Minnesota Pollution Control Agency
520 Lafayette Road
St.Paul, MN 55155-4194

319/Clean Water Partnership/ Total Maximum Daily Loads

Semi-Annual Report for Reporting Year 2008

Reporting Period: ☐ January 1 through June 30, 2008 (Due August 1, 2008)
☒ July 1 through December 31, 2008 (Due February 1, 2009)

All information is required by U.S. Environmental Protection Agency (EPA). Do not leave blanks. This report form can be typed using your computer. Use the "**tab**" key to move through the fields of this form. Enter responses using text and check boxes as indicated. Keep a copy for your records.

I. General Report Information

1.	Project Title:	Duluth Residential Stormwater Reduction Demonstration Project for Lake Superior Tributaries		
2.	Project Sponsor:	City of Duluth/Utility Operations		
3.	Project Representative:	Chris Kleist		
4.	Email Address:	ckleist@duluthmn.gov		
5.	Loan Sponsor (if applicable):			
6.	Contract Number:	B10575	Loan Number:	
7.	MPCA Project Manager:	Karen Evens		
8.	Contract Start Date:	2-27-2008	Contract End Date:	6-30-2011
9.	Best Management Practice (BMP) Name (Refer to BMP List):	570, 912		
10.	**319/Clean Water Partnership (CWP) only** - Nonpoint Source (NPS) Category (Refer to NPS Definition of Categories):			
		Primary	**Secondary**	**Others**
	Category			
11.	**319/CWP only** - NPS Functional Category (Refer to NPS Definition of Categories):			
		Primary	**Secondary**	**Others**
	Category	**20**	**600**	
12.	Waterbody type (refer to NPS Waterbody Type):	**ST**		
13.	Hydrologic unit code (8 digits):	04010102	Latitude-longitude:	**46’50’’11’’’ x -92’00’’22’’’**
14.	**319/ CWP only:** Type of pollutant(s) addressed (refer to NPS Pollutants):	**1500**		
15.	Ecoregion (refer to NPS Ecoregion):	**5000**		

16. Basin name (check all that apply): Statewide

- ☒ Lake Superior
- ☐ Lower Mississippi/Cedar
- ☐ Upper Mississippi
- ☐ Minnesota
- ☐ Rainy
- ☐ Red River
- ☐ Des Moines
- ☐ Missouri
- ☐ St. Croix

II. Project Description

1. Project Description Summary (taken from work plan summary) – Include at least two paragraphs that briefly summarize the project scope, the processes and the events that occurred **before** this reporting period.

We propose to demonstrate the effectiveness of residential Best Management Practices (BMPs) at reducing stormwater runoff problems for Lake Superior tributaries. We will install residential BMPs in a subwatershed in an older residential neighborhood and compare the runoff to that of a similar control subwatershed without stormwater BMPs. The neighborhoods identified for the program are located in the Lester-Amity stream system that is on the Minnesota 303(d) list for turbidity. Tributaries receiving the runoff from the targeted neighborhoods/subwatersheds are being severely eroded by high peak flows and deliver highly turbid water to the stream. Water flow, temperature, and turbidity measurements will be taken within storm sewers in both subwatersheds before and after BMP installation, requiring *three* full field seasons of work. Flow, temperature, and turbidity data from storm sewer flow will be posted and interpreted on the educational Lake Superior Streams website, as will final results. Resident knowledge of runoff issues, solutions, and responsibilities will be evaluated at the beginning and end of the project. Results from this demonstration project should be applicable throughout the Great Lakes.

Both Lester River and Amity Creek are on the Minnesota 303(d) list for excessive turbidity. Other Lake Superior North Shore and South Shore streams, and streams elsewhere around the Great Lakes, face a similar problem. In the western arm of Lake Superior, streams nearing the lake often cut through clay soils. These highly erodable soils are particularly vulnerable to excessive stream power caused by high levels of runoff during heavy rainstorms and snowmelt (Anderson et al. 2003). Runoff from residential neighborhoods helps to create these high peak flows, leading to the erosion that creates turbidity in Amity Creek and similar stream systems. Recently, the runoff problem was inadvertently exacerbated in Duluth as residential footing drains were disconnected from the City's sanitary sewer system, as required, and sump pumps were installed discharging water to yards and ultimately to the stormwater sewer system. This resulted in an additional 10-20 gallons of water potentially entering the storm sewer system per minute per household during heavy rains (15,000 – 30,000 gal/hr for a 25-home neighborhood). City staff report many complaints from residents about wet yards and winter icing from sump pump activity. The City is seeking an effective program for addressing this nuisance ponding at the source, and reducing flows to the storm water system and winter icing problems.

The project proposes to look at alternate BMPs for residential use as well as the more familiar rain garden, recognizing that small residential lots and short northern summers deter many residents from attempting the rain garden solution. The project will identify alternatives for smaller spaces, with less maintenance and lower cost. The information gathered from the pilot installation of BMPs will be used to encourage other residents to adopt similar solutions to address nuisance ponding and reduce loadings to storm sewers by retaining runoff and increasing infiltration at the source.

The Amity Creek tributary under consideration for the proposed project runs turbid during storm events, and has severely eroding banks and gullying due to excessive runoff received from adjoining neighborhoods' storm sewers. Excessive runoff, and the associated sediment caused by the increased erosion, often carries greater loads of nutrients and chloride into streams (Anderson et al. 2003). In Duluth, total runoff infiltration is not feasible, so this project is directed at reducing high intensity flows, primarily by retention with some increased infiltration. We will demonstrate that runoff retention BMPs implemented at the residential level can reduce storm sewer peak flows. The project will also document the challenges and solutions to retrofitting older residential areas (50-100 yrs old) with runoff BMPs. The end result will reduce runoff/footing drain discharge within a problem subwatershed and create a demonstration project for other Lake Superior and Great Lakes communities.

The project began Feb. 27, 2008. Prior to this, the project leaders met with the Minnesota leaders of the 319 SIDMA Social Indicators Evaluation project. These researchers are assisting EPA in developing an evaluation survey tool to help document improvements in knowledge and awareness by the public in areas where 319 programs are active. Our project was selected as a test case; several of us helped beta-test the SIDMA software and survey system; later, two different survey types were developed and administered as pre-BMP installation surveys: the KAP survey given door-to-door by a Minnesota Conservation Corps college crew and the EPA SIDMA survey at a neighborhood meeting. The door-to-door survey was very successful, with a 72% response rate.

Monitoring equipment (flow, temperature, conductivity, and turbidity) was installed in the two neighborhood storm sewer systems in April and was kept in place until the ground began freezing in November. Snowmelt runoff data were captured, as well as several spring storm events. Two volunteers willing to read rain gauges were found near the target neighborhoods and provided with rain gauges, monitoring instructions, and data collection spreadsheets.

2. Specific Project Goals – Include numeric, quantifiable goals for environmental improvement, the number of Best Management Practices to be installed, **pollutant reductions** as well as programmatic and social goals.

We are using paired subwatersheds (neighborhoods) of Amity Creek to demonstrate the effectiveness of homeowner BMPs to reduce residential stormwater and footing drain water to storm sewers. The resulting data will be interpreted on an existing stream education website and used to educate neighborhood, City of Duluth, and regional residents on stormwater issues, individual responsibility, and BMP options. Flyers and training materials developed in the course of this project will be used by the City, Minnesota Sea Grant, and other local agencies and groups to inform area residents about stormwater issues and BMP choices that individuals can implement. All of these activities will result in reduced stormwater inflow to storm sewers.

- We will install as many residential stormwater runoff reduction BMPs as the grant can afford and homeowners in the target neighborhood will accept – the target is at least a dozen homes accepting a BMP.
- The project will result in a measurable increase in the knowledge and understanding of neighborhood residents about stormwater runoff issues, environmental problems, and ways that they can help solve the problem (i.e., increase in individual responsibility).
- We expect that the stormwater flow will be measurably reduced in the storm sewers of the target neighborhood. These storm sewers flow into a local 303d-listed stream, Amity Creek.

- The ability of the Regional Stormwater Protection Team members to cooperate and collaborate on stormwater runoff reduction issues will be substantially increased by their collaboration on this project, making future projects both more likely and easier to initiate.

III. Semi-annual Report Information

1. Project activities completed during last six (6) months according to the program elements or tasks:

Objectives A and B: Installation of Monitoring Equipment and Collection of Baseline Stormwater Data:
Flow monitors and Hydrolab units that record flow volume, temperature, turbidity, and conductivity were installed in the two storm sewers draining the control and target neighborhoods from April through early November. Collection of the pre-BMP storm sewer flow and temperature data was quite successful, and the high number of rainstorms this spring and summer provided an interesting pre-BMP dataset. The two neighborhoods are fairly well matched in terms of runoff amounts. However, season and apparently the amount of soil saturation make a large difference in the amount of runoff coming through storm sewers. For example, rainfall events in the spring and early summer, or following another rainstorm, result in high amounts of runoff, while similar amounts of rain in mid-to-late summer and after a dry spell result in much lower runoff amounts (see Figure 2 at end of report). We are exploring ways to help control for these confounding effects in the dataset by categorizing runoff events depending on season and the number of days since a previous rainfall.

Two volunteer rain gauge readers provided rainfall data throughout the spring, summer, and fall. These data were compared to the City of Duluth's automated rain gauge installed a mile or so from the study area (and several hundred feet lower down by the lake). In most cases, the rainfall amounts were similar for storm events, but in one or two cases there were differences.

Objective D: Select Target Neighborhood
All residents of both neighborhoods and the intervening street (the street between the two neighborhoods included in the study) were invited to a neighborhood meeting in early September. At this meeting had the residents take and provide feedback on the SIDMA survey. The SIDMA survey, with its locked choice of questions, was not a good fit for our small project, taking a long time for folks to fill out and providing our research team with little of the information that we really wanted to get from residents. The main goal of the meeting, however was to provide the residents with a description of the project and information about the potential BMPs that we will be offering to the street that is chosen as the treatment street. Surprisingly, the street showing the most interest was the one we had not considered because its storm sewer pipes are a slightly different configuration than the other two streets. The meeting went well, although it was attended by only about a dozen residents (out of more than 70 households invited). And we were left to re-consider which streets could be selected to receive the BMPs.

After walking all three streets with an engineer from Barr Engineering who does residential stormwater reduction work in neighborhoods in the Minneapolis area, we decided that the middle street (Idlewild) would work best as the treatment street after all (this is the street that we had NOT previously thought would be an option, but whose residents showed the greatest amount of interest in participating in the project because they truly had runoff problems). We immediately installed monitoring equipment in the storm sewer to catch the fall rains, and will reinstall the equipment in April to catch snowmelt and spring storms. This should provide us with sufficient preinstallation data.

In October, we canvassed the treatment street to sign up residents willing to work with us. We are also including residents on the downhill side of the upper street (Kingston) because the water from their properties drains down onto the treatment street (using a bit more of a drainage area approach than just strictly going by streets). So far, 18 households are willing to consider BMPs, with only two households turning us down, two still considering, and two that we have not been able to contact. We will continue working with the willing households in the spring, concentrating on those who have the worst water problems and whose properties contribute the most to the runoff problem.

Objective E: Design property-specific BMPs
Engineers from South Saint Louis Soil and Water Conservation District and Barr Engineering have visited over half of the properties whose owners have indicated an interest in participating in the project. They have come up with a number of BMPs that have potential, including work on a ditch that drains runoff in the backyards between the streets, locations for rain gardens, areas in which tree and shrub plantings would be beneficial, driveways in need of trench drains that lead to rain gardens, and rain barrels. In the next few months (before spring), we will list specific BMPs for each property and discuss these options with the property owners in preparation for BMP construction in mid-summer.

2. Challenges faced (optional):

- More sand, sediment, and debris are moving through the storm sewer pipes than we expected, burying the monitoring probes at times. This has resulted in a need for more frequent equipment care than was anticipated, causing higher personnel costs for monitoring than we projected. This has also caused the chloride and turbidity data to be quite compromised. On the other hand, it provides a good teaching opportunity for us to talk to the residents about keeping the storm sewers clean.
- Neither of the two streets originally targeted for potential BMP installation proved to be ideal. Instead, the intervening street was deemed to both have more interested residents and to have more potential for stormwater runoff reduction BMPs to have a significant effect. Therefore, we installed monitoring equipment in the intervening street in September to catch the fall storms for pre-installation data, and will reinstall the monitoring equipment in the spring of 2009 to catch the spring runoff and storms to collect further pre-installation data.
- Administratively, the Expenditure Report is in a form that is very difficult for the University and the Project Manager to complete, and it may be impossible to make the amounts exactly match those that are invoiced. However, detailed monthly invoices are submitted by the University of Minnesota's Sponsored Projects Administration office and detailed personnel effort

records are maintained by the University and NRRI based on bi-monthly (2 week) reporting intervals.

3. Summary of monitoring data collected:

Table 1. Preliminary storm sewer flows from two of the monitored streets in the study neighborhoods for the ice-free season of 2008. These figures have not been weighted by drainage area.

	Rain amount (inches)	Newer St. storm sewer flow (gal)	Older St. storm sewer flow (gal)	Ratio Older st.: newer st.
April	1.6	219,470	676,183	3.1
May	1.9	277,310	470,295	1.7
June	2.8	420,739	655,171	1.6
July	2.3	95,015	124,885	1.3
August	1.5	151,581	85,450	0.6
September	4.2	304,480	474,455	1.6
October	1.6	97,079	254,370	2.6
Season to date	16	1,565,674	2,740,809	1.8

Table 1 shows storm sewer flow data for the ice-free season of 2008 for two of the streets in the neighborhoods. The older street typically contributes more stormwater, in general, during rainstorms, but these data have not yet been weighted by drainage area, which is the next step. As expected, the amount of water entering storm sewers depends on the dryness of the soil, so that rain events shortly after snowmelt result in greater storm sewer flows than rain events that occur later in the spring and summer after the soils have dried.

Note: Data are collected in residential stormwater sewers and thus are not appropriate for the STORET system. Therefore these data are not being submitted to STORET, but will be made available on request to interested parties.

4. Have all monitoring stations been established in STORET? ☐ Yes ☒ No

5. Are the data being routinely submitted for storage into STORET? ☐ Yes ☒ No Last submittal date:

6. Are the data being annually entered into E-Link? ☐ Yes ☒ No Date last entered:

7. Identify any significant **findings** and **results** of the project to date, as well as any unanticipated findings:

Flow data were collected with reasonable ease during the ice-free season. The streets are generating reasonably comparable amounts of runoff and the runoff pattern is quite similar for the two streets. However, the amount of runoff is greatly influenced by season and time since the last significant rain event. We interpret this as a soil moisture effect, with much greater runoff occurring when soil moisture levels are high and the ground cannot hold much water. This is good news, indicating that there may be more potential for infiltration than we had first thought. However, it will make data analysis more difficult because it means that the amount of runoff from a one-inch rainstorm may vary by 4 or more times depending on soil moisture levels. We are investigating statistical and modeling ways to deal with this analysis issue. See Table 1 for a summary of stormwater runoff from two of the streets during the ice-free season.

Temperature data were also reliably collected from the storm sewers during runoff events. Unlike the flow data, there was sometimes a large temperature difference in the summer between the two streets, with the runoff from the older and more shaded street being more than 5 ºC cooler than the runoff from the newer and almost completely unshaded street (see Figure 3 at end of report). We will be able to use these data to demonstrate the benefits of street shading in helping to keep runoff cool, and thus helping to keep our local streams cooler during summer rainstorms.

8. Describe specific (quantifiable, if possible) results achieved during this period:

Flow, temperature, turbidity, and conductivity monitoring devices were successfully installed in two storm sewer pipes and quantitative stormwater runoff and stormwater temperature data were collected from April to November.

Eighteen of 24 households asked have agreed to consider having BMPs installed on their properties. Ten of these properties have been visited by engineers, who have created recommendations of the most appropriate BMPs.

9. Summarize any work plan changes:

After the work plan was written, but prior to the start of the contract, the project team realized that one of the two proposed locations was not as appropriate for this work as previously thought. Since only one location was to be selected, the inappropriate location was dropped from consideration at that time and all efforts have since focused on the Lakeside neighborhoods.

During the organizational meeting, the project team expressed doubt about installing BMPs at the neighborhood school because that school is now on a list for closure and much of the school grounds do not drain into the storm sewers that are being monitored. Instead, we will focus on installing more BMPs in the target neighborhood, the middle street (Idlewild St.).

10. List anticipated activities for next six (6) months:

Objective E: Design Property-Specific BMPs:

We will continue with the property-specific BMP designs for the rest of the households interested in the project. We will meet with these property owners to select BMPs to install and appropriate choices for plantings, etc. This will allow the ordering of materials early in the spring so that BMP installation can begin when the ground dries out this summer. BMPs may include rain gardens, rain barrels, swales, rock-filled infiltration basins, dry creek beds, etc.

Objective F: Conduct BMP Training Workshop

We will prepare training materials for the MCC crews working with us this summer on BMP installation, and for interested local landscaping companies that would like to learn more about BMPs. BMP installation training will be done in conjunction with the start of BMP installation, and will be repeated as necessary if MCC crews switch out during the weeks of BMP installation/construction.

Objective J: Education, outreach, and evaluation

We are designing web pages for the Lake Superior Streams website that will inform the public about the project and will allow us to more easily keep neighborhood residents up-to-date on it. We will post data from the project on this website, as well as sample and summary results that are explained for the general public. As we build and install BMPs, pictures and information about them will also be featured in the Design Toolkit section as case studies. We are also developing some of the storm runoff data into "vignettes" that feature animated graphs to illustrate the flow through the storm sewer from the neighborhoods.

11. List all products (documents, pamphlets, videos, maps, etc.) produced in this reporting period.

We have created a number of presentations about this project, the BMP options, and our results thus far. We have also created a couple of handouts about the project and BMP options as well as collecting handouts on BMPs from a number of other organizations around the state and nation. Maps of the neighborhood area showing storm sewer flow direction have been created (see Figure 4 at end of report).

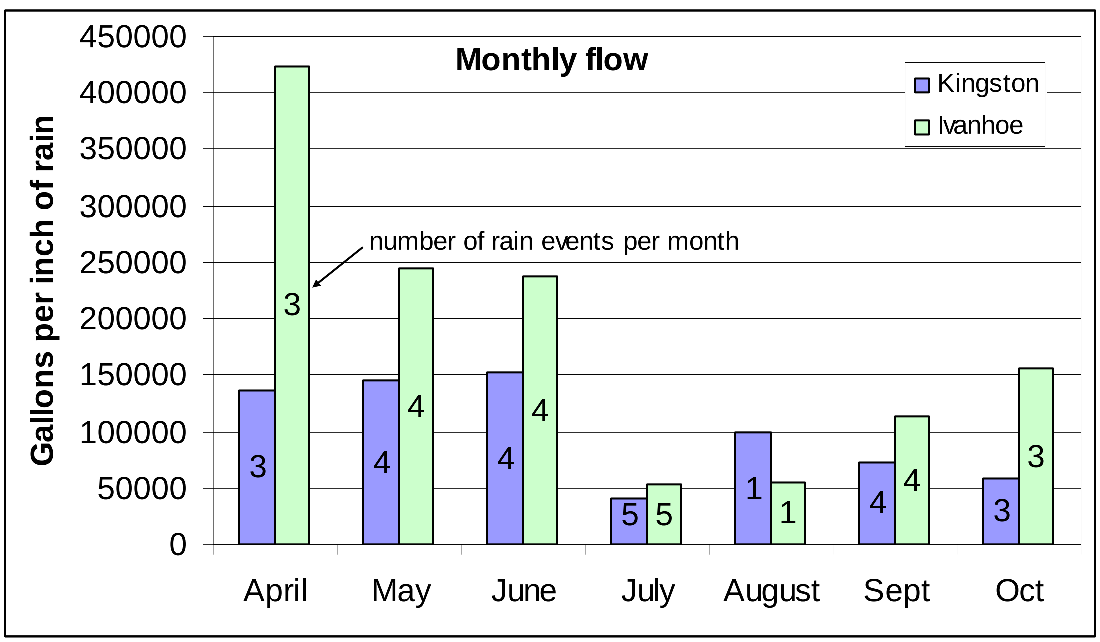
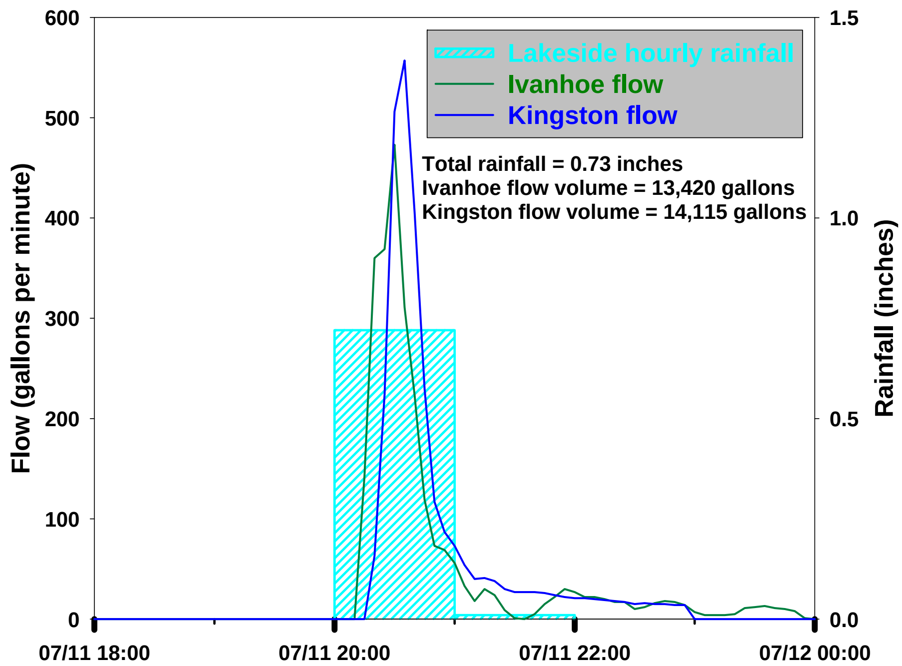


Figure 1. Storm sewer flow data from two of the streets in the study neighborhood for the ice-free season of 2008. Kingston Street is newer and further up the hill than Ivanhoe, which is a quite a bit older street. Kingston Street generates more flow overall, but these figures have not yet been adjusted for drainage area.



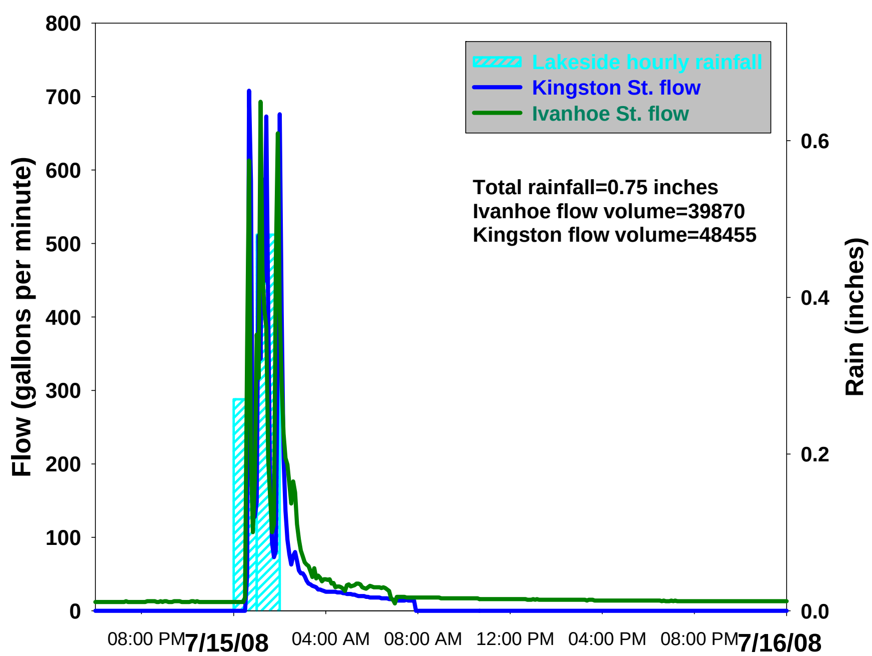


Figure 2. Two rainstorms occurring in close succession in July illustrate the influence of the ability of the soil to store runoff. In the top graph, ¾ inch rain fell in about an hour, generating less than 15,000 gals of runoff from each street. In the bottom graph, four days later another ¾ inch rain falls in just an hour or two but generates roughly 40,000 gals of runoff (or more) from the same streets.

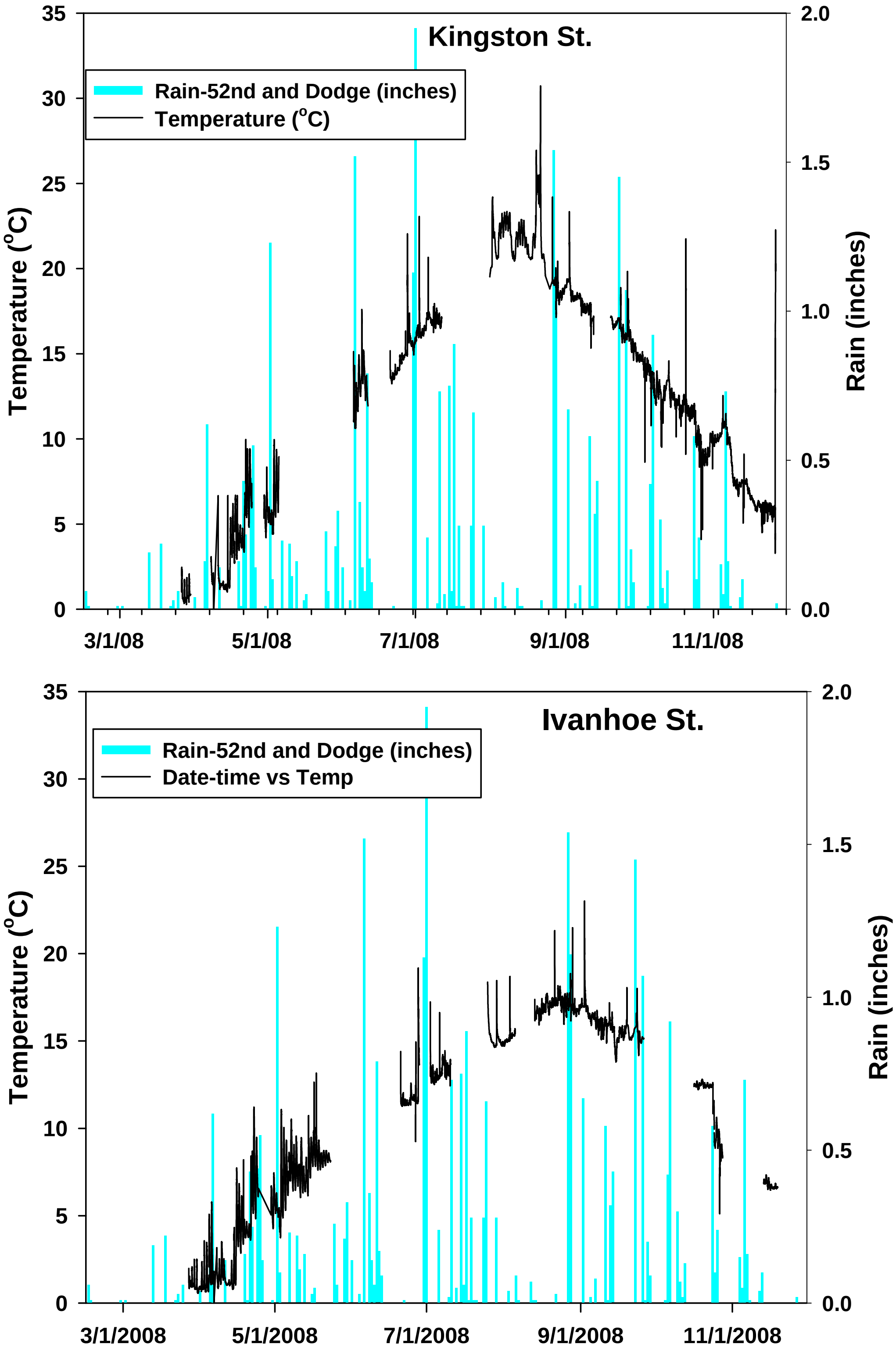


Figure 3. Temperature of stormwater runoff across the ice-free season in the storm sewers superimposed on storm events. The street in the upper graph is newer, has darker blacktop, and very little street and yard shading compared to the street in the lower graph. This may be what contributes to a 6-7 ºC lower storm sewer water temperature for Ivanhoe St.

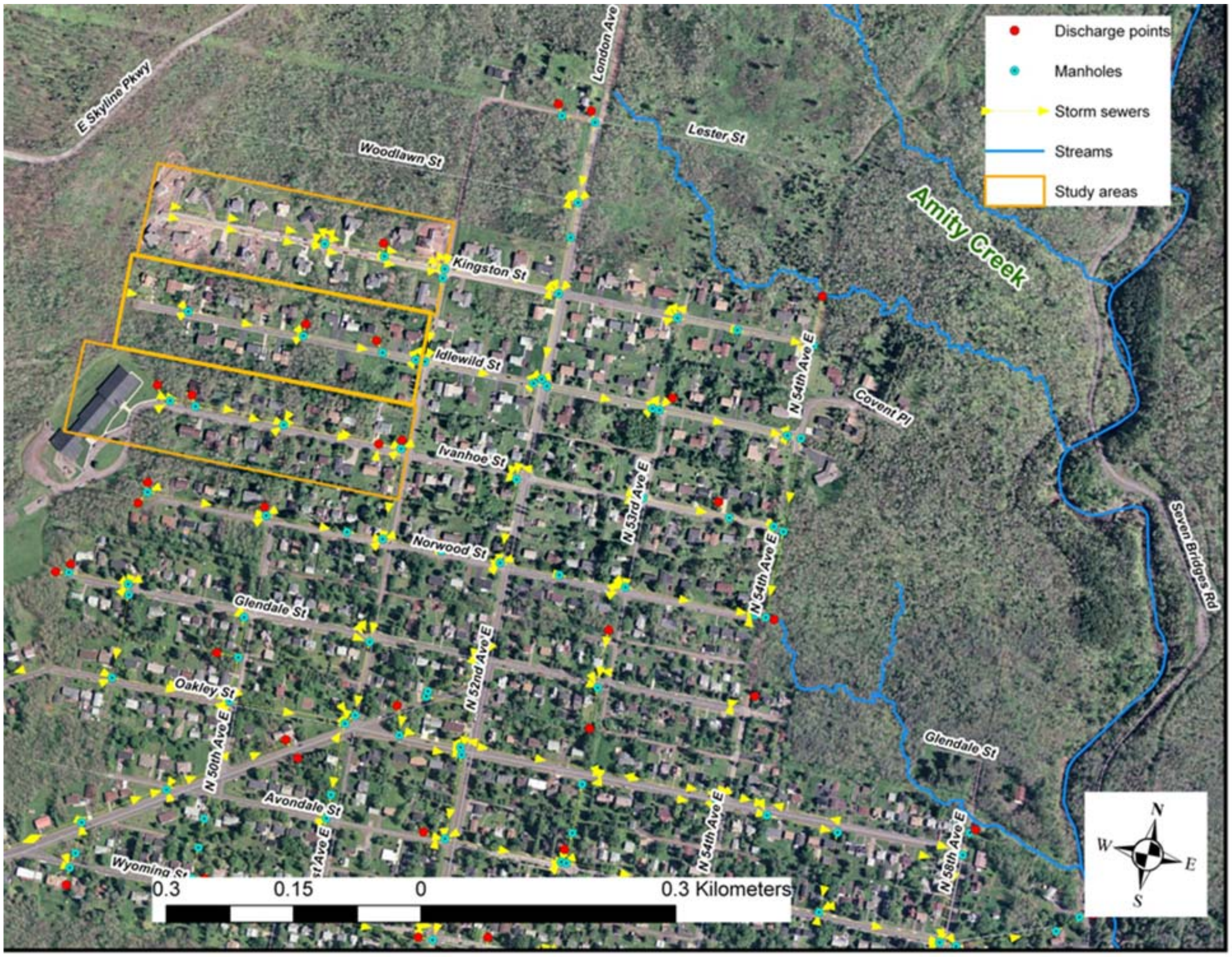


Figure 4. Aerial photograph of study neighborhoods (outlined in yellow) near Amity Creek and its tributaries. Yellow arrows show the direction of storm sewer flow, and blue and red dots indicate flow points and manholes into the storm sewers.