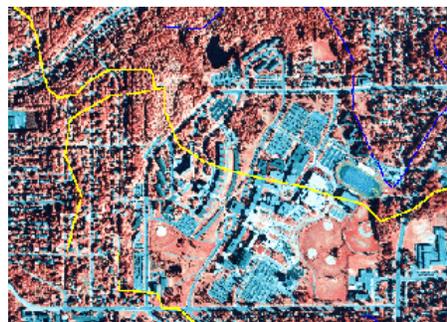


Figure 8. Infrared aerial photo available via GIS - IMS tool

3. *Duluth Streams* staff educational activities – City of Duluth staff and University of Minnesota-Duluth PIs have been very active in the community – serving on related agency committees and disseminating educational and technical information via talks, seminars, lectures, and publications in a variety of formats. These are summarized with estimates of audiences as a measure of project impacts in Table 1. The website is linked to numerous other educational and agency websites, including the Minnesota Pollution Control Agency’s Stormwater Section, and we expect to have portions of the site, particularly the UNDERSTANDING section, linked from the EPA’s Watershed Academy website.

4. Journal articles and conference presentations – These are tabulated in Appendix 1 with

examples of poster presentations in Appendix 2.

5. Agency and university use and sustainability – Perhaps the most important measures of the success of *Duluth Streams* is its use by local and regional agencies and the success of the partnership that created it. In fact, in a long-term effort to promote positive community and individual activities to protect the waters of the region, PIs Marnie Lonsdale (City of Duluth) and Cynthia Hagley (Sea Grant-UMD) organized 19 governments and groups in 2003 to expand the *Duluth Streams* partnership to form the Regional Stormwater Protection Team (RSPT). Their mission: To protect and enhance the region's shared water resources through stormwater pollution prevention by providing coordinated educational programs and technical assistance. This group has expanded and continues to meet monthly to develop grant proposals, plan technical workshops and educational activities (Appendix 8). It was funded by a grant from Minnesota's Lake Superior Coastal Program (LSCP) in addition to contributions of funds and effort by area MS4 Permittees to produce brochures and pamphlets, kiosk materials for the Duluth Home Show (the single largest convention of the year) and a set of radio and television ads (see Appendix 3 and 5).

The RSPT Partnership created by the funding of *Duluth Streams* has already led to a number of agency collaborations to leverage funding to broaden the geographical purview of the website, add curricula and training for different audiences, and establish volunteer monitoring programs to promote stream stewardship, establish benchmarks, and supplement more intensive monitoring programs. The combined data set will be the basis for long-term water quality assessments of the streams and will improve our understanding of how regional streams respond to increased development stressors. These efforts include: the St. Louis River *Riverwatch* program (w/Fond du Lac Tribal Community College funded by USDA); the Lake Superior Beach Monitoring Program (*minnesotabeaches.org* funded by MPCA and w/WLSSD); a Conservation Design Toolkit (w/MPCA, the MN Office of Environmental Assistance and regional trade associations); Project Northland NEMO (w/ regional townships and municipalities to use simple GIS tools for improving comprehensive land use planning); and the University of Minnesota-Duluth's campus wide Stormwater Pollution Prevention Plan, which has already generated numerous fact sheets, BMP instructions to staff, and case study examples of a number of low impact design (LID) projects on campus that are planned for inclusion on the website.

Three subsequent grants from the LSCP began in October 2004. Two are educational in nature involving watershed/water festivals. The third will provide funding to NRRI-UMD to: (1) develop additional data vignettes from the intensive monitoring sites; (2) expand the website to include sections for each of the RSPT member MS4 permittees (Hermantown, MN, Proctor, MN, Cloquet, MN, Superior, WI, and U. of Minnesota-Duluth); and (3) create a contractor training section based on the materials developed by the RSPT for an erosion control workshop in January 2005. The Partnership generated ~ \$46,000 of in-kind effort to match this grant. At least three more grants are planned for submission to this program again for FY 2005/2006.

Duluth Streams PIs Marnie Lonsdale (City of Duluth), Richard Axler (NRRI-UMD) and Cynthia Hagley (Sea Grant-UMD) are also invited members of the University of Minnesota Stormwater Protection Plan Steering Committee since its inception in 2003. A number of materials produced by UMD-Facilities Management staff, including contractor training instructions, BMPs, and

photo narratives of BMPs being installed and maintained on campus, will be adapted for inclusion on the *Duluth Streams* website as web pages and/or PowerPoint slide shows.

There have been two other small grants from the Minnesota Pollution Control Agency in support of *Duluth Streams*. The first provided funding to establish www.minnesotabeaches.org which will be home to all microbial pathogen data for the area (i.e., Minnesota's Lake Superior/St. Louis River Estuary) beaches. However, the website's name was chosen in order to eventually provide a clearinghouse for beaches statewide. There is also a section for fecal coliform/*E. coli* data collected by WLSSD from local streams and by the St. Louis County Environmental Health Department for ponds and lakes in the area. There is also considerable historical data of this kind that has not been completely analyzed for trends and has not been readily available to the public. The second grant is for a new website section with information related to low impact and conservation design and was described in detail in Section IV.6. *Duluth Streams* staff also has collaborated on two proposals submitted by *The Nature Conservancy* that involve education and outreach for a Duluth Natural Waterways Project and a classification and assessment project for streams within the Duluth Natural Areas Program.

Table 1. Duluth Streams related Outreach & Education Activities Jan 2003 – Sep 2004				
DATE	WHO	VENUE	Audience	Number
Feb 8, 2002	Sea Grant	<i>Infusing water quality curriculum with cutting edge technology</i>	MN Earth Science Teachers Conference Annual Meeting middle/high school	110
Mar 2002	City of Duluth	Stormwater Education materials and discussion – Duluth Home Show	General public	>250
Apr 2002	City of Duluth	Stowe Elementary School Water Festival (stormwater education booth, demos, staff)	K-6 students teachers	>200
Apr – July 2002	NRRI	<i>Duluth Streams</i> Project description Press Releases to Newspapers; feature on local TV news station	general public (236" of column space ~ \$32,000 of advertising to statewide audiences).	1000's
Apr 18, 2002	NRRI	Newspaper story about TMDLs for Earth Day (press release story)	general public	1000's
May 23, 2002	Sea Grant	<i>Land Use and Impervious Surface Impacts on Water Quality</i> . Lesson plan for middle school students.	Lake County middle school students at Lake County Field Days	50
Sep 7, 2002	Sea Grant	<i>Everyone lives in a watershed</i> . Fact sheet distributed at Harvest Festival plus booth with poster and staff	Local residents at Duluth Harvest Festival	~250
Oct 29, 2002	Sea Grant	NEMO and <i>Duluth Streams</i> presentation	Local government employees at NPDES Phase II workshop	~75
Oct 30, 2002	Sea Grant	3 Presentations on NPS pollution, solutions and monitoring	Harbor City High School 10 th grade science classes	~36

Nov 25, 2002	Sea Grant	NEMO and <i>Duluth Streams</i> presentation	City of Proctor, MN Planning and Zoning staff	10
Oct 2002 – May 2003	NRRI, Sea Grant, Extension	Establish student stream monitoring at 1 middle school and 2 high schools	Students and teachers	30
Jan 2002 – Jun 2004	City of Duluth	Stormwater Education Presentations to 25 school groups	Students and teachers	>2500
Jan 27, 2003	Sea Grant, UMD-Education	<i>Water on the Web/DuluthStreams</i> seminar	Graduate students, teachers U. of Minnesota-Duluth	20
Feb 5, 2003	Sea Grant	NEMO and <i>Duluth Streams</i> presentation	Duluth Environmental Advisory Committee	20
Feb 13, 2003	Sea Grant, UMD-Education	<i>Using "Live" Data to Teach about Water - Water on the Web (WOW), Lake Access, and Duluth Streams</i>	Phi Delta Kappa chapter meeting in Duluth, MN.	50
Feb 13, 2003	Sea Grant	Why stormwater is important, Overview of SWPPP and six minimum measures	UMD Stormwater Pollution Prevention Plan meeting	40
Feb 17-20, 2003	NRRI, City of Duluth	<i>Urban Storm Water: Enhancing Programs at the Local Level</i> , Chicago, Illinois; Chicago Botanic Garden and U.S. EPA.	Agencies, academia, consultants, NGOs	250
Mar 4, 2003	Sea Grant	NEMO and <i>Duluth Streams</i> presentation	Seminar for scientists, technicians at NRRI-UMD	45
Mar 25, 2003	NRRI, Extension	St. Louis RiverWatch Festival, Cloquet, MN (4 sessions x 2 topics involving <i>Duluth Streams</i>) <i>How Well Do You Know Your Watershed?</i>	High School students, teachers; environmental educators	~100
Mar 25, 2003	Sea Grant	Duluth stream water quality and public health issues related to contaminants	Community Health class at UMD (Health 3101)	25
Mar 26, 2003	Sea Grant and City of Duluth	Bedrock influenced tributary streams to the St. Louis River and Western Lake Superior	St. Louis River RAP CAC Board and interested citizens	25

Apr 2003	City of Duluth	<i>Duluth Streams</i> project overview	EPA Region V staff	5
Apr 2003	City of Duluth NRRI, Sea Grant	<i>Duluth Streams</i> Stormwater Booth at Duluth Homeshow	General public	>500
Apr 2003– Jun 2004	City of Duluth	Distribute Stream Information <i>Trading Cards</i> to elementary and middle school students	K-8 students	> 1000
May 2003	Washburn-Edison Middle School	Lectures, field assistance; introduction to website and National Monitoring Day activities	Gr 6-8 Science Elective Students + Teachers	12
May 2003	City of Duluth	<i>Duluth Streams</i> project and website presentation	St. Louis River Remedial Action Plan Board general public	25
Jun 28 – Jul 2, 2003	NRRI Sea Grant	Society for Conservation Biology Annual Meeting, Duluth, MN – <i>Duluth Streams</i> Poster presentation and demo + portion of <i>Water on the Web</i> talk	Agencies academia NGOs	>250
Aug 13-14, 03	NRRI	Talk and Poster at <i>Frontiers in Monitoring the Environment Conference</i> Minneapolis, MN, NSF–ACE	Academia	75
Sep 2003	MPCA	TV Interviews on Duluth’s ABC, NBC, and CBS affiliates. One interview done “stream-side” on Amity Creek – Duluth-streams site.	General public	1000's
Sep 2003.	City of Duluth, NRRI	Duluth HarvestFest – <i>Duluth Streams</i> Stormwater presentation with City of Duluth Stormwater Utility	General public	~100
Sep 18, 2003	City of Duluth NRRI	<i>Duluth Streams</i> presentations to National Sea Grant Advisory Panel	Agency, academic and NGO	20
Oct 2003 – May 2004	NRRI, Sea Grant	Introduce <i>Duluth Streams</i> website into student stream monitoring activities at 1 middle school and 1 high school	Students and teachers	125

Oct 2003-Sep 2004	City of Duluth NRRI, Sea Grant	Established Duluth Area Regional Stormwater Protection Team (16 meetings to date) – Develop workshops, brochures, media materials focused on stormwater issues	Agencies, academia (research and extension education), NGOs	25 (1000's via brochures, TV-radio ads, booths)
Oct 20-23, 2003	City of Duluth	3 rd National Nonpoint Source Pollution Information and Education Programs Conference, Chicago IL	Agencies, academia, consultants, NGOs	~250
Jan 2004	NRRI	Newspaper feature (<i>Duluth Budgeteer</i>)	General public	1000's
Feb 4, 2004	MPCA	Duluth Area Chapter of the Izaak Walton League	NGO	~30
Oct 2003-Jun 2004	City of Duluth	Presentations to City Neighborhood Planning Districts 1, 2, 3, 5, 6, 7, 9, 10 groups – 8 presentations to date	General public	>150
March 13-14, 2004	Sea Grant	Liquid Science Sea Grant Seminars – <i>Water on the Web and Duluth Streams: Windows to the health of northern Minnesota streams and lakes</i>	Duluth and Grand Marais citizens	50
Mar 23-24, 2004	MPCA	MN Water Annual Conference, Minneapolis, MN Lake Superior North Shore Streams Water Quality	Agencies, academia, consultants, NGOs, public	~ 400
Mar 23-24, 2004	NRRI	MN Water Conference, Minneapolis, MN . <i>Duluth Streams.org</i> : Web-based delivery of automated data using advanced data visualization techniques for understanding urban stormwater and water quality issues.	Agencies academia consultants NGOs general public	~ 400
Mar 23, 2004	NRRI, Extension	St. Louis River Watch Festival – 4 sessions x 2 topics involving <i>Duluth Streams</i>	High School students and teachers; environmental educators	~100
Jan 2003 - Sep 2004	NRRI	St. Louis River Watch Website development and hosting via <i>www.duluthstreams.org</i>	High School and Middle School students and teachers; environmental educators	100s-1000s (>33 High Schools)

Apr 2004	City of Duluth NRRI	Duluth City Council (public meeting)	Decision makers, general public	100
Apr 2004	City of Duluth NRRI, Sea Grant	<i>Duluth Streams</i> + Duluth Regional Stormwater Team Booths at Duluth Homeshow	General public	>500
May 8, 2004	City of Duluth Sea Grant, NRRI	<i>Duluth Streams</i> website; stream invertebrate indicators of water quality and stormwater education	Duluth Zoo – <i>ZooTracks</i> Public Event	>250
May 11, 2004	Sea Grant	Liquid Science Sea Grant talk series Hartley Nature Center: " <i>Linking Land Use to Water Quality on the North Shore.</i> "	Duluth and Grand Marais, MN citizens	50
May 17-20, 2004	MPCA	National Water Quality Monitoring Conference, Chattanooga, Tenn.	Agencies, academia, consultants, NGOs, public	~ 500
Jun 2-4, 2004	Sea Grant, NRRI	Water Outreach National Facilitation Project Best Education Practices for Water Outreach Professionals, Madison, Wisconsin (Symp. Proc)	Public, agencies, academia, consultants, NGOs	~150
Jun 2004	ProjectWebsite NRRI, Sea Grant	Current average monthly page requests excluding <i>Duluth Streams</i> staff	Public, agencies, academia, consultants, NGOs, schools, businesses, contractors	~230,000 website hits/mo and 25,000 page requests/mo (as of Sep 2004)
Jun 2004 – Jun 2005	NRRI Sea Grant	Develop Conservation Design Toolkit section for <i>Duluth Streams</i> website in Partnership with MN Pollution Control Agency	Contractors homeowners landscapers, realtors	in development
May – Oct 2003	City of Duluth Sea Grant NRRI	Assist RSPT in developing TV spots intended to alert and educate the general public about stormwater impacts on streams and L. Superior	General Public via TV spots that are now on the DS website	10's of thousands TV viewers
Oct 2004	NRRI	MN Land Information System /GIS Annual Conference (Abstract /Oral Presentation)	Agencies, academia, consultants, NGOs	>300

Oct 11-12 2004	Washburn-Edison Middle School	Lectures, field assistance; introduction to website and National Monitoring Day activities	Gr 6-8 Science Elective Students + Teachers	12
Oct 2004 - Sep 2005	City of Duluth Sea Grant NRRI	Develop Regional Stormwater Protection Team sections for adjacent communities; data vignettes and contractor training section (NOAA – L. Superior Coastal Program grant)	Public, agencies, academia, consultants, NGOs, schools, businesses, contractors	in development
Feb 2003 – Sep 2004	NRRI, Sea Grant City of Duluth	Participate as Steering Committee and Education Committee members of U. of Minnesota-Duluth Stormwater Pollution Prevention Plan; design BMPs, monitoring programs, educational and training materials, website and slideshow materials	Student body, faculty, UMD staff, UMD contractors	15,000
Dec 16, 2004	SeaGrant, NRRI	<i>Flash Flood for DuluthStreams.org : Modelling and Visualization of Stream Response to Rain Events in Duluth's Urban Watersheds.</i>	Video Digital Imaging Lab Seminar Series, U. of Minnesota-Duluth	20

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APPENDIX 1. Publications and Presentation Abstracts

1. Hagley, C.A. Infusing water quality curriculum with cutting edge technology. Presented at the 16th Annual Minnesota Earth Science Teachers Conference, held at the Science Museum of Minnesota, February 8, 2002.
2. Axler, R. and M. Lonsdale. 2003. *Duluth Streams: Community Partnerships For Understanding Water Quality and Stormwater Impacts at the Head of the Great Lakes* (www.duluthstreams.org) . Coastline Issue 13.1 (www.epa.gov/owow/estuaries/coastlines), February 2003. p.10-15.
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6. Axler, R., C.Hagley, G. Host, B.Munson, G.Merrick and C.Richards. *Duluth Streams: Automated sensing and data visualization for understanding urban stormwater issues*. NSF workshop "Frontiers in Assessing and Monitoring the Environment" and presented the poster ". August 11-12, 2003. Minneapolis, MN.
7. Axler, R., E. Ruzycski, J. Reed, J. Henneck, N.Will and G. Host (NRRI); M. Lonsdale (City of Duluth); C. Hagley, J.Schomberg, C. Richards and B.Munson (MN Sea Grant). *DuluthStreams.org: Web-based delivery of automated data using advanced data visualization techniques for understanding urban stormwater and water quality issues*. Minnesota Water 2004, Minneapolis, MN, March 23-24, 2004.
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9. Hagley, C., M. Lonsdale, R.Axler, G.Host, C.Richards and B. Munson. 2004. *Duluth Streams: Making water quality, land use, and stormwater data come alive for decision-makers*. Water Outreach National Facilitation Project, Madison, Wisconsin, June 2-4, 2004 (Symposium proceedings to be published).

10. Sjerven, G. and R. Axler. 2004. MN Land Information System /GIS Annual Conference (Abstract /Oral Presentation), October 2004, St. Cloud, MN

11. Axler, R. et al (12 co-authors) 2004. Using time-relevant, intensive lake and stream data for training technicians and educating citizens, students, resource agencies and decision-makers. In *"Sensors for Environmental Observatories (SEO)*, National Science Foundation Environmental Engineering Directorate sponsored workshop, U. of Washington-Seattle, WA. on Nov 30 - Dec 2, 2004.

12. Host,G., R.Axler, B.Munson, C.Hagley, and C.Richards. Remote underwater sensing technology and data visualization. In *Future of Open Water Observation Technology for the Great Lakes*, workshop, sponsored by the National Oceanic Atmospheric Administration and the International Joint Commission, Arbor, MI, Nov 30-Dec 3, 2004.

APPENDIX 2. Examples of poster presentations from national conferences and public venues

1. Lonsdale, Marion, Richard Axler, Cynthia Hagley, George Host, Carl Richards and Bruce Munson. 2003. *Duluth Streams: Community partnerships for understanding urban stormwater and water quality issues at the head of the Great Lakes*. Presented at *Urban Storm Water: Enhancing Programs at the Local Level Conference*, February 17-20, 2003, Chicago, Illinois; sponsored by the Chicago Botanic Garden and U.S. Environmental Protection Agency.
2. Hagley, C., M. Lonsdale, R. Axler, G. Host, C. Richards and B. Munson. 2004. *Duluth Streams: Making water quality, land use, and stormwater data come alive for decision-makers*. Presented at *Water Outreach National Facilitation Project*, Madison, Wisconsin, June 2-4, 2004 (Symposium proceedings to be published).
3. Harvest Day Festivals, September 2002 and 2003

APPENDIX 3. Examples of Fact Sheets used for Lake Superior (i.e. Duluth) Zoo Kiosk and for distribution at various local public events

1. Project Abstract
2. Where does stormwater come from ?
3. Where does stormwater go ?
4. What is in stormwater ?
5. How does stormwater runoff impact streams ?
6. Everyone lives in a watershed !
7. Reduce polluted urban runoff – things you can do to protect the waters of our streams, rivers and Lake Superior

APPENDIX 4 – *duluthstreams.org* major section pages (as of September 30, 2004) and draft *LakeSuperiorStreams.org* home page (December 2004)

APPENDIX 5. Home page for TV ads produced by the Regional Stormwater Protection Team (RSPT) in Fall 2004. These TV spots and additional radio spots will be aired in Spring 2005 to coincide with the snowmelt runoff.

APPENDIX 6. Example of mini-lessons (data vignettes) using automated stream monitoring unit data

The following plots and slides were developed to illustrate how transient runoff events from summer rainstorms, from autumn snowstorms, and from spring runoff can cause dramatic effects on water quality and potentially aquatic organisms. The rainstorms in summer caused sharp increases in stageheight and flow, and turbidity, but EC25 decreased due to dilution. On occasion there were also significant increases in stream temperature. The snowstorms led to little if any change in stageheight and flow or turbidity but caused a dramatic increase in EC25 due to meltwater enriched with roadsalt. Spring runoff leads to greatly increased flows, increased salt (EC25 exceeded the criterion for brook trout for several weeks in Tischer Creek in 2004) and increased turbidity from suspended sediment. Greatly increased stormwater runoff also usually coincides with greatly increased sewage treatment plant discharge and sometimes sanitary sewer overflows because of widespread inflow and infiltration problems.

APPENDIX 7. Example lesson developed for Washburn Edison Middle School Stream Elective science class. The context was that the class had been collecting stream invertebrate data in the spring plus limited chemical and physical data. *DuluthStreams* staff worked with the class to implement an intensive spring and fall monitoring program for transparency and EC25 in order to “capture” episodic stormwater and snowmelt runoff events. The data were also submitted to the *National Water Monitoring Day* website and the school now has joined the St. Louis RiverWatch program. These slides summarize class data for 2002-2003 and compare them to the automated sensor data set that is located <1 mile downstream.

Appendix 8. Regional Stormwater Protection created as an expansion of the *Duluth Streams Partnership* including *Memorandum of Understanding*

<p>City of Duluth (218)730-4130 mlonsdale@ci.duluth.mn.us</p> <p>City of Hermantown (218)729-3600 llander@hermantownmn.com</p> <p>City of Proctor (218)624-3641 cityhall@ci.proctor.mn.us</p> <p>City of Superior (218)394-0392 hancocks@ci.superior.wi.us</p> <p>Duluth Township (218)525-5705 jcook@ci.duluth.mn.us or duluthtp@aol.com</p> <p>Facilities Management University of Minnesota - Duluth (218)726-8261 crichar1@d.umn.edu</p> <p>Fond du Lac Band of Lake Superior Chippewa Reservation (218)878-8022 richardgitar@fdlrez.com</p> <p>Lake County, Minnesota (218)834-8321 dick.sigel@co.lake.mn.us</p> <p>Minnesota Department of Transportation (218)723-4840 todd.campbell@dot.state.mn.us</p> <p>Minnesota Pollution Control Agency (218)733-2358 chris.butler@pca.state.mn.us</p>	<p>Minnesota Sea Grant University of Minnesota - Duluth (218)726-8106 chagley@umn.edu</p> <p>Natural Resources Research Institute <i>Duluth Streams</i> group University of Minnesota-Duluth (218)720-4279 duluthstreams@nrri.umn.edu</p> <p>Nonpoint Education for Municipal Officials (NEMO) Northland NEMO at Minnesota Sea Grant University Minnesota - Duluth (218)726-6182 jschombe@d.umn.edu</p> <p>U. of Wisconsin-Superior (218)394-8525 SOHallor@staff.uwsuper.edu</p> <p>St. Louis County (218)625-3830 ulringj@co.st-louis.mn.us</p> <p>St. Louis River Citizens Action Committee (218)733-9520 slrcac@stlouisriver.org</p> <p>South St. Louis Co. Soil & Water Conservation District (218)723-4867 info@southstlouisswcd.org</p> <p>Western Lake Superior Sanitary District (218)740-4806 joe.stepun@WLSSD.Duluth.MN.US</p> <p>Wisconsin Department of Natural Resources (715)392-7988 jerecj@dnr.state.wi.us</p>
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MEMORANDUM OF UNDERSTANDING
to establish a
REGIONAL STORMWATER PROTECTION TEAM

A. INTRODUCTION

This Memorandum of Understanding (MOU) formalizes coordination of the Regional Stormwater Protection Team (RSPT), an information networking task force of agencies and jurisdictions including, but not limited to the signatory entities listed on page three.

The RSPT mission is to protect and enhance the region's shared water resources through stormwater pollution prevention by providing coordinated educational programs and technical assistance. Team members are committed to preventing and resolving issues of mutual concern for environmental protection on a regional watershed scale. This commitment is reinforced by policies internal to each agency. To sustain long-term commitment, the signatories agree to establish and implement the Interagency Stormwater Pollution Prevention Initiative described herein.

The goals of this initiative are to foster stormwater pollution prevention as the preferred environmental protection strategy within local and state agencies and to support and promote similar efforts within the private sector and at the community level. Benefits of working together include offering a focal point for pollution prevention, reducing expenses by sharing knowledge and resources, minimizing duplication of effort and increasing grant application success, all of which will help significantly enhance the protection of Lake Superior, the Duluth-Superior Harbor and all their tributaries.

In the spirit of these objectives, the agencies represented by the signatories on this document agree to maintain a cooperative working relationship to promote stormwater pollution prevention.

This MOU does not create enforceable legal obligations, but rather is an expression of intent by the signatories to work with one another as partners to reduce stormwater pollution.

Nothing in this agreement is intended, nor shall it act in any way to alter, impede, or interfere with the authorities and procedures of the agencies involved in carrying out their regulatory and law enforcement responsibilities or their individual missions.

B. PURPOSE

Through this document, the members of the Regional Stormwater Protection Team establish a common agenda to work together on pollution prevention objectives and specific goals in a cost effective and consistent manner. Successful implementation of this collaboration effort will help to:

1. Incorporate stormwater pollution prevention measures into local jurisdiction and agency programs and planning;
2. Avoid a piecemeal approach to stormwater pollution prevention and program development;
3. Share resources for stormwater pollution prevention projects;
4. Enhance efficiency in the delivery of prevention services;
5. Provide consistent regional environmental messages;
6. Improve communication and interrelationships between agencies and local jurisdictions;
7. Support existing agency missions and partnership agreements;
8. Reduce stormwater peak flows and pollutant loads within the Western Lake Superior Watershed.

C. AREAS OF AGREEMENT:

The signatories agree to promote stormwater pollution prevention and pursue issues of mutual concern. In particular, the parties will strive to:

1. Seek opportunities to collaborate on stormwater pollution prevention projects of mutual interest, to demonstrate pollution prevention technologies and techniques.
 - a. Stage periodic environmental show and tell events,
 - b. Develop educational materials and co-sponsor workshops focused toward specific audiences,
 - c. Develop an information clearinghouse,
 - d. Identify areas where policies conflict and may need to be revised to achieve goals,
 - e. Develop collaborative grant proposals.
2. Share, exchange and learn stormwater pollution prevention technologies and techniques through periodic meetings and joint training programs.
 - a. Share strategies and progress in implementation,
 - b. Provide relevant technology updates,
 - c. Participate in environmental roundtable discussions,
 - d. Share innovative ideas.
3. Demonstrate watershed-wide environmental leadership in stormwater pollution prevention.
 - a. Promote stormwater pollution prevention through press releases and other interpretive programs conducted by participating agencies,
 - b. Enhance watershed-wide efforts to increase communications and education about the importance of stormwater pollution prevention.
4. Seek opportunities to eliminate or reduce stormwater pollution and encourage use of efficient pollution prevention technologies and techniques.
 - a. Identify root causes of stormwater pollution and take steps to reduce or eliminate wastes through stormwater pollution prevention techniques,
 - b. Identify and overcome barriers to adoption of stormwater pollution prevention practices,

- c. Educate the general citizenry about stormwater pollution prevention through formal and informal education.
5. Cooperate in evaluating stormwater pollution prevention.
 - a. Evaluate needs and goals of participating agencies,
 - b. Determine what information is required to meet goals and needs,
 - c. Measure progress in reducing stormwater pollution.
 6. Develop and demonstrate environmentally benign and beneficial alternatives to current non-sustainable practices.

D. ORGANIZATION STRUCTURE (see Attachment A)

Each participant shall designate at least one contact to monitor pollution prevention coordination activities within their singular jurisdiction. These individuals shall provide input to the RSPT on the initiative. The RSPT will oversee the development and implementation of the interagency initiative to facilitate communication and coordination on stormwater pollution prevention.

The RSPT meets regularly. All ideas are encouraged and welcome. Appropriate projects, workgroup formations, and courses of action are determined by a consensus of the members.

E. CHANGES TO THE AGREEMENT:

Amendments or additional appendices may be developed and implemented by mutual written agreement of the signatories at any time without renegotiating the entire MOU. A party may also terminate its participation in this agreement after providing 30 days written notice to the other parties.

F. EFFECTIVE DATE OF AGREEMENT:

This agreement is effective April 1, 2004 and will remain in effect for all parties unless and until they choose to formally terminate.

G. SIGNATORIES

Herb Bergson, Mayor	City of Duluth	Date
Richard Kieren, Mayor	City of Proctor	Date

David Allen, Mayor	City of Hermantown	Date
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Dave Ross, Mayor	City of Superior	Date
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Marcus Hall, Public Works Director	St. Louis County	Date
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George Sundstrom, Chairperson	Duluth Township	Date
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Earl Elde, Chairperson	Midway Township	Date
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George Andrews, Chairperson	Rice Lake Township	Date
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Todd Campbell, District Hydraulics Engineer	MN Dept. of Transportation	Date
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Suzanne Hanson, Duluth Manager	Minnesota Pollution Control Agency	Date
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Sue O'Halloran, Water Quality Specialist	Lake Superior Research Institute University of WI, Superior	Date
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Greg Fox, Vice Chancellor Finance & Operations	University of MN-Duluth	Date
<hr/>		
R.C. Boheim, Manager	South St. Louis Soil and Water Conservation District	Date
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Kurt N.W. Soderberg, Western Lake Superior Sanitary Dist. Date
Executive Director

Robert B. Peacock, Fond du Lac Reservation Business Date
Chairman Committee

Carl Richards, University of MN Sea Grant Date
Director

Lucinda Johnson, Center for Water and the Environment Date
Associate Director Natural Resources Research Institute
University of Minnesota-Duluth

Duane Lahti Wisconsin Department of Natural Date
Resources

Lynelle Hanson St. Louis River Citizens Action Date
Committee

Attachment A

BY-LAWS

Regional Stormwater Protection Team Operational Structure

The Regional Stormwater Protection Team shall work in the following areas:

I. Data collection and analysis

- A. Develop and maintain regional audiences' mailing lists and list of groups, organizations and trade associations.
- B. Develop and maintain a measurement system that analysis and assays outreach and communication efforts.

II. Outreach

- A. Develop a joint stormwater pollution prevention message and share it with companies, organizations, associations and the general citizenry.
- B. Develop and maintain educational materials to achieve awareness and compliance on a cooperative basis from citizens and businesses.

III. Communication

- A. Meet monthly to discuss stormwater pollution prevention issues facing the region.
- B. Communicate status of local, regional, state or national activities.
- C. Communicate on the status of specific regulatory decisions to the extent such decisions affect development of a regional stormwater pollution prevention management system.
- D. Develop technical assistance roundtable discussion groups.
- E. Share information about current and planned written materials.
- F. Develop additional relationships with related groups and organizations.

IV. Organization

- A. Chairperson: This position will serve no less than 12 months and is responsible for organizing and leading meetings.
- B. Vice Chair: This position will serve no less than 12 months and will prepare to serve as chair for the following 12 months.
- C. Fiscal Agents: Fiscal Agents identified in each successful grant application will prepare and present periodic fiscal statements to the Team.
- D. Note taker: This position will serve on a monthly basis and is responsible for keeping and distributing meeting minutes.