Prior Lake Stormwater Management & Flood Mitigation Study

Prepared for
Prior Lake-Spring Lake Watershed District and the City of Prior Lake

December, 2016

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Certifications

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the state of Minnesota.

	December 6, 2016
Gregory John Wilson	Date
PE #: 25782	

Acronyms

Acronym	Description
BWSR	Board of Water & Soil Resources
CAC	Citizens Advisory Committee
FEMA	Federal Emergency Management Agency
FIS	Flood Insurance Study
HSEM	Homeland Security and Emergency Management
LAC	Lakes Advisory Committee
LiDAR	Light Detection and Ranging
MSL	Mean Sea Level
MnDNR	Minnesota Department of Natural Resources
MnDOT	Minnesota Department of Transportation
MPCA	Minnesota Pollution Control Agency
NRCS	Natural Resources Conservation Service
NWL	Normal Water Level
OHW	Ordinary High Water
PLOC	Prior Lake Outlet Channel
PLSLWD	Prior Lake-Spring Lake Watershed District
SMSC	Shakopee Mdewakanton Sioux Community
TAC	Technical Advisory Committee

Glossary

Term	Definition
Access	Used to describe extent to which vehicles can safely pass through flood waters to reach residences and business
Flashiness	Refers to flow rates that quickly rise (and fall) to higher peak levels, with increasing likelihood for flooding
Improved habitat	Describes wetland conditions that mimic natural wetland benefits for waterfowl habitat
Normalized peak discharge	Peak discharge rate (in cfs) at a point in the watershed divided by its total drainage area (in acres)
Upper Watershed Storage	Any storage area upstream of the Spring Lake and Prior Lake basins

1.0 Executive Summary

1.1 Introduction

In the spring of 2014, the Prior Lake watershed experienced record amounts of precipitation which led to a historic flooding event. This event triggered many questions and highlighted the need to develop watershed modeling and evaluate flood mitigation strategies for future events. Prior Lake-Spring Lake Watershed District (PLSLWD) and the City of Prior Lake, in collaboration with Spring Lake Township, retained Barr to complete this study which includes calibrated modeling of the watershed, review of flood-related issues and projects, identification and evaluation of a suite of potential flood reduction strategies and implementation plan recommendations. The study work also included a public input process that has engaged a broad range of stakeholders including local units of government, lake associations, the agricultural community and private landowners. Their input was used to guide the development and evaluation of the available flood mitigation options described herein.

The study area included the Prior Lake-Spring Lake watershed upstream of the Lower Prior Lake outlet structure, encompassing approximately 19,000 acres (30 square miles) of land in Scott County, Minnesota with agricultural land predominant in the south and western areas and residential land uses surrounding the study lakes.

Lake levels for Upper and Lower Prior Lakes have historically been one of the most important issues for the community, specifically the residents living around the Lakes, since Prior Lake does not have a natural outlet. In 1978 a Flood Insurance Study (FIS) was completed for Prior Lake, which established the regulatory flood zone around Prior Lake and resulted in the calculated 100-year flood elevation of 908.9 feet mean sea level (MSL). After significant study, public process and agency coordination the establishment of the Prior Lake Outlet and Channel (PLOC) was selected as the first flood mitigation effort by the PLSLWD and the outlet system was first used in 1983. In 1987, an operating plan was adopted for outlet control structure which set operating procedures and allowable discharges. The FIS was updated in 1997, but the modeling did not account for the benefit of the outlet structure because the channel capacity downstream of the control structure and legal constraints with the adjoining communities limit the discharge the City of Prior Lake can pass through the control structure (FEMA, 1997). Beginning in 2004, PLSLWD pursued improvements to the outlet structure of the PLOC which included a fixed weir set at an elevation of 902.5 feet MSL and a slide gate to allow manual discharge of water between lake level elevations of 902.0 and 902.5 feet MSL. The current outlet configuration will not allow the outflow rate to exceed 65 cfs.

Even with the lake outlet in operation, the 2014 flood level of 906.2 feet MSL for Prior Lake is significantly higher than any other flood event since 1915 (PLSLWD, 2003). Without the lake outlet, the 2014 flood level would have been more than 6 feet higher. There is a significant incremental increase in the number of homes that are at risk of flooding for each foot above a lake level of 906.5 feet MSL, while there are linear increases in other types of infrastructure at risk with increasing flood levels.

1.2 Study Goals

The goals of this study were as follows:

1. Update the flood model
2. Compile and review historical studies and projects to summarize efforts already accomplished toward flood damage reduction
3. Identify a universe of flood damage reduction strategies
4. Evaluate the cost/benefit of the strategies and define community goals for flood protection
5. Develop an implementation plan that identifies a suite of projects or mechanisms to reduce flood damage potential

1.3 Community Planning Process

This study included a process for gathering input from the community, including advisory groups, study partners, and decision-making bodies that needed to be part of the process (see Section 4). The following describes the results of the community planning process with the meetings listed in chronological order:

1. Public Kick-Off Meeting—February 19, 2015. This open house format meeting was intended to inform the public of the study goals and objectives, receive input on what they experienced during the 2014 flooding and to obtain their ideas for flood mitigation options. The meeting included specific survey questions to provide feedback, which was also made available on the PLSLWD website.
2. First Advisory Group Meeting—May 7, 2015. This meeting was used to present preliminary modeling results and gather feedback on potential flood mitigation options and the draft criteria for a selection matrix.
3. Second Public Meeting—May 28, 2015. Attendees were provided with a study update, including a summary of the watershed modeling and an overview of the matrix. Thirty attendees (with 18 indicating that they live on the lakeshore, eight in the city, and three in rural areas) completed a survey that rated important factors in selecting a potential flood-mitigation project and their feelings about use of public funding for flood mitigation efforts. The survey results indicated the following:
    a. Water quality was most important factor, followed closely by cost/benefit
    b. Half of the respondents thought it was important, and another 36% thought it was very important that options should protect properties and public roads below the 100-year FEMA flood level
    c. Project readiness was the least important factor
    d. 69% supported use of public money to protect individual homes/businesses
    e. 60% supported increasing property taxes to finance the options
    f. City of Prior Lake has obligation to maintain emergency access to properties
    g. General sentiment that public funds should be used to benefit entire community
4. Farmer Listening Session—February 3, 2016. This meeting was held to gain a better understanding of how farmers were impacted during the 2014 flood event and receive feedback

regarding the proposed flood mitigation. The meeting was hosted by the PLSLWD Farmer-led Council.

5. Second Advisory Group Meeting—February 4, 2016. This meeting was held to gather feedback on the up-to-date information from the analysis of flood mitigation scenarios as well as responding to public policy questions that included:
    a. Should public dollars be used to protect public infrastructure (such as sanitary sewer and water utilities)? There was consensus that this should be maintained
    b. To what degree should access (from streets) be provided during flood events? There was not unanimity on this, except that emergency vehicle access should be maintained
    c. To what degree should public dollars be used to protect or assist in the protection of private property? There was general consensus that it was a government's responsibility to provide access to properties through public rights-of-way, however not necessarily protect the property itself. However, there was not specific feedback on the allowable frequency and duration of access disturbances. Some felt that public dollars should not be spent on specific improvements to private property (such as floodproofing or buyouts) but did support strategies such as upper watershed storage. Some felt that less frequent flooding with a longer period between events was okay, but we should consider protecting homes that get flooded on a greater frequency (such as 25 years).
6. First Joint Policy Group Meeting—February 8, 2016. The policy makers provided direction on the community goals and priorities to be used to complete the study. Those goals and priorities are as follows:
    a. Protection of Public Safety - Maintain emergency vehicle access at all times
    b. Protection of Health and Safety - Protect public utility infrastructure (i.e. sanitary sewer and water distribution)
    c. Maintain traffic flow through the County Road 21 corridor
    d. Maintain access to private properties
7. Second Joint Policy Group Meeting—September 26, 2016. Policymakers met to discuss the preliminary study report and to provide comments on a staff recommendation regarding implementation. The recommendation included strategies to address short-term needs along with longer- term goals to reduce the amount of potential damage from future flooding events. In the short term, the staff recommendation identified two strategies that included more deliberate use of the low-flow gate on the Prior Lake outlet structure and a more coordinated method of deploying temporary flood protection measures. For the longer term, the recommendation included working with willing landowners to secure permanent or temporary areas in the upper watershed where water could be stored to reduce the lake levels and potential damage during future flood events. This would provide flood reduction benefits to both Spring and Prior Lakes and would be implemented incrementally over time. Support by policymakers for upstream storage was limited to working with willing landowners when studying and implementing potential projects.
8. Third Public Meeting—November 16, 2016. Attendees were presented with an update on the study that included the project goals and selected flood mitigation options recommended by

policymakers. The meeting provided an opportunity for the public to ask questions about the study. Information presented at the meeting was also made available on the PLSLWD website.

1.4 Monitoring and Modeling

PLSLWD collected lake stage and stream flow data for several sites within the Prior Lake watershed during the 2014 monitoring season which were used for watershed model calibration. More than seven inches of rainfall fell across most of the watershed between June 15th and the 20th, which contributed to the peak discharge rates observed at all five monitoring sites. The peak Spring Lake elevation occurred three days after the peak discharge rates occurred in the upper watershed, while Prior Lake did not reach its peak flood level until 11 days after the peak discharge occurred in the upper portion of the Spring Lake watershed. The County Ditch 13 watershed, which represents 29% of the Prior Lake watershed, contributed more than 53% of the flow volume that discharged from the Prior Lake outlet in 2014. In addition, watershed yield and peak discharge rates (normalized to drainage area) from the County Ditch 13 watershed were more than 30% higher than any of the monitoring stations used in the model calibration.

Barr created a PCSWMM computer model capable of simulating the complexity of watershed runoff from the various types of land surfaces based on the available climate data, land use/land cover characteristics, soil type, topography and imperviousness, and then subsequently route the runoff through stream and ditch channels as well as storage areas and storm sewer/culverts, including the lake basins based on the physical constraints of the individual outlets and conveyances. Model development and preliminary use included calibration to observed flow rates and lake elevations throughout the watershed for the June-July 2014 flood event and running the model for design events intended to simulate flood levels for the 2, 10, 25, 50, 100 and 500-year return period with Atlas 14 rainfall amounts for the critical duration (30-days) event. The 100-year design event modeling produces higher lake levels (approximately one-foot higher) than the peak levels that were observed in each lake in 2014. However, the predicted flood level for Prior Lake is 1.8 feet lower than the FEMA 100-year elevation of 908.9 feet MSL, as it accounts for the effect of the existing outlet while the FEMA modeling did not. **Analysis of the monitoring and modeling data indicated that enhanced upper watershed storage – particularly in the County Ditch 13 watershed – and better control of peak discharge from the Spring Lake outlet had the highest potential for reducing peak elevations in Prior Lake.** Upper watershed storage is defined as any storage area upstream of Spring Lake and the Prior Lake basins. To have a noticeable effect on the peak Prior Lake elevation, detention storage areas would need to detain water until after Prior Lake had reached its peak.

1.5 Results Summary

Based on feedback from the public a list of flood mitigation options was developed. Each mitigation option was then rated according to its relative merits for criteria that were weighted to correspond with the study objectives and what the public viewed as important factors in selecting potential flood-mitigation options. The results of this analysis showed that improvement options involving upper watershed and Spring Lake storage, sandbagging and modifications to the Prior Lake outlet (including both increased capacity and proactive outlet management) scored highly. The results also indicated that floodproofing and/or buyouts could also be considered as part of the overall solution. As a result of relative comparisons of the merits of the universe of options the flood mitigation analysis was narrowed down to the following seven options:

- Option A—Enhanced Protection (coordinated temporary protection measures)
- Option B—Spring Lake Storage
- Option C—Prior Lake Outlet Modification (increase capacity)
- Option D—Upper Watershed Storage
- Option E—Combine Options B, C & D
- Option F—Floodproofing (for at-risk primary structures)
- Option G—Actively Manage Prior Lake outlet (low-flow gate)

Figure EX-1 shows how each of the potential improvement options are expected to improve the flood impacts for each of the flood frequency events, including summary information pertaining to the total estimated costs and number of primary structures and inaccessible properties at each flood level. **The figure shows that, if the conservative cost estimates for securing Spring Lake drainage easements are accurate, then the Spring Lake storage option will not be as cost effective (from a flood control perspective) as increasing the Prior Lake outlet capacity or increasing upper watershed storage. Options involving an increase to the Prior Lake outlet capacity and increasing upper watershed storage are comparable at cost-effectively controlling flooding on Prior Lake. Upper watershed storage provides better flood control for the larger flood events than any of the other individual options. For the 100-year event, the upper watershed storage option would protect an additional 30-35 primary structures and maintain accessibility to an additional 50 properties.**

Implementing a combination of the first three options would drop the 100-year flood level to within a half-foot of the OHW for Prior Lake (see **Figure EX-1**), which is likely more protection than would be necessary for this event. However, the predicted 500-year flood level for Option E would still approach the high-water level experienced during 2014**. Implementation of some combination of upper watershed storage (Option D), increased Prior Lake outlet capacity (Option C) and actively managing the Prior Lake outlet low-flow gate (Option G)** is expected to meet the study goals in the most cost-effective manner. The biggest limitation of this combination of options is that it may take several years for full implementation. As a result, **it is expected that some combination of Options G and A will need to represent the short-term implementation measures**. **A scaled-down version of Option B, that involves less inundation on Spring Lake and less easement cost, may also represent a more cost-effective and viable short-term implementation measure**. **It is also expected that floodproofing (Option F) and/or buyouts will be a cost-effective measure for the lowest primary structures.**

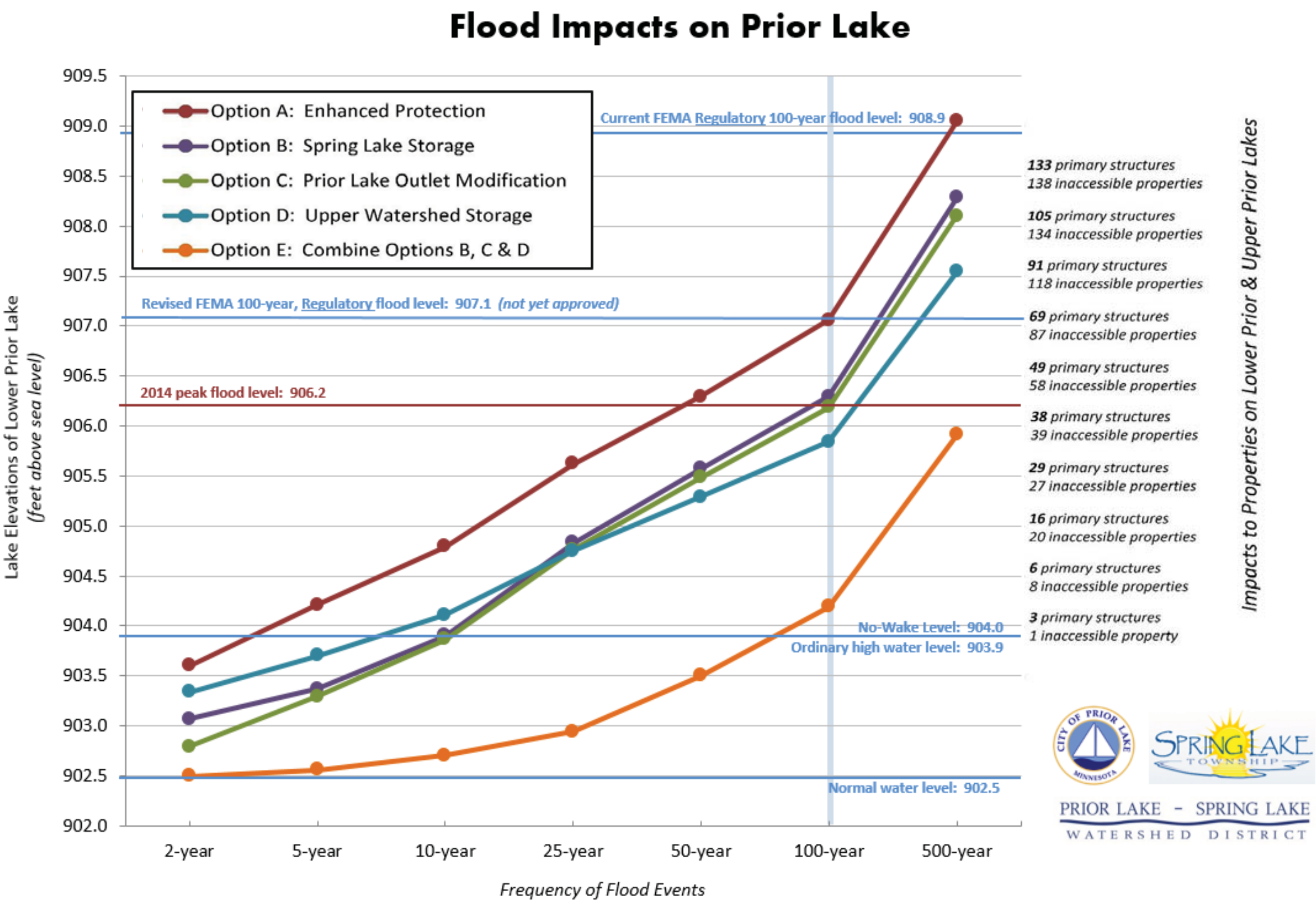


Figure EX-1 Cost/Benefit Summary of Potential Improvement Options

2.0 Background

2.1 Study Partners

The study is sponsored by the PLSLWD and the City of Prior Lake, in collaboration with Spring Lake Township. The Minnesota Department of Natural Resources (MnDNR) has also provided input for permitting and review of potential mitigation options. The advisory committees also included representatives from Scott County, Scott Soil and Water Conservation District, PLSLWD's Citizen Advisory Committee (CAC), City of Prior Lake's Lakes Advisory Committee (LAC), Lake Associations and elected officials. It is expected that future implementation projects may also require coordination and/or partnerships with the City of Shakopee, the Shakopee Mdewakanton Sioux Community and the Lower Minnesota Watershed District, in addition to oversight and approvals from permit authorities.

Barr Engineering Co. was retained by the study partners—the City of Prior Lake and PLSLWD—to provide assistance in completing this study, which includes updated modeling of the watershed, review of flood-related issues and projects, identification and evaluation of a suite of potential flood reduction strategies and implementation plan recommendations. A public input process that engaged a broad range of stakeholders and included local units of government, lake associations, the agricultural community and private landowners has been used to guide the development and evaluation of the available flood mitigation options. This report describes the results of this study.

2.2 Watershed Characteristics

The Prior Lake-Spring Lake Watershed is located in Scott County on the southwest edge of the Twin Cities metro area. The Watershed encompasses 42 square miles of land, primarily agricultural. Water flows from primarily agricultural areas north into Spring Lake, through Upper and Lower Prior Lake (located in the City of Prior Lake), and ultimately discharges to the Minnesota River through the PLOC.

The study area included the Prior Lake-Spring Lake watershed upstream of the Lower Prior Lake outlet structure, encompassing approximately 19,000 acres (30 square miles) of land in Scott County, Minnesota (**Figure 2-1**). The watershed area was divided into 202 subwatersheds for this study. **Figure 2-2** shows how the current (2010) land use varies across the watershed with agricultural land predominant in the south and western areas and residential land uses surrounding the study lakes.

Figure 2-3 shows that there are several natural depressions and wetlands in the upper watershed topography that would have been landlocked under pre-settlement conditions. Some of the depressions in the eastern portion of the watershed are still landlocked under current conditions.

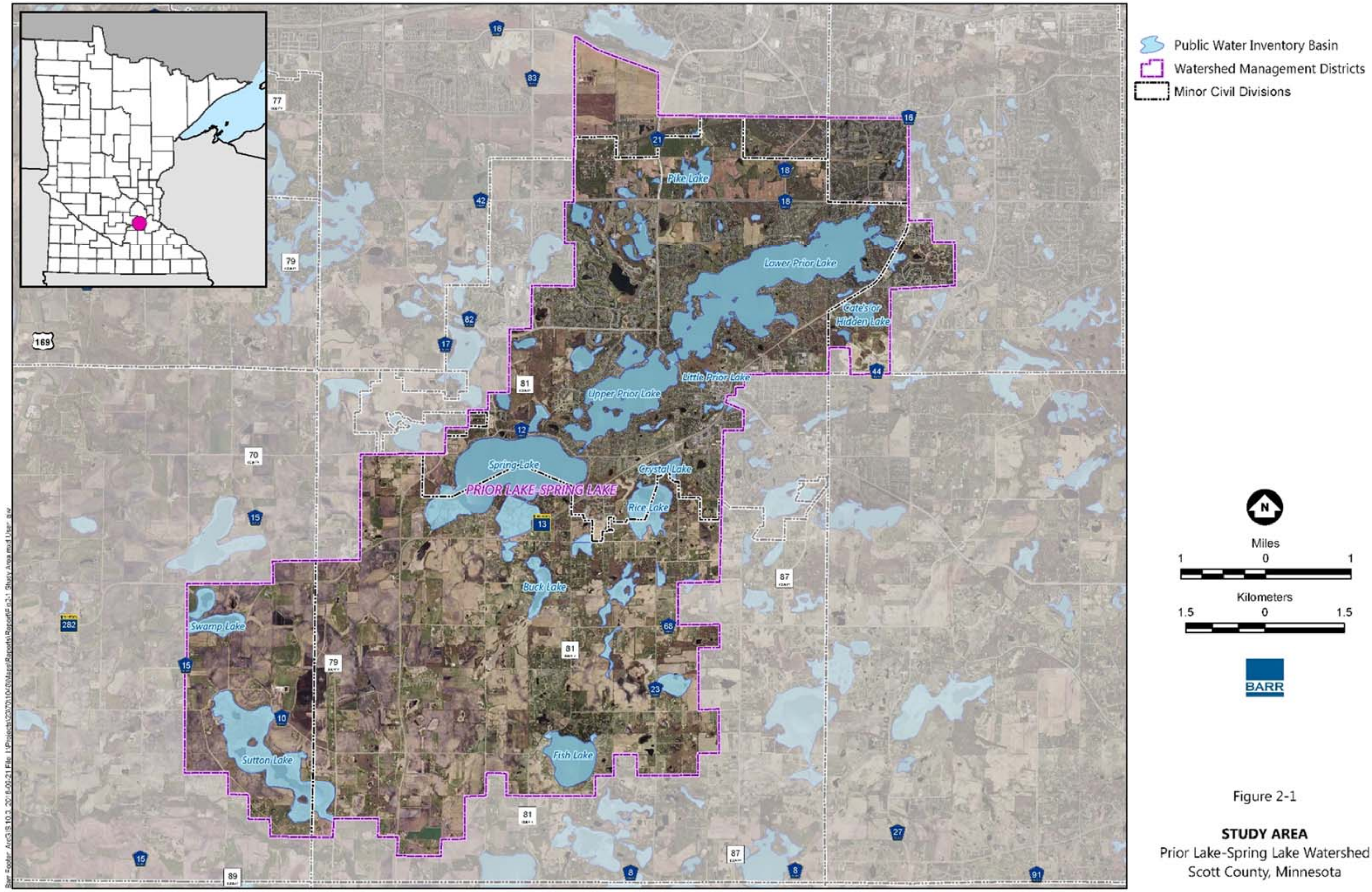


Figure 2-1 Study Area

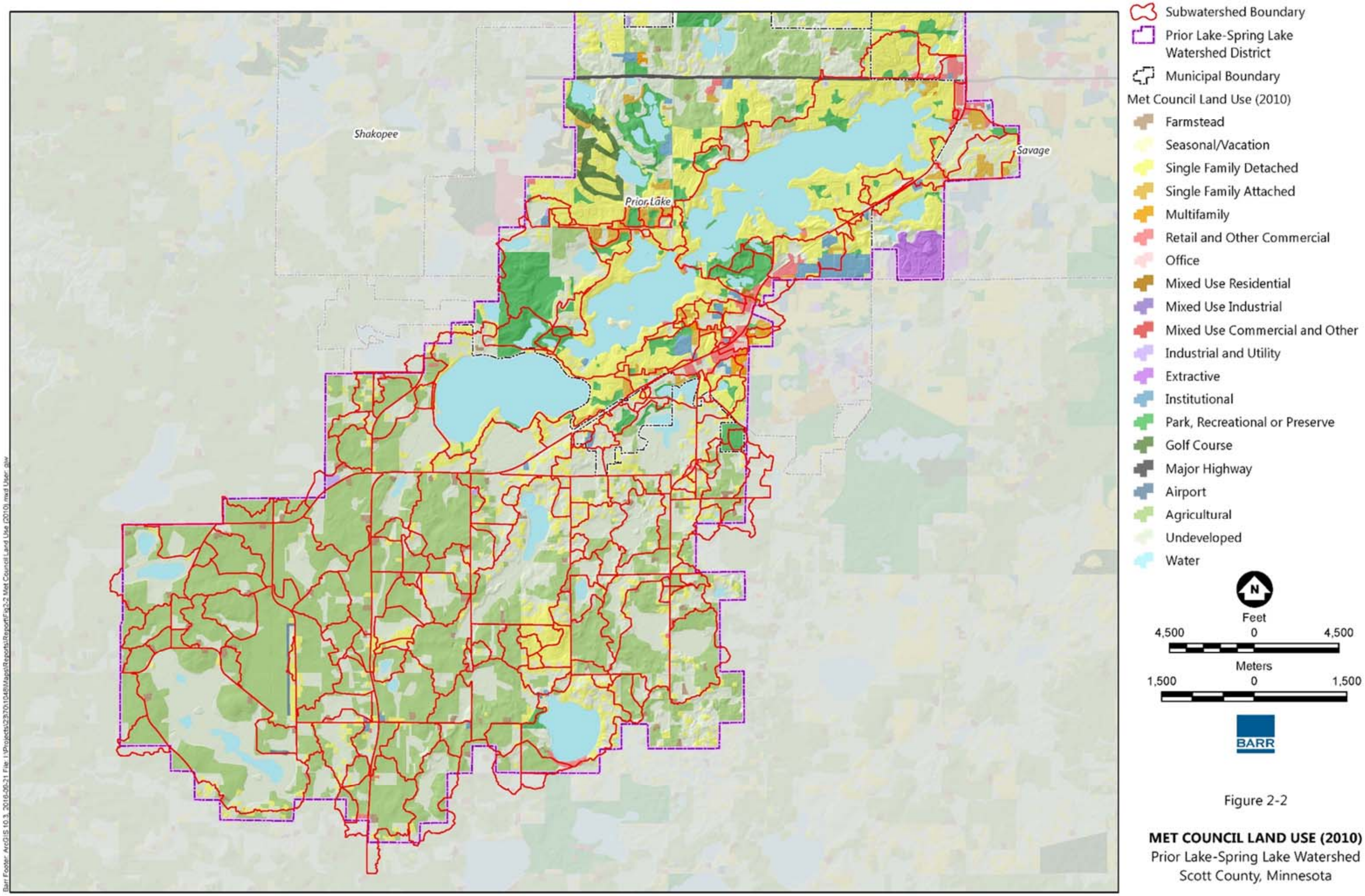


Figure 2-2 Met Council Land Use (2010)

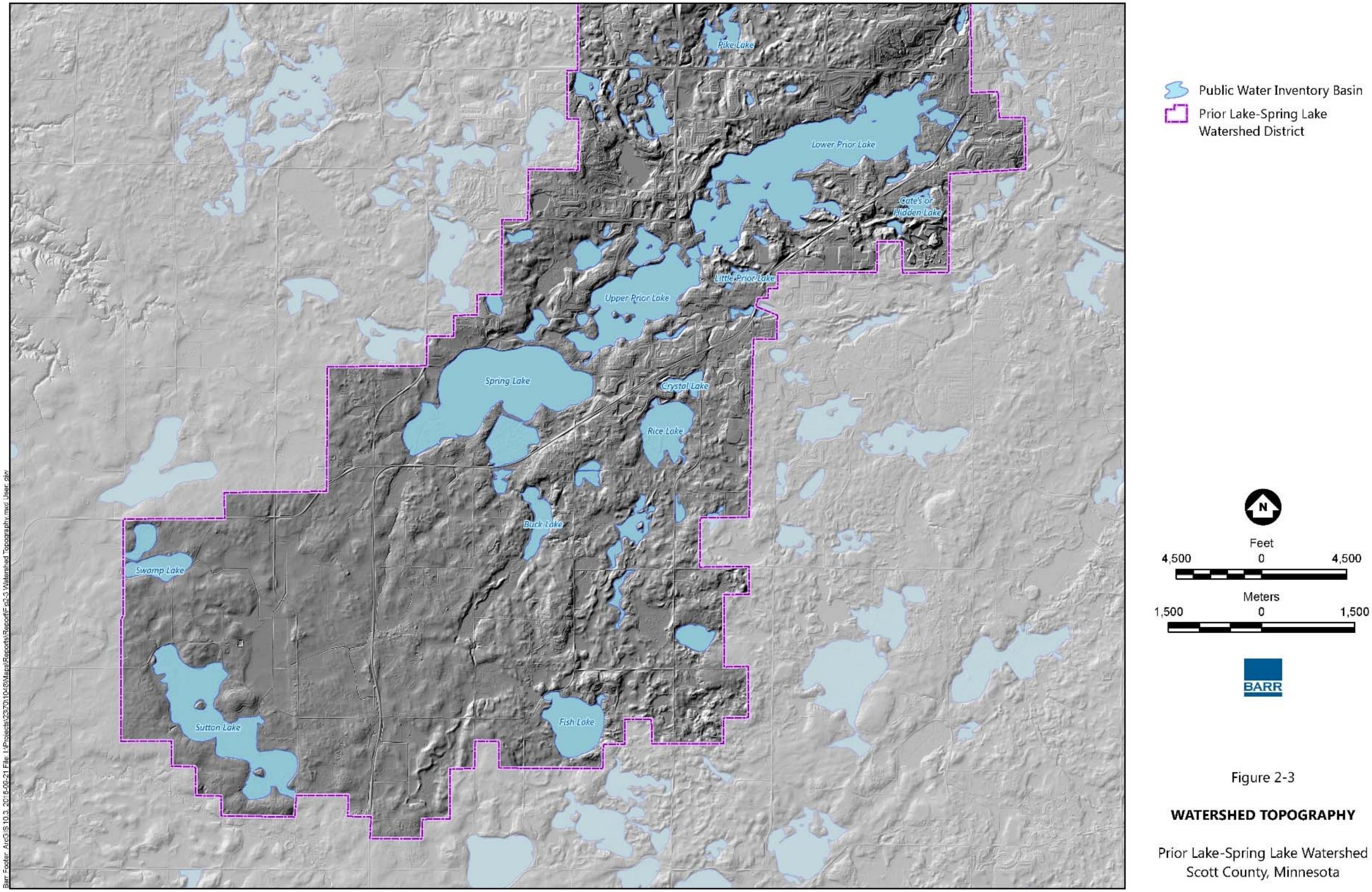


Figure 2-3 Watershed Topography

2.3 History

Lake levels for Upper and Lower Prior Lakes have historically been one of the most important issues for the community, specifically the residents living around the Lakes, since Prior Lake does not have a natural outlet. Residents have observed wide lake level variations dating to the early 1900s, with elevations reportedly varying by up to 34 feet, according to PLSLWD reports from the late 1970s. Levels were likely below 890 during the dustbowl era of the 1930s, based on historic aerial photography. In 1965 and 1969 there were significant flooding events that impacted the entire region, including Prior Lake. Unfortunately, the official MnDNR record contains no water level data for Prior Lake for 1965 and only one reading for 1969. According to records for the Minnesota River, the 1965 flood is considered to be approximately equal to the 1-percent annual chance (or 100-year) flood, and was followed by the 1969 flood which was a 2.5-percent chance (40-year) flood. This regional flooding prompted significant discussion regarding potential mitigation of future events on Prior Lake and a petition from the property owners (resident freeholders) in June 24, 1969, to form a watershed district to address these concerns. The Prior Lake-Spring Lake Watershed District (PLSLWD) was established in March 1970 by order of the Minnesota Water Resources Board (MWRB) under the authority of the Minnesota Watershed Act (Minnesota Statutes, Chapter 112).

Much of the early efforts of the PLSLWD focused on lake level issues and the development of an outlet system. After significant study, public process and agency coordination, the establishment of the Prior Lake Outlet and Channel (PLOC) was selected as the first flood mitigation effort by the PLSLWD. In 1979 the MnDNR issued a permit to the PLSLWD for the PLOC. The cities of Prior Lake and Shakopee and the PLSLWD entered into a Joint Powers Agreement (JPA) regarding the PLOC in 1981 and the outlet system was first used in 1983. This JPA guided the operation of the PLOC and originally provided the City of Shakopee the authority to require the outlet to be closed during certain events. In 1987 a Management Policy and Operating Procedures for the Outlet Control Structure for Prior Lake (Operating Plan) was adopted to set management goals and policy, operating procedures including allowable discharges; and review and amendment procedures.

In parallel to the creation of the Watershed District, on a federal level the National Flood Insurance Program was being developed. This program established an insurance funding mechanism with the primary goal of reducing risks within the now defined 100-year flood risk zone. In 1978 a Flood Insurance Study (FIS) was completed for Prior Lake, which established the regulatory flood zone around Prior Lake and resulted in the calculated 100-year flood elevation of 908.9 feet mean sea level (MSL). For property owners now identified to be in the 100-year flood risk zone to make use of the program, the community needed to establish an ordinance and administer the program on a local level. Prior Lake has administered the program since 1995. The local ordinance restricts the development of structures within the 100-year flood risk zones and seeks to eliminate flood risk of structures in these zones by requiring removal or floodproofing if significant improvements are completed. The FIS was updated in 1997, but the modeling did not account for the benefit of the outlet structure because the channel capacity downstream of the control structure and legal constraints with the adjoining communities limit the discharge the City of Prior Lake can pass through the control structure (FEMA, 1997). The current Flood

Insurance Rate Maps (FIRMS), and thus regulatory requirements are based on this 1997 study. Actual flood levels are thought to be less due to the benefit of the PLOC.

Beginning in 2004, PLSLWD pursued improvements to the outlet structure of the PLOC which had started to show signs of aging and monitoring showed that it was inefficient in maximizing the use of the 36" outlet pipe. The DNR approved proposed structure update plans in 2005 and the new outlet box was completed in 2011. It includes a fixed weir set at an elevation of 902.5 feet MSL and a slide gate to allow manual discharge of water between lake level elevations of 902.0 and 902.5 feet MSL. In conjunction with these improvements, revisions to the Operating Plan were made. These revisions allow continual discharge over the weir without legal limitation by downstream jurisdictions. The outlet structure was replaced in 2010, but maintained the same fixed weir and slide (low flow) gate features at the same elevations, subject to the same Operating Plan procedures (further described in **Table 2-1**). The current outlet configuration will not allow the outflow rate to exceed 65 cfs.

Table 2-1 Summary of Existing Prior Lake Outlet Management Policy and Operating Procedures

Lake Level	Discharge Policy	Low Flow Gate Operation
Below 902.0	No discharge allowed	Closed
902.0 to 902.5	During March and April low flow gate discharge is allowed above elevation 902.0 (with MnDNR approval), based on an analysis of expected lake level rise due to snowmelt and upstream reserves. Otherwise, low flow gate should remain closed when lake levels are at or below 902.5. PLSLWD may also request permission on a case by case basis to discharge in the fall of the year under extraordinary wet conditions with a significant amount of flow coming into Prior Lake by November 1st.	March-April: Open (with to MnDNR approval) May-February: Closed
902.5 to 903.5	Outlet structure discharge regulated by fixed weir	Closed
903.5 & above	Outlet structure may operate at full capacity	Closed

Notes:
The MnDNR generally recommends that the low flow gate remain closed with the exception of the March and April drawdown period. There could be unique cases where a discharge increase would be beneficial and the lower gate could be opened provided that the lake was not drawn down below 902.5, subject to MnDNR approval.

In the spring of 2014, the Prior Lake watershed experienced record amounts of precipitation that led to a historic flooding event, which resulted in extensive sandbagging, pumping, inundation of seven public roads including partial or full closure of Scott County Highway 21 (the main arterial road that bisects the City of Prior Lake) for nearly five weeks, prolonged restrictions (up to six weeks) on property access, no wake restrictions on Prior and Spring Lakes throughout most of the 2014 boating season and extensive damages throughout the watershed, including crop/soil damage and low yields, impacts to nearly 50 private structures and approximately $955,000 of damage to the Prior Lake Outlet Channel (PLOC). The City of Prior Lake spent $190,000 to mitigate the effects of the flooding during the flood event. This event triggered many questions and highlighted the need to update watershed modeling and use it to evaluate flood mitigation strategies for future events. The results of these analyses can, in turn, help inform decisions and policies of the organizations within the watershed.

MnDNR historical Prior Lake and Spring Lake level records are presented graphically in **Figure 2-4**, and since 1971 in **Figure 2-5**. The Prior Lake outlet began operation in 1983 and **Figure 2-5** shows how much higher Prior Lake flooding would have been in the recent past without the 65 cfs outlet discharge capacity. **Figure 2-5** also shows that, with the exception of 2009, there has been discharge from the Prior Lake outlet every year since 1992. The lake level data shown in **Figure 2-4** shows that, even with the lake outlet in operation, the 2014 flood level of 906.2 feet MSL for Prior Lake is significantly higher than any other flood event on record with the exception of the highest known flooding events from 1906 and 1915 that reached respective high water levels of 907.6 and 907.0 feet MSL (PLSLWD, 2003). The 2014 flood level of 913.3 feet MSL for Spring Lake was approximately one foot higher than any other flood event on record.

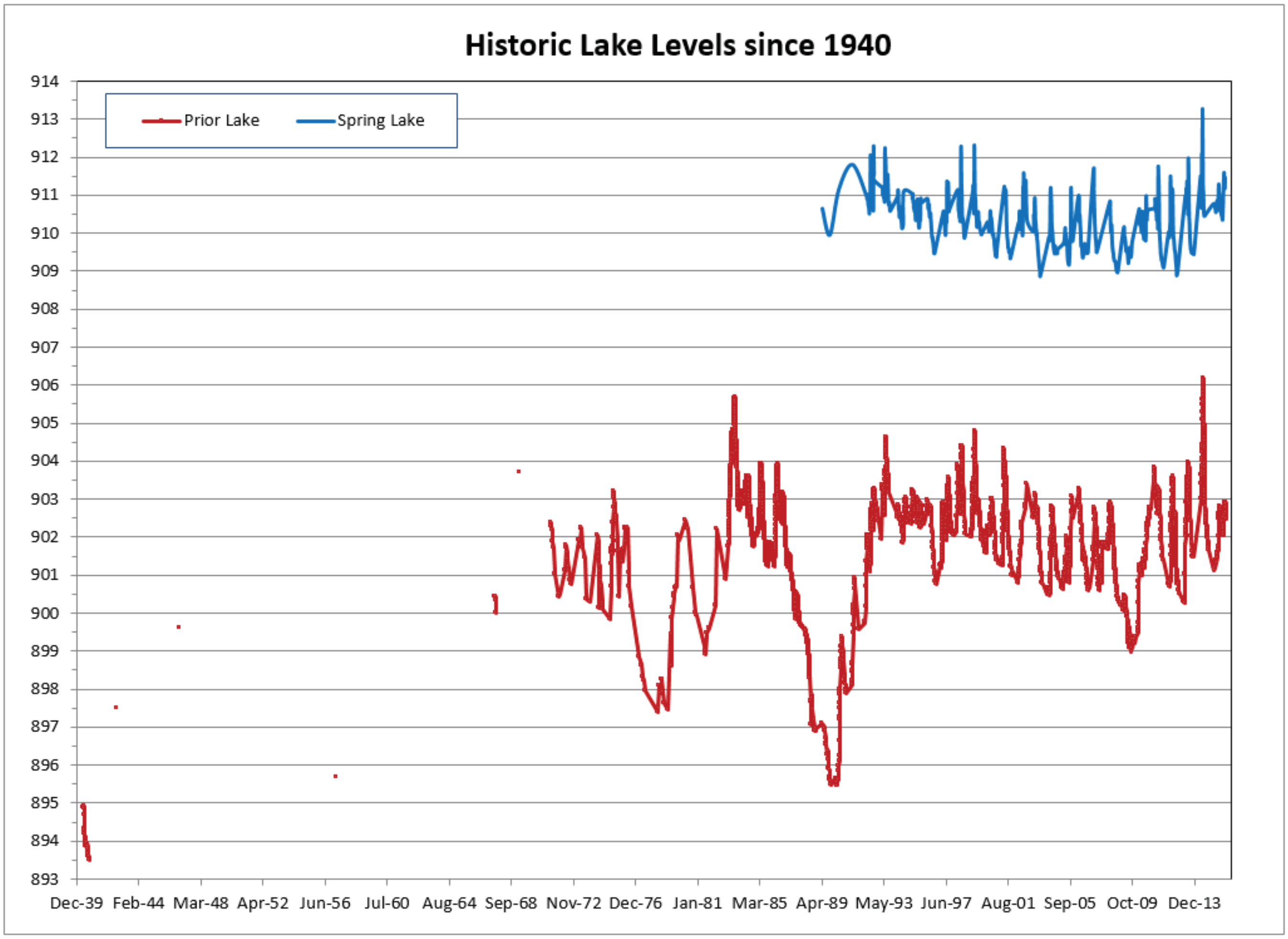


Figure 2-4 **Historical Prior Lake and Spring Lake Levels**

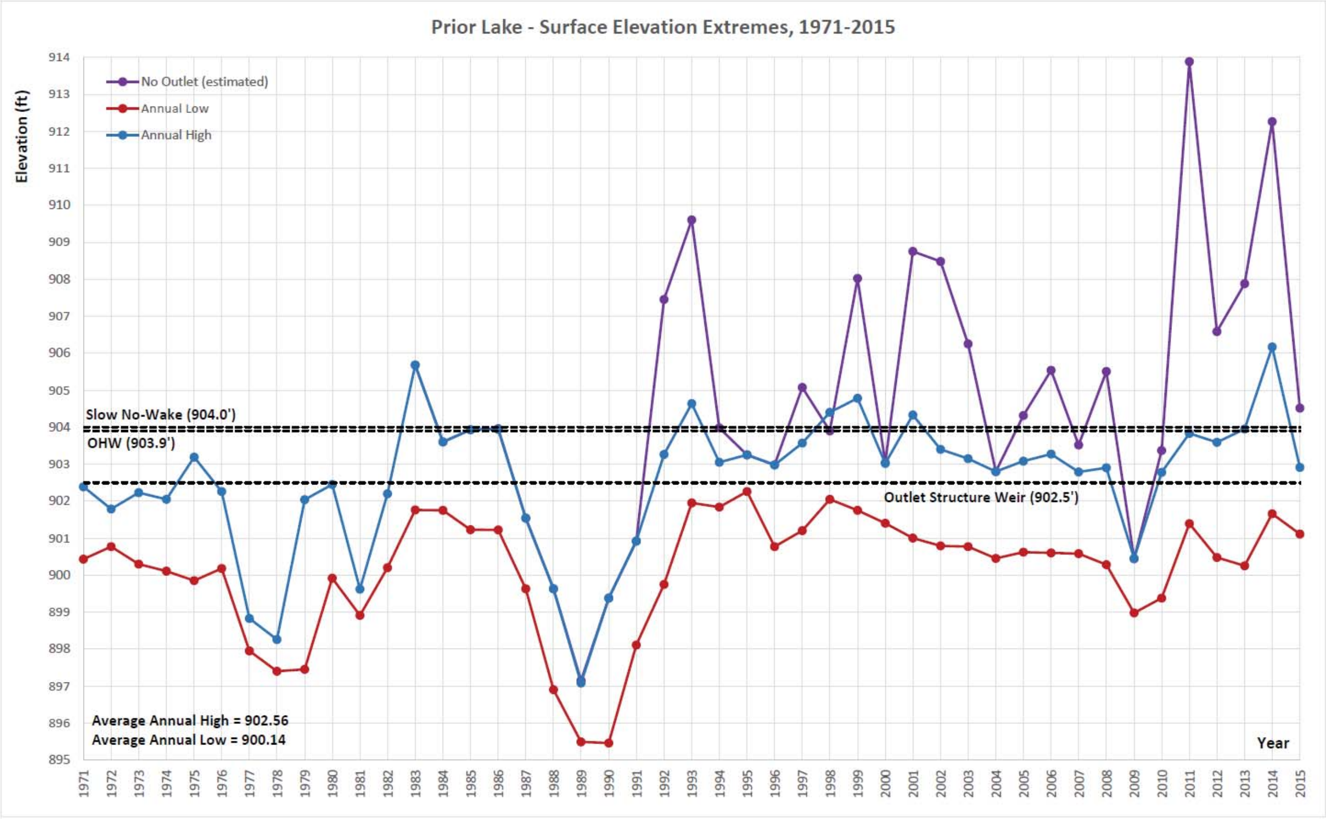


Figure 2-5 Prior Lake and Spring Lake Levels Since 1971

Using the annual high water level data from the 32 years of Prior Lake levels since the outlet was brought on-line, the recurrence of various lake levels can be analyzed based on the frequency with which the respective lake levels have been exceeded during the recent period of record (since the lake outlet was brought on-line). **Figure 2-6** shows the frequency analysis for the Prior Lake high water level observations since 1983, with 2014 representing the highest point on the graph. **Figure 2-6** shows that the high-water levels plotted against the recurrence period follows a straight-line when graphed this way. The figure also shows that there were five years where the Prior Lake level remained below the outlet control elevation or Normal Water Level (NWL) of 902.5 feet MSL.

Since 1983 PLSLWD has been estimating how high the annual Prior Lake level maximum levels would have been without the influence of the lake outlet (shown in **Figure 2-5**). The resulting estimates of the annual high water levels without the lake outlet can be combined with 20 years of lake level data from Prior Lake and the recurrence of various lake levels can be re-analyzed based on the frequency with which the respective lake levels have been exceeded during the entire period of record. **Figure 2-6** shows the frequency analysis for the 52 years of combined Prior Lake high water level observations and estimates without the lake outlet. 2014 represents the second highest point on the graph in **Figure 2-6**, which shows that without the lake outlet, the flood level would have been more than 6 feet higher. Without the lake outlet, the highest estimated lake level would have been 913.9 feet MSL in 2011. **Figure 2-6** also shows that the Prior Lake level remained below the NWL during ten of the 52 years with lake level readings.

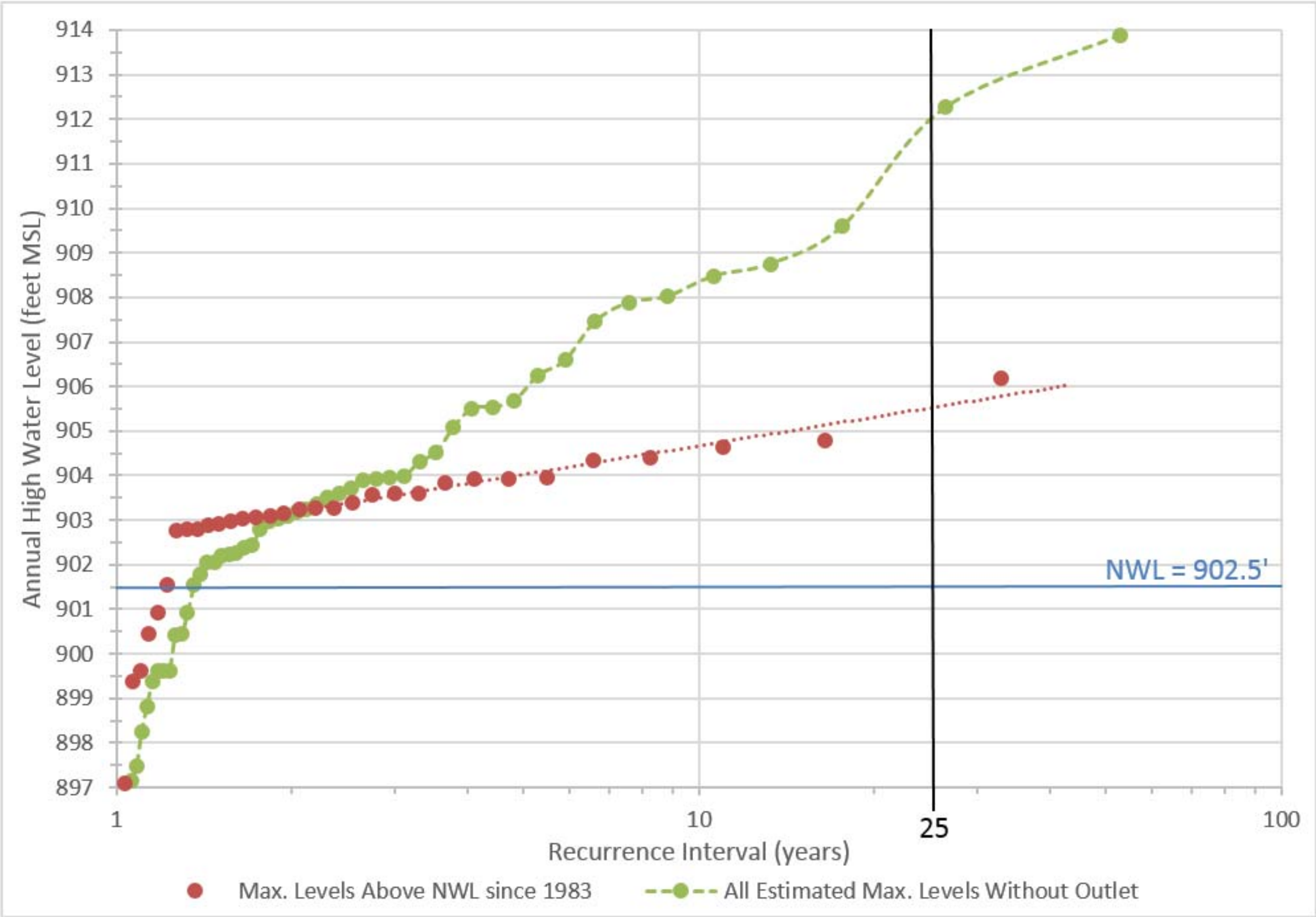


Figure 2-6 Prior Lake Annual High Water Frequency Analyses With and Without Lake Outlet

The City of Prior Lake used recent Scott County LiDAR elevation data (MnDNR, 2011) to estimate the number of primary (homes) and secondary residential structures, street segments and manhole openings at-risk by incremental lake level elevations surrounding the Prior Lake basins (shown graphically in **Figure 2-7**). **Figure 2-7** shows that there is a significant uptick in the number of homes that are at risk of flooding above the lake levels of 906.5 feet MSL, while there are linear increases in other types of infrastructure at risk with increasing flood levels.

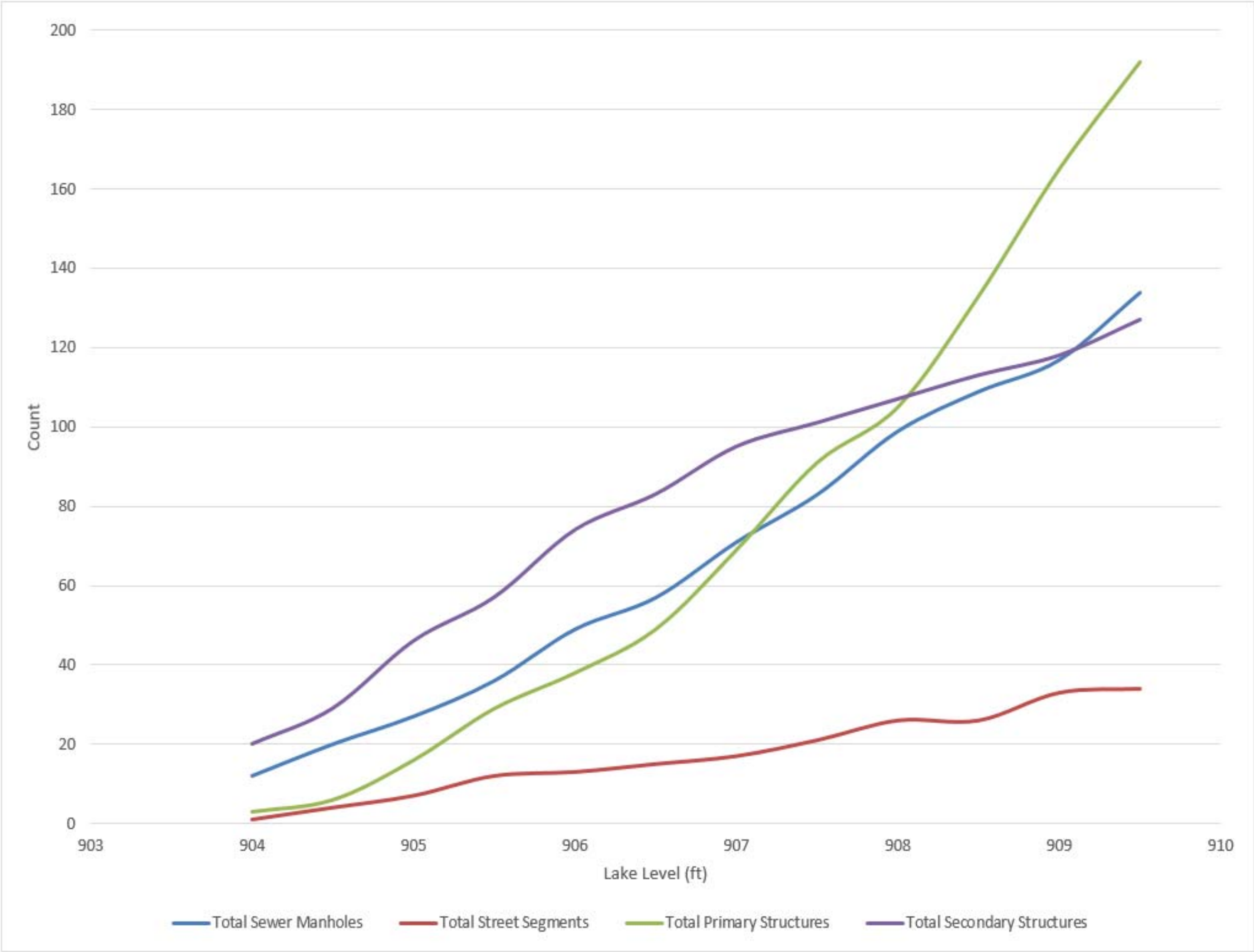


Figure 2-7 Public and Private Impacts by Prior Lake Level

3.0 Goals and Objectives

3.1 Study Goals

The flood of 2014 triggered many questions regarding flooding on Spring Lake and the Prior Lake basins and highlighted the need to update tools that help inform decisions and policies of the organizations within the watershed. Study partners identified updating the existing watershed model and evaluating flood damage reduction strategies as major study priorities. Stakeholder integration was identified as being key to the success of the study and implementation portion of the plan and public input was incorporated throughout the study process. The goals of this study were as follows:

1. Update the flood model
2. Compile and review historical studies and projects to summarize efforts already accomplished toward flood damage reduction
3. Identify a universe of flood damage reduction strategies
4. Evaluate the cost/benefit of the strategies and define community goals for flood protection
5. Develop an implementation plan that identifies a suite of projects or mechanisms to reduce flood damage potential

3.2 Study Objectives

To achieve the study goals, the main objectives of this study involved the following:

1. Updating the existing watershed model with new and up to date inputs including Atlas 14 precipitation data, monitoring data, as-built information, and topographic data (County LIDAR). Calibrating the watershed model to accurately simulate the 2014 flood event.
2. Compiling historical information and reviewing flood-related issues and projects to increase understanding of current flood damage risks
3. Identifying potential flood mitigation measures that will reduce the risk of flood damage.
4. Developing a decision matrix to evaluate the options that include cost/benefit factors and secondary benefits including water quality and natural resource benefits, restoring natural hydrology, improving groundwater recharge and drought tolerance, feasibility issues, upstream/downstream and human impacts.
5. Evaluating flood damage reduction strategies based upon the decision matrix.
6. Using the modeling and cost benefit, define community goals for flood damage reduction as approved by the policymakers.
7. Using the evaluation matrix and community goals develop an implementation plan that includes a potential suite of flood damage reduction strategies, defines partner roles and potential funding sources.

3.3 Community Goals and Priorities

Based on discussion at the policymakers' joint meetings on February 8, 2016 and September 26, 2016, the policymakers provided direction on the community goals and priories to be used to complete the study. Those goals and priorities are as follows:

1. Protection of Public Safety - Maintain emergency vehicle access at all times
2. Protection of Health and Safety - Protect public utility infrastructure (i.e. sanitary sewer and water distribution.)
3. Maintain traffic flow through the County Road 21 corridor
4. Maintain access to private properties

4.0 Community Planning Process

Many residents were impacted by the flood of 2014 and expressed a desire to be involved in future flood damage reduction planning. It is key for the success of the implementation plan that stakeholders be integrated into the process to provide input and ultimately comment on the approved plan. This study included a process for gathering input from the community, including other jurisdictions that are located within the watershed. There were also several advisory groups, study partners, and decision making bodies that needed to be part of the process. The following groups had involvement at key times with their respective roles throughout the process:

- Technical Advisory Committee (TAC) – This group included key staff from PLSLWD, City of Prior Lake, and Spring Lake Township who have regulatory authority within the watershed, as well as representatives from Scott County and Scott Soil and Water Conservation District to ensure coordinated results. The technical working group was intended to drive the modeling and planning process. (12 Meetings). In addition, the staffs of the City of Prior Lake, PLSLWD and Spring Lake Township met regularly to guide the TAC and the final drafts of the Study.
- Advisory Groups – PLSLWD's Citizen Advisory Committee (CAC), City of Prior Lake's Lakes Advisory Committee (LAC), Prior Lake and Spring Lake Associations, and representation from policy groups: Spring Lake Township, Scott Soil and Water Conservation District and City of Prior Lake (elected and appointed officials) and the Scott Water Management Organization. This stakeholder group provided feedback and ideas from representatives that remain actively involved in surface water issues. Functions of this group included communicating ideas to and from the public, communicating planning status, and helping to educate the public using factual information. (Two Meetings)
- Policy Group – An ad hoc group including the Prior Lake City Council, Spring Township Supervisors and the Board of Managers of the Prior Lake-Spring Lake Watershed PLSLWD. This group provided policy direction, and plan development guidance.
- Public/Stakeholders - Generate flood mitigation ideas, stay informed on the process and assist in reaching out to inform the wider community regarding the status of this planning effort. (Three Public Meetings)
- PLSLWD's Farmer-Led Council – A group of local farmers that PLSLWD has previously engaged to develop and guide implementation strategies that will accomplish nutrient reduction goals within the Watershed District. This group provided information regarding impacts experienced by the agricultural producers as a result of the historic rainfalls in 2014.

The following sections describe the results of the community planning process with the meetings listed in chronological order.

4.1 Public Kick-Off Meeting—February 19, 2015

This open house format meeting was intended to inform the public of the study goals and objectives, receive input on what they experienced during the 2014 flooding and to obtain their ideas for flood mitigation options. The meeting included informal small group discussions following short presentations, as well as specific survey questions to provide feedback, which was also made available on the PLSLWD website. The survey responses and open house comments were compiled and summarized according to the major considerations and used to guide the development of mitigation options that should be considered in the process.

4.2 First Advisory Group Meeting—May 7, 2015

This meeting was used to present preliminary modeling results and gather feedback on potential flood mitigation options and the draft criteria for a selection matrix. It was explained that the preliminary modeling was being calibrated to accurately replicate the 2014 flood event before it could in turn be used to evaluate the following flood mitigation strategies:

- Changes to upper watershed storage/detention
- Changes to storage/detention in Spring Lake
- Increases to the Prior Lake outlet capacity
- Floodproofing and/or property buyouts/removals

Potential criteria to evaluate the flood mitigation strategies that could be considered discussed included:

- Costs of projects (design/prep, construction, loss of property/use
- Benefits/Impacts (ecological, water quality, etc.)
- Feasibility (regulations, available funding, etc.)
- Inconvenience factors (loss of use, accessibility, etc.)
- Timing (how long to implement)

4.3 Second Public Meeting—May 28, 2015

Attendees were provided with a study update, including a summary of the watershed model that has been created using the most current data available which allowed Barr to simulate what will happen during significant flood events for possible mitigation scenarios, and an overview of the matrix that has been developed to help guide decision makers through the project selection/implementation process and help weigh the costs against the benefits of different stormwater management strategies. Receiving public feedback at this meeting was important to consider as the modeling was being finalized and alternatives were being studied.

Thirty attendees (with 18 indicating that they live on the lakeshore, eight in the city, and three in rural areas) completed a survey that asked participants about the location of their properties, what they viewed as important factors in selecting a potential flood-mitigation project, and their feelings about use of public funding for flood mitigation efforts. The important factors rated by each survey respondent included cost-benefit ratio, water quality benefits, protection below the 100-year FEMA flood level and project readiness. The survey results indicated the following, based on 30 total responses:

- Water quality was most important factor, followed closely by cost/benefit

- Half of the respondents thought it was important, and another 36% thought it was very important that options should protect properties and public roads below the 100-year FEMA flood level
- Project readiness was least important factor
- 69% supported use of public money to protect individual homes/businesses
- 60% supported increasing property taxes to finance the options
- City of Prior Lake has obligation to maintain emergency access to properties
- General sentiment that public funds should be used to benefit entire community

4.4 Farmer Listening Session—February 3, 2016

This meeting was held to gain a better understanding of how farmers were impacted during the 2014 flood event and receive feedback regarding the proposed flood mitigation options. Paul Krueger, a local dairy farmer and a member of the District's Farmer-led Council, helped facilitate the meeting. Prior to the meeting, farmers and operators within the upper watershed were sent a questionnaire to help gather information about the impacts of the flood on their fields, buildings and crops, and to share their comments or concerns about this study. Twenty-three participants attended the session and shared flood damage experiences. Attendees were prompted with questions concerning the impacts of the 2014 on their farming operations and property. The seven potential flood mitigation options were explored with a focus on the Upper Watershed Storage Option. The questionnaire results and feedback during the meeting can be summarized by the following:

- Upstream farmers also suffered unheard losses during the 2014 flood such as:
  - Many farmers tried to re-plant after the heavy rains, only to get hit again and lose the 2nd crop. Crop insurance only covers the first.
  - If fields are flooded for a certain period of time, the microbes in the soil die off. Farmers need time to re-build the soil before they can plant crops again. Some flood damaged fields will take two or more years to recover.
  - For dairy farmers, crop insurance does not cover the purchase of replacement silage for their cows. Buying silage is much more expensive than growing your own, and many farmers took a hard hit in 2014.
  - Farmers experienced a loss of valuable soil that washed away during flood events.
  - For some, the rain washed away a 2-year application of fertilizer. Not only did they lose the year's fertilizer, but the following as well.
- Concerns about the creation of upper watershed storage areas affecting tile lines upstream.
- Farm acreage in the Twin Cities area is extremely valuable as the amount of tillable land decreases every year with the expansion of the urban areas. This should be considered when identifying upper watershed storage areas.

4.5 Second Advisory Group Meeting—February 4, 2016

This meeting was held to gather feedback on the up-to-date information from the analysis of flood mitigation scenarios as well as responding to the following public policy questions:

- Should public dollars be used to protect public infrastructure (such as sanitary sewer and water utilities)? There was fairly consistent support that the City of Prior Lake has a responsibility to protect and minimize damage to public infrastructure.
- To what degree should access (from streets) be provided during flood events? Three street/access priorities were identified—in descending order, these priorities include access for emergency services, major transportation routes (such as CR21), and local access.
- To what degree should public dollars be used to protect or assist in the protection of private property? There were a range of opinions on this topic. Some felt it was a government's responsibility to provide access to properties through public rights-of-way, however not necessarily protect the property itself. However, there was not specific feedback on the allowable frequency and duration of access disturbances. Some felt that public dollars should not be spent on specific improvements to private property (such as floodproofing or buyouts) but did support strategies such as upper watershed storage. Some felt that less frequent flooding with a longer period between events was okay, but we should consider protecting homes that get flooded on a greater frequency (such as 25 years).

4.6 First Joint Policy Group Meeting—February 8, 2016

This was the first meeting of the Joint Policy Group. The participants reviewed the most recent modeling results and discussed possible mitigation options, as well as the same policy questions that were introduced at the last advisory group meeting. The questions were: Should public dollars be used to protect public infrastructure? To what degree should access be provided? To what degree should public dollars be used to protect or assist in the protection of private property? How would the options be funded? Common themes from the discussion included:

- Public access should be protected
- Buying out homes below the Prior Lake level of 907.1 feet MSL is generally not supported
- Some support for upper watershed storage option
- Homeowners should take responsibility for their properties

Significantly more discussion regarding the mitigation options, funding and policy questions occurred, and it was decided that another meeting should be held to allow more time for discussion.

4.7 Second Joint Policy Group Meeting—September 26, 2016

This was the second and final meeting of the Joint Policy Group. This meeting was facilitated by Steve Woods, Executive Director, The Freshwater Society. The goal of the meeting was to have the policymakers weigh in on the recommendations of their staff on how to proceed in the short and long term.

Staff described the Study results: there is now an updated flood model and stormwater management strategy. They reviewed the "universe of options," an analysis matrix and seven options: Actively Manage the Prior Lake Outlet; Upper Watershed Storage; Prior Lake Outlet Modification; Flood Storage Combination; Enhanced Protection; Spring Lake Storage and Floodproofing/Buyouts.

The policymakers (Spring Lake Township, City of Prior Lake and Prior Lake-Spring Lake Watershed District) supported the staff recommendation regarding the level of protection and the options to meet it:

- First-tier priority is to reduce the flood level on Prior Lake to 905.5 at the 25-year return period which will protect six out of eight right-of-way areas that would otherwise become inundated with flood water under existing conditions
- Second-tier priority is to cost effectively provide additional flood damage reduction based upon future assessments as part of an adaptive management strategy
- Short-term strategy: To achieve that level of protection, the policymakers supported the staff recommendation for a short-term goal of the Enhanced Protection and Actively Manage the Prior Lake Outlet options. The Short-term Goal supported Option A-Enhanced Protection, which is a City-led interim strategy to address any flood event while other permanent options are being developed and Option G-Actively Managed Prior Lake Outlet, which is a strategy that will involve PLSLWD managing more deliberate operation of the existing low-flow gate.
- Long-term strategy: Staff recommended the Upper Watershed Storage Option which includes working with willing landowners to secure permanent or temporary areas in the upper watershed where water could be stored to reduce the lake levels and potential damage during future flood events. This would provide flood reduction benefits to both Spring and Prior Lakes and would be implemented incrementally over time. Policymakers showed support for working with willing landowners only in the upper watershed.
- An adaptive management strategy will be used after the Study is completed, which is a systematic approach for improving overall results by learning from incremental outcomes. It will include: regular assessment every 5 years; exploration of alternative ways to meet the objectives and adjusting management actions, as necessary.

4.8 Third Public Meeting—November 16, 2016

The purpose of the Final Public Meeting was to provide an overview of the Study and Recommendations and to receive public comments. There were approximately 25 attendees.

The upper watershed, lower watershed and Prior Lake Outlet Channel impacts of the 2014 flood were described and the four study goals were restated:

- Update the Flood Model
- Identify Flood Mitigation Options
- Evaluate Flood Mitigation Options
- Develop an Implementation Plan

A Universe of 20 Options recommended by participants in the meetings, staff and policymakers were identified and ranked by: water quality and natural resources; stormwater management; legal authority; project readiness; human impacts and incremental costs. Seven options resulted from the ranking: Actively Manage Prior Lake Outlet; Upper Watershed Storage; Prior Lake Outlet Modification; Combination of Storage Options; Enhanced Protection; Spring Lake Storage and Floodproofing/Buyouts.

At their meeting on September 26, the policymakers (Spring Lake Township, City of Prior Lake and Prior Lake-Spring Lake Watershed District) supported the staff recommendation regarding the level of protection and the options to meet it:

- High priority to reduce the flood level on Prior Lake to 905.5 at the 25-year return period
- Secondary priority to cost effectively provide additional flood damage reduction based upon future assessments as part of an adaptive management strategy
- To achieve that level of protection, the policymakers supported the staff recommendation for a short-term goal of the Enhanced Protection and Actively Manage the Prior Lake Outlet options. For a long-term goal, staff recommended the Upper Watershed Storage Option, which could be done in a gradual fashion.

An adaptive management strategy will be used after the Study is completed, which is a systematic approach for improving overall results by learning from incremental outcomes.

For the Study, adaptive management will include: regular assessment every 5 years; exploration of alternative ways to meet the objectives and adjusting management actions, as necessary.

5.0 Watershed Monitoring and Modeling

PLSLWD has been collecting stream stage and flow data for several sites within the Prior Lake watershed. Continuous (15-minute interval) stage monitoring data collected at five sites during the 2014 monitoring season – two major tributaries and one minor tributary to Spring Lake, were used for model calibration along with continuous data collected from the Spring Lake and Prior Lake outlets (**Figure 5-1)**

Most of the available monitoring data covered the time period from March 28th through October, 2014, with some individual measurements prior to March 28, 2014.

Table 5-1 summarizes drainage characteristics for five PLSLWD monitoring sites considered for use in the watershed model calibration. The combined drainage area of the Buck Lake and County Ditch 13 sites accounts for 76 percent of the Spring Lake watershed and 52 percent of the Prior Lake watershed.

Table 5-1 Drainage Characteristics of Watershed Monitoring Sites

Monitoring Site—Site #	Watershed Area (acres)[1]	Percent of Spring Lake Watershed Area	Percent of Prior Lake Watershed Area
Marshall Road Crossing—Site 19	401	3%	2%
Buck Lake Outlet—Site 14	4,036	32%	21%
County Ditch 13—Site 7	5,526	44%	29%
Spring Lake Outlet—Site 21	12,703	100%	66%
Prior Lake Outlet	19,239	--	100%

[1] Watershed areas include potentially landlocked or non-contributing areas.

5.1 Monitoring

Figure 5-2 shows the measured hydrograph data for the five watershed monitoring sites for the period between the end of April and July, 2014. More than seven inches of rainfall fell across most of the watershed between June 15th and the 20th, which contributed to the peak discharge rates observed at all five monitoring sites. While all three of the tributary stations experienced peak flow on June 19th, the flow monitoring results show that the tributary stations experienced varying levels of flashiness and relative magnitudes of peak discharge. All of the storm flow at Site 19 discharged within two days, while flow at Sites 7 and 14 returned to pre-storm levels within six days after peak discharge. For the Spring Lake outlet, peak discharge occurred on June 22nd – three days after the peak discharge rates occurred at the three tributary monitoring stations. Flow out of the Spring Lake outlet returned to pre-storm levels within 14 days of the peak discharge. The peak Prior Lake level and outlet discharge rate occurred on June 30th and Prior Lake did not return to pre-storm levels for more than 40 days.

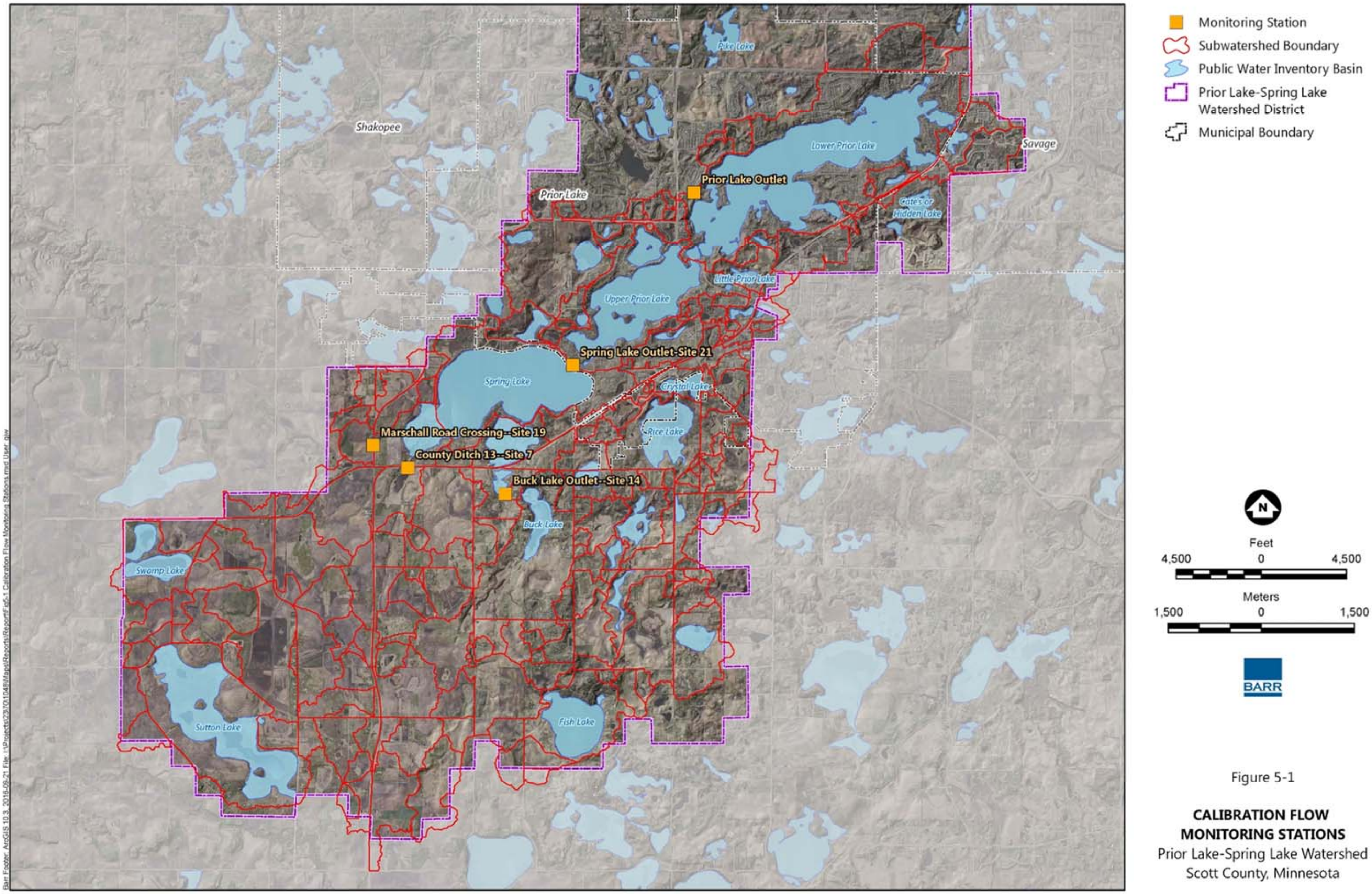


Figure 5-1 Calibration Flow Monitoring Stations

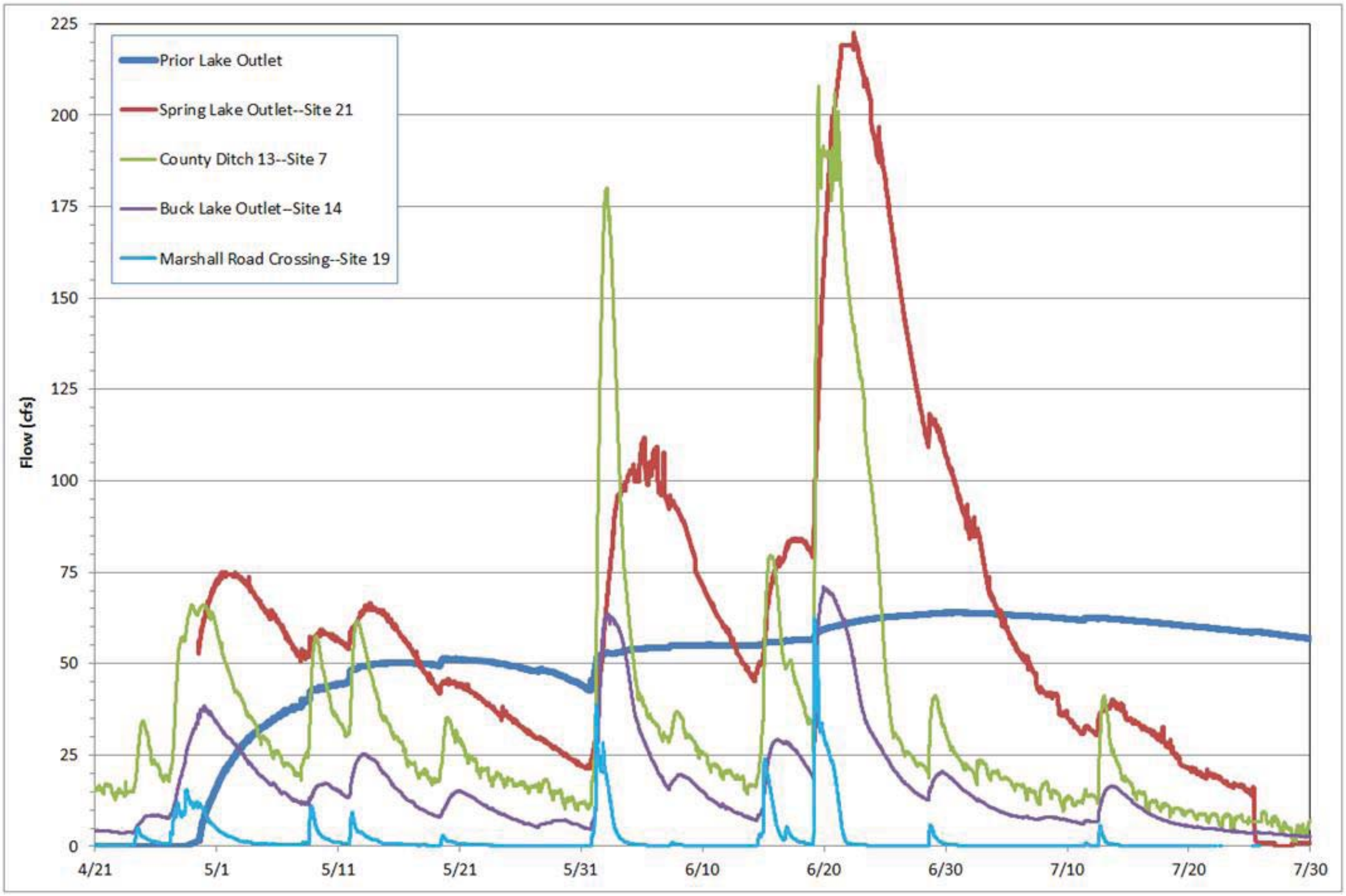


Figure 5-2 Calibration Station Flow Data for 2014

It is important to note that flow out of the Prior Lake outlet did not begin until April 29, 2014 because the beginning lake elevation was 900.10 feet MSL on March 28th, which would have required approximately 3,460 acre-feet of inflow to raise the Prior Lake elevation to the control elevation of 902.5 feet MSL. In addition, lake level and outflow estimates from the Spring Lake outlet do not begin until April 29th, when the estimated outflow rate already exceeded 50 cfs.

Figure 5-3 shows how the combined hydrograph of the three monitored tributaries compares to the flow discharging from the Spring Lake and Prior Lake outlets. This figure allows for a more direct comparison of the magnitude and timing of the Spring Lake inflow hydrographs to the resulting discharges from each of the lake outlets. The peak Spring Lake elevation occurred three days after the peak discharge rates occurred in the upper watershed, while Prior Lake did not reach its peak flood level until 11 days after the peak discharge occurred in the upper portion of the Spring Lake watershed.

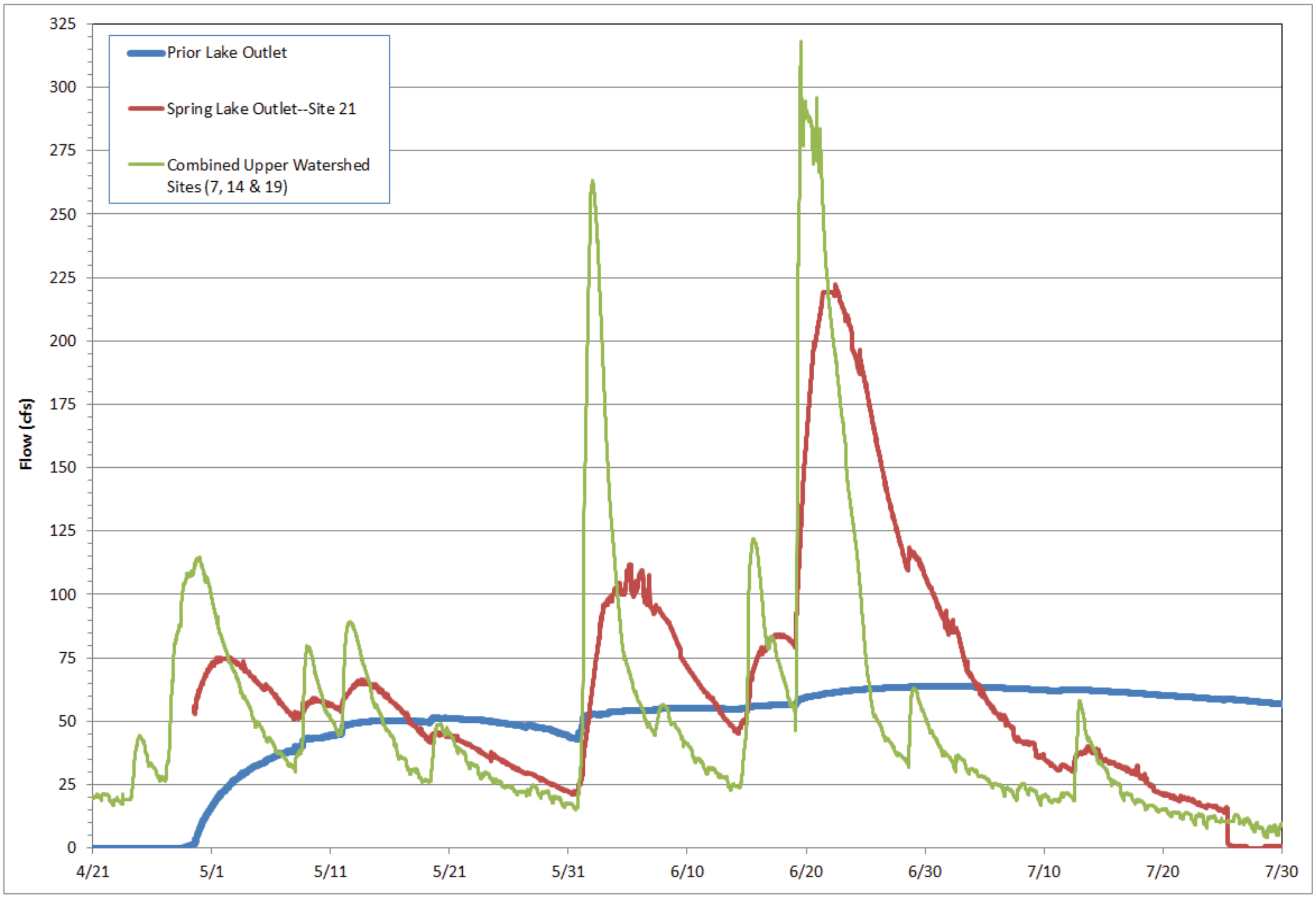


Figure 5-3 Observed Flow Data for 2014 with Upper Watershed Sites Combined

Table 5-2 summarizes the measured flow volume through September 10th, expressed both in acre-feet and as the yield (volume divided by watershed area) in inches, as well as two expressions of the peak discharge rates at the five monitoring stations (with the last column normalized to watershed area).

Table 5-2 2014 Flow Monitoring Summary

Monitoring Site—Site #	Measured Flow Volume—thru 9/10/14 (acre-feet)	Watershed Yield (inches)	Peak Discharge Rate (cfs)	Area-Normalized Peak Discharge Rate (cfs/acre)
Marschall Road Crossing—Site 19	468	13.5	62	0.155
Buck Lake Outlet—Site 14	3,732	10.8	71	0.018
County Ditch 13—Site 7	8,259	17.6	207	0.038
Combined Upper Watershed—Sites 7, 14 & 19	12,458	14.6	318	0.032
Spring Lake Outlet—Site 21	12,021[1]	11.4	222	0.018
Prior Lake Outlet	15,485[2]	9.7	64	0.003

[1] Does not include unmonitored volume associated with the Spring Lake outlet discharge prior to April 29, 2014.

[2] Includes water volume associated with lake level rise in advance of discharge from the Prior Lake outlet.

The following conclusions can be drawn from the 2014 monitoring data:

- The upper Spring Lake watershed (combining drainage to Sites 7, 14 and 19), which represents 52% of the Prior Lake watershed, contributed more than 80% of the flow volume that discharged from the Prior Lake outlet in 2014
- The County Ditch 13 watershed, which represents 29% of the Prior Lake watershed, contributed more than 53% of the flow volume that discharged from the Prior Lake outlet in 2014
- The Buck Lake watershed, which represents 21% of the Prior Lake watershed, contributed 24% of the flow volume that discharged from the Prior Lake outlet in 2014
- Watershed yield from the County Ditch 13 watershed was significantly higher (more than 30% higher) than any of the other watershed monitoring stations
- Watershed yield from the Buck Lake tributary was significantly lower than the other upper Spring Lake watershed tributaries, but higher than the areas draining directly to Prior Lake
- The normalized peak discharge rate for the County Ditch 13 watershed is an order of magnitude higher than the normalized peak discharge rate for the Prior Lake outlet in 2014
- The available lake and wetland storage in the Buck Lake Outlet watershed results in less than half the normalized peak discharge rate computed for the County Ditch 13 watershed

Our analysis of the 2014 monitoring data indicated that enhanced upper watershed storage – particularly in the County Ditch 13 watershed – and better control of peak discharge from the

Spring Lake outlet would have had the highest potential for reducing peak elevations in Prior Lake during the 2014 storm events.

5.2 Model Development and Calibration

Barr created a PCSWMM computer model that is capable of simulating the complexity of watershed runoff from the various types of land surfaces based on the available climate data, land use/land cover characteristics, soil type, topography and imperviousness, and then subsequently route the runoff through stream and ditch channels as well as storage areas and storm sewer/culverts, including the lake basins based on the physical constraints of the individual outlets and conveyances. Model development and preliminary use involved the following steps:

1. Subdividing watersheds to road crossings of drainageways and major storage areas
2. Identifying road culvert, storm sewers, and surface channels that collectively route flow to Prior Lake
3. Creating a watershed model to simulate flow rates and lake elevations throughout the study area
4. Calibrating the watershed model to observed flow rates and lake elevations throughout the watershed for the June 2014 -July 2014 flood event
5. Running the calibrated watershed model for design events intended to simulate flood levels for the 2, 10, 25, 50, 100 and 500-year return period Atlas 14 rainfall amounts for the critical duration event, which was determined to be 30-days.

Detailed discussion regarding the watershed modeling approach and methodology is included in Appendix A. Barr initially used data from the tributary monitoring sites, except for the Marshall Road Crossing (Site 19), for model calibration. Following calibration to the observed flows at the upstream stations, the modeling was calibrated to the watersheds contributing directly to Upper Prior Lake and Lower Prior Lake.

The resulting model generally matched the Prior Lake elevation, but over-predicted the monitored peak elevation that occurred on June 30, and predicted a slower recession rate than the shown by the monitoring data. Adjustments were made to account for groundwater seepage from Prior Lake under high water levels and the final watershed modeling was calibrated to match the peak elevation of Prior Lake and the recession limb of that peak. **Figure 5-4** compares the calibrated watershed modeling results, with and without seepage, to the Prior Lake level monitoring data.

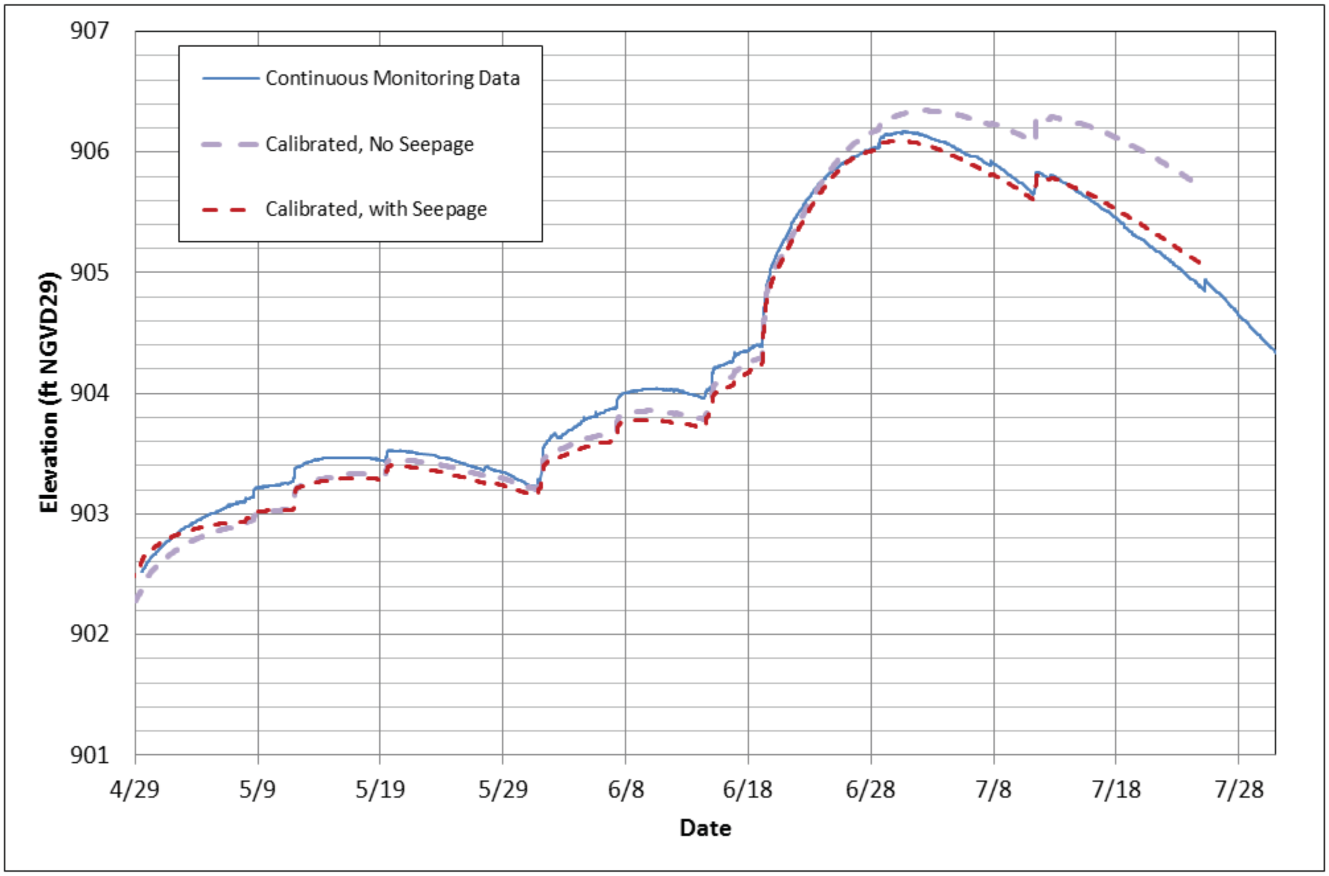


Figure 5-4 Prior Lake Watershed Model Calibration

5.3 Final Modeling Summary

Barr used the calibrated watershed model to determine the critical duration 100-year event, i.e. the 100-year event that resulted in the highest lake elevation for the 2014 existing conditions. Barr evaluated rainfall events ranging from the 100-year, 10-day event through the 100-year, 60-day event. The 30-day event was selected as the critical event for Prior Lake as it produced a peak flood level that was comparable or higher than any of the other durations.

The calibrated watershed model to evaluate the 30-day design event for several return recurrences in addition to the 100-year event, including the 2-, 10-, 25-, 50-, and 500-year events. Table 5-3 shows the peak elevations of Spring Lake and Prior Lake for each of the 30-day events. The 100-year results show that the design event modeling produces higher lake levels (approximately one-foot higher) than the peak levels that were observed in each lake in 2014. However, the predicted flood level for Prior Lake is 1.8 feet lower than the FEMA 100-year elevation of 908.9 feet MSL, as it accounts for the effect of the existing outlet while the FEMA modeling does not. The current FEMA 100-year elevation for Spring Lake is 914.4 feet MSL, which is consistent with the results shown in **Table 5-3**.

Table 5-3 Watershed Model 30-Day Duration Design Event Results

Event Return Recurrence	Rainfall Depth (in)	Spring Lake Peak Elevation (ft)	Prior Lake Peak Elevation (ft)
2-year	8.31	912.4	903.6
10-year	10.8	913.3	904.8
25-year	12.3	913.7	905.6
50-year	13.5	914.1	906.3
100-year	14.6	914.5	907.1
500-year	17.1	915.3	908.4

The peak 100-year Prior Lake elevation determined by this study occurred approximately 14 days after the peak rainfall intensity of the 100-year, 30-day Atlas 14 rainfall event. To have a noticeable effect on the peak Prior Lake elevation, detention storage areas would need to detain water until after Prior Lake had reached its peak.

6.0 Identification of Mitigation Options

Based on feedback from the public kickoff meeting (February 19, 2015) and the second public meeting (May 28, 2015), the TAC developed a list of flood mitigation options. Each mitigation option was then rated according to its relative merits for the following criteria, which were weighted to correspond with the study objectives and what the public viewed as important factors in selecting potential flood-mitigation options:

- Stormwater management benefits, including flood reduction
- Water quality and natural resource benefits
- Legal authority, including access for construction equipment without have to secure additional permissions or easements from other landowners
- Project readiness
- Human impacts
- Cost

The results of this analysis were compiled in **Table 6-1**, which showed that improvement options involving upper watershed and Spring Lake storage, sandbagging and modifications to the Prior Lake outlet (including both increased capacity and proactive outlet management) scored highly. The results also indicated that floodproofing and/or buyouts should also be considered as part of the overall solution.

As a result of relative comparisons of the merits of the universe of options shown in **Table 6-1**, and more detailed analysis including preliminary modeling of potential structural measures, the TAC narrowed the flood mitigation analysis down to the following seven options:

- Option A—Enhanced Protection (coordinated temporary protection measures)
- Option B—Spring Lake Storage
- Option C—Increase Prior Lake outlet capacity
- Option D—Upper Watershed Storage
- Option E—Combine Options B, C & D
- Option F—Floodproofing (for at-risk primary structures)
- Option G—Actively Manage Prior Lake outlet (low-flow gate)

#	Option	15% WATER QUALITY AND NATURAL RESOURCE BENEFITS: Reduces nutrient loading to Spring and Prior Lakes; Restores natural hydrology of watershed (0=none, 5=poor, 10=fair, 15=good)	30% STORMWATER MANAGEMENT BENEFITS: Increases stormwater storage; Restores natural hydrology; Reduces flood level lake volume; Opportunity for groundwater recharge (0=none, 10=poor, 20=fair, 30=good)	10% LEGAL AUTHORITY: Ability to secure permits (Need/difficulty to secure approval from local jurisdictions); Access to the property (Need/difficulty to secure easements; Extent of ongoing legal approvals) (0=difficult, 5=fair, 10=good/no issue)	10% PROJECT READINESS: Time to complete the project; Public acceptance (0=poor, 5=fair, 10=good)	10% HUMAN IMPACTS: Access to roadways, homes & businesses; Private time & effort spent on flood prevention or fixing damage (0=poor, 5=fair, 10=good)	25% INCREMENTAL COSTS (RELATIVE TO BENEFIT): Capital Cost (Public + Private); O & M Costs (Public + Private); Potential Funding (Eligibility for outside funding) (0=very high, 8=high, 16=fair, 25=low/none)	FINAL SCORE
1	Dam on Spring Lake (Scenario 1a)	5	20	5	5	5	16	51
2	Create other upstream storage areas (not otherwise listed; Option 3a)	10	20	5	0	5	16	46
3	Dam on Sutton Lake (3a)	10	20	5	5	5	16	51
4	Dam on Buck Lake (3a)	5	15	5	5	5	16	46
5	Lease upstream land for storage (3a)	10	20	5	0	5	16	46
6	Let water out of the outlet starting at 901-foot level	0	10	0	5	10	16	41
7	Increase Prior Lake outlet capacity (Scenarios 2a & 2b)	0	20	0	0	5	8	33
8	Pump water out of lake for municipal use or groundwater recharge	5	0	0	0	0	8	8
9	Create new pond in Spring Lake Regional Park	10	10	0	0	5	16	31
10	Encourage/require raingardens & rainbarrels	0	5	5	10	5	8	33
11	Encourage/require more citizens to pump from lake	5	0	10	5	10	8	33
12	Sandbagging	0	10	10	10	5	16	51
13	Pump water to Campbell Lake	0	5	0	0	0	0	5
14	Do nothing/no sandbagging	0	0	10	5	0	0	15
15	Flood-proof homes	0	10	10	5	5	8	38
16	Dam on Artic Lake (3b)	0	10	0	0	5	8	23
17	Employ natural lake drain on Candy Cove	5	15	0	0	5	0	20
18	Re-open the old outlet on the east side of Prior Lake/re-establish TH13 overflow	5	0	0	0	5	8	13
19	Buyouts	0	10	10	5	5	8	38
20	Build a small seawall in areas prone to flooding	0	10	0	0	5	8	23

Table 6-1 Initial Comparison Matrix of Flood Mitigation Options

7.0 Flood Mitigation Analysis

7.1 Potential Improvement Options

As discussed in the previous section, the calibrated watershed model was used to evaluate several potential flood-reduction measures. Each measure was evaluated separately (i.e. as if it was the only measure that was implemented) and then all of the potential flood-reduction measures were implemented together (i.e. as if they were all implemented). Those measures that were judged to be reasonable and to have a measurable impact on the peak flood elevation of Prior Lake were combined with the existing conditions modeling and other potential mitigation options from **Table 6-1** to narrow the analysis down to the following seven options:

- Option A—Enhanced Protection
- Option B—Spring Lake Storage
- Option C—Prior Lake Outlet Modification
- Option D—Upper Watershed Storage
- Option E—Combine Options B, C & D
- Option F—Floodproofing
- Option G—Actively Manage Prior Lake Outlet (low-flow gate)

With the exception of Option F (which was based on the existing conditions), all of the above options were modeled to estimate the flood control benefits. In addition to the potential benefits (including flood reduction, water quality and natural resources benefits), detailed cost estimates and evaluations of other selection criteria were developed for each of the seven options.

7.1.1 Option A—Enhanced Protection

This option primarily involves coordinated temporary protection measures, similar to flood control efforts that were utilized during high water in 2014, and is consistent with the calibrated existing conditions modeling described in Section 5 (i.e., this option does not change current flood levels, it simply improves resiliency). As a result, it is expected that some form of enhanced protection measures may need to be implemented several times within a 100-year period. At a minimum, it is also expected that this option would incorporate structural measures to prevent storm sewer backflow at the Highway 21 crossing.

7.1.2 Option B—Spring Lake Storage

The existing Spring Lake Outlet structure is a concrete sill with a bottom width of 16 feet and invert elevation of 909.9 feet MSL. During extreme Prior Lake flooding events, temporary sandbagging at the Spring Lake outlet has been implemented to increase the available storage within Spring Lake. Barr evaluated a permanent embankment with a weir overflow and a 24-inch diameter outlet pipe that would maintain the existing Spring Lake normal water elevation of 909.9 feet MSL during typical flows while allowing for additional storage during high flows. It was estimated that 261 landowners would be impacted from the implementation of this option. **Figure 7-1** shows the predicted Spring Lake levels under existing conditions for the 100-year, 30-day design event and the predicted water levels for the 2-, 5-, 10-, 50-, 100-, and 500-year, 30-day design event for proposed conditions with this improvement option.

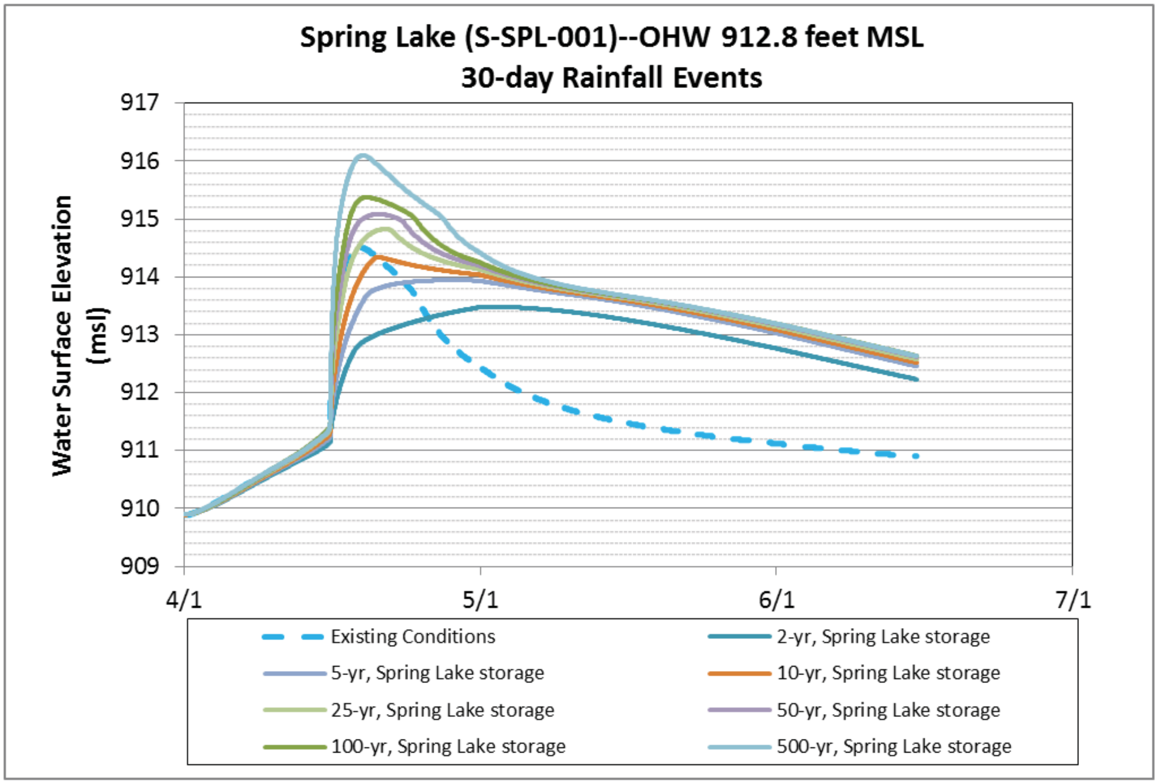


Figure 7-1 Existing and proposed conditions elevations for Spring Lake with modified outlet

7.1.3 Option C—Prior Lake Outlet Modification

The Prior Lake outlet structure is currently limited to a maximum flow of approximately 65 cfs through its design and through legal agreements with downstream communities. A key factor in the 2014 flooding was the occurrence of several consecutive rainstorms separated by intervals that were too short for Prior Lake to return to its normal water elevation before the next storm. To achieve a higher discharge rate, this option assumes that the existing outlet pipe system would be supplemented with the construction of an additional parallel pipe, gate valve and submerged inlet that would be independent of the existing outlet structure. An additional pipe system consisting of a 24-inch diameter pipe was modeled that would be constructed with an upstream invert elevation of 898.5, or four feet below Prior Lake's normal water elevation of 902.5. The proposed pipe system would be approximately 2,600 feet long and would be equipped with a gate valve that would be left closed during normal flow conditions and opened during flood flow conditions, subject to MnDNR permit approval and an agreement with downstream communities regarding its operation. This conceptual design would allow for a flow rate of approximately 15 cfs through the new pipe with the headwater at 902.5, while the pipe size would limit the peak flow to approximately 20 cfs at higher water elevations. With both outlets operating, the maximum operating discharge during high water elevations would be approximately 85 cfs. It was estimated that this option would require easement acquisition on four parcels of land to implement.

For this improvement option, the watershed modeling was revised to account for the combined discharge capacity of both the existing and proposed outlet pipes. It was assumed that the existing low-flow gate, which is manually operated and housed within the Prior Lake Outlet Structure, would be opened prior to the start of the simulation ("actively managed discharge") and would remain open throughout the event.

7.1.4 Option D—Upper Watershed Storage

Working with the TAC, Barr identified a number of potential upper watershed storage areas. These areas were selected during the model development phase of this study as a proof of concept to demonstrate the feasibility of Option D, and not as an early version of any project location planning. These sites were selected solely on their storage potential, based upon model and topographic data, and no contact with landowners was made nor were there any assurances made that any of these areas will be available for use in the upper watershed storage option. The sites selected for further evaluation included locations where modeling showed temporary ponding already occurred under existing conditions, locations where the existing topography allowed for significant increased storage by adding limited additional infrastructure, and other locations where local interest had previously been shown.

Barr screened the potential sites using the 100-year, 30-day design event modeling and selected ten sites for more-detailed modeling, nine of which include the development of additional storage volume. An option including Little Prior Lake was included in the analysis to account for additional storage that could be provided with existing infrastructure, but wasn't utilized in 2014. Barr modeled each area with a restrictive outlet that would decrease its discharge rate and assumed that berms would be constructed as needed to increase the area's storage volume in order to achieve the required detention time. **Table 7-1** summarizes the existing and proposed outlet characteristics for each of the upper watershed storage areas. It was estimated that 120 landowners would be impacted by longer floodwater inundation times due to implementation of this option with several of these landowners also experiencing higher flood levels (that would not threaten structures). Figures showing the location of the detention areas and comparing the existing and proposed conditions 100-year inundation extents are shown in Appendix A. Appendix A includes modeling and discussion of an extra storage option that would have combined the Spring Lake storage option with extensive modifications to the Arctic Lake outlet. While this option would provide good flood control benefits for Prior Lake, it was eliminated from further consideration due to the high cost and negative impacts on the current efforts to restore the water quality and integrity of Arctic Lake.

As discussed in Section 5, our analysis of the 2014 monitoring data indicated that enhanced upper watershed storage, particularly in the County Ditch 13 watershed, has the highest potential for reducing peak elevations in Prior Lake. **Table 7-1** shows two expressions of the modeled existing and estimated (Option D) peak discharge rates for each of the upper watershed storage areas as well as the resulting effects at the Spring Lake and Prior Lake outlets for the 100-year, 30-day design event. The peak discharge rates were normalized to the respective watershed (contributing) areas, as shown in the last two columns of **Table 7-2**, to provide an impartial way to compare how well the predicted flood flows are or can be controlled in various areas of the watershed. **The results show that the upper watershed storage envisioned for Option D will bring the normalized peak discharge rates to levels that are comparable to what would occur at the Spring Lake outlet for several of the potential storage sites, most notably Buck Lake, S-SPL-054, S-SPL-080, S-SPL-094 and Sutton Lake. Except for S-SPL-046 and S-SPL-078, which would experience 10 to 13 percent reductions in the peak discharge rate with Option D, all other upper watershed storage sites would reduce their respective peak discharge rates by more than 68 percent.**

Table 7-1 Upper Watershed Storage Summary

Storage Site Name	Tributary Watershed	Existing Outlet	Proposed Restrictive Outlet and Overflow Structure
S-LPL-048 (Little Prior Lake)	Lower Prior Lake	1.5-ft diameter storm sewer pipe with skimmer (gate open)	1.5-ft diameter storm sewer pipe with skimmer (gate closed)
S-BL-001 (Buck Lake)	Buck Lake	Open channel	2-ft diameter orifice 6 x 6 ft box
S-BL-020	Buck Lake	Open channel	0.5-ft diameter orifice 6 x 6 ft box
S-SPL-046	County Ditch 13	30-ft weir	2-ft diameter orifice 30-ft weir
S-SPL-054	County Ditch 13	Open channel	0.3-ft diameter orifice 6 x 6 ft box
S-SPL-059	County Ditch 13	Open channel	0.5-ft diameter orifice 6 x 6 ft box
S-SPL-078	County Ditch 13	4-ft diameter culvert	0.5-ft diameter orifice 6 x 6 ft box
S-SPL-080	County Ditch 13	2-ft diameter culvert (estimated)	0.5-ft diameter orifice 6 x 6 ft box
S-SPL-094	County Ditch 13	5-ft diameter culvert	2-ft diameter orifice 6 x 6 ft box
S-SUL-001 (Sutton Lake)	County Ditch 13	4-ft diameter culvert	1-ft diameter orifice 6 x 6 ft box

Table 7-2 Existing/Option D Peak Discharge Rates for Upper Watershed Storage Areas/Lakes

Location	Contributing Area (acres)	Peak Discharge Rate (cfs)		Area-Normalized Peak Discharge Rate (cfs/acre)	
		Existing Conditions	Option D	Existing Conditions	Option D
S-BL-001 (Buck Lake)	4,021	194.4	61.4	0.048	0.015
S-BL-020	1,186	301	81.6	0.254	0.069
S-LPL-048 (Little Prior Lake)	131	12.1	0	0.092	0
S-SPL-046	5,526	271.7	242.9	0.049	0.044
S-SPL-054	226	183.5	0.8	0.814	0.004
S-SPL-059	255	306.9	18.0	1.206	0.071
S-SPL-078	339	140.3	123.0	0.414	0.363
S-SPL-080	216	34	3.0	0.157	0.014
S-SPL-094	3,127	132.6	40.1	0.042	0.013
S-SUL-001 (Sutton Lake)	1,546	117.6	25.8	0.076	0.017
Spring Lake Outlet	12,703	286.8	170.3	0.023	0.013
Prior Lake Outlet	19,239	67.7	62.6	0.004	0.003

During the 2014 open water period it was estimated that approximately 2,200 pounds of phosphorus in the flow from County Ditch 13 would have bypassed the ferric chloride treatment system and entered Spring Lake. This phosphorus load is approximately 375 pounds more than MPCA's total maximum daily load (TMDL) loading capacity for all of the sources of phosphorus entering Spring Lake on an annual basis (Wenck, 2011). Based on the peak flow reductions associated with Option D, it is estimated that the ferric chloride treatment system could have treated approximately 690 pounds of additional phosphorus from the County Ditch 13 flows, not including the additional treatment that would have been realized within each one of the upper watershed storage areas during 2014.

7.1.5 Option E—Combine Options B, C & D

This option combines all of the previously described features of the Spring Lake storage (Option B), Prior Lake outlet modification (Option C) and upper watershed storage (Option D) options into one option for the purposes of modeling the potential for combined benefits and cost effectiveness. It was estimated that a total of 385 landowners would be impacted from the implementation of this option.

7.1.6 Option F—Floodproofing

This option primarily involves the development of permanent protection measures for at-risk primary structures, including buyouts where floodproofing is infeasible or not cost-effective, and is consistent with the calibrated existing conditions modeling described in Section 5 (i.e., this option does not change current flood levels, it simply improves resiliency). At a minimum, it is also expected that this option would need to incorporate structural measures to prevent storm sewer backflow at the Highway 21 crossing.

7.1.7 Option G—Actively Managed Prior Lake Outlet

For this improvement option, it was assumed that the existing low-flow gate, which is manually operated and housed within the Prior Lake Outlet Structure, would be opened in advance of large inflows and would remain open throughout the event. It further assumes that full outlet capacity above NWL would be the same as it currently exists (in Option A) and that the proposed gate controlling the proposed additional outlet pipe would be closed if the Prior Lake elevation fell to 902.0 or below.

Simulation of this option resulted in Prior Lake being drawn down to 902.0 in most cases at the start of the simulation. Modeling of the actively managed discharge option while maintaining the current Prior Lake outlet configuration resulted in an estimated Prior Lake flood level of 906.8 feet MSL for the 100-year, 30-day rainfall event, which is 0.3 feet lower than the predicted flood level under existing conditions (with the existing, unmanaged outlet structure).

As a stand-alone option, it is also expected that this option would need to incorporate structural measures to prevent storm sewer backflow at the Highway 21 crossing.

7.2 Improvement Options Modeling and Cost Summary

As previously discussed, each potential flood mitigation measure was evaluated by modeling it with the calibrated watershed model using the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year, 30-day Atlas 14 rainfall events. Barr also evaluated all of the potential upper watershed storage areas together, and all of the flood mitigation options together. **Table 7-3** and **Figure 7-2** summarize the resulting simulated peak water surface elevations for Prior Lake. The results show that implementation of Options B and C would provide similar but significant benefits for all storm frequencies, while Option D provides more benefit during the 100-and 500-year events and less benefit during the more frequent storms. Option E would result in significant flood reductions across the board with predicted flood levels that are lower than the OHW for all but the 100- and 500-year events. Since the OHW is typically attained in a lake at a ten-year frequency, Option E would likely alter the OHW elevation and represents a greater flood level reduction than what should be considered or recommended in the implementation plan.

Table 7-3 Simulated Prior Lake Peak Elevations for flood mitigation options

Simulation	Peak Prior Lake Water Surface Elevation (ft) (Change from Existing Conditions in ft)						
	2-year	5-year	10-year	25-year	50-year	100-year	500-year
Existing Conditions/Enhanced Protection/Floodproofing (Options A & F)	903.6	904.2	904.8	905.6	906.3	907.1	909.0
Spring Lake Storage (Option B)	903.1 (-0.5)	903.4 (-0.8)	903.9 (-0.9)	904.8 (-0.8)	905.6 (-0.7)	906.3 (-0.8)	908.3 (-0.8)
Prior Lake Outlet Modification (Option C)	902.8 (-0.8)	903.3 (-0.9)	903.9 (-0.9)	904.8 (-0.9)	905.5 (-0.8)	906.2 (-0.9)	908.1 (-1.0)
Upper Watershed Storage (Option D)	903.3 (-0.3)	903.7 (-0.5)	904.1 (-0.7)	904.8 (-0.9)	905.3 (-1.0)	905.8 (-1.2)	907.5 (-1.5)
Combine Options B, C & D (Option E)	902.5 (-1.1)	902.6 (-1.7)	902.7 (-2.1)	902.9 (-2.7)	903.5 (-2.8)	904.2 (-2.9)	905.9 (-3.1)

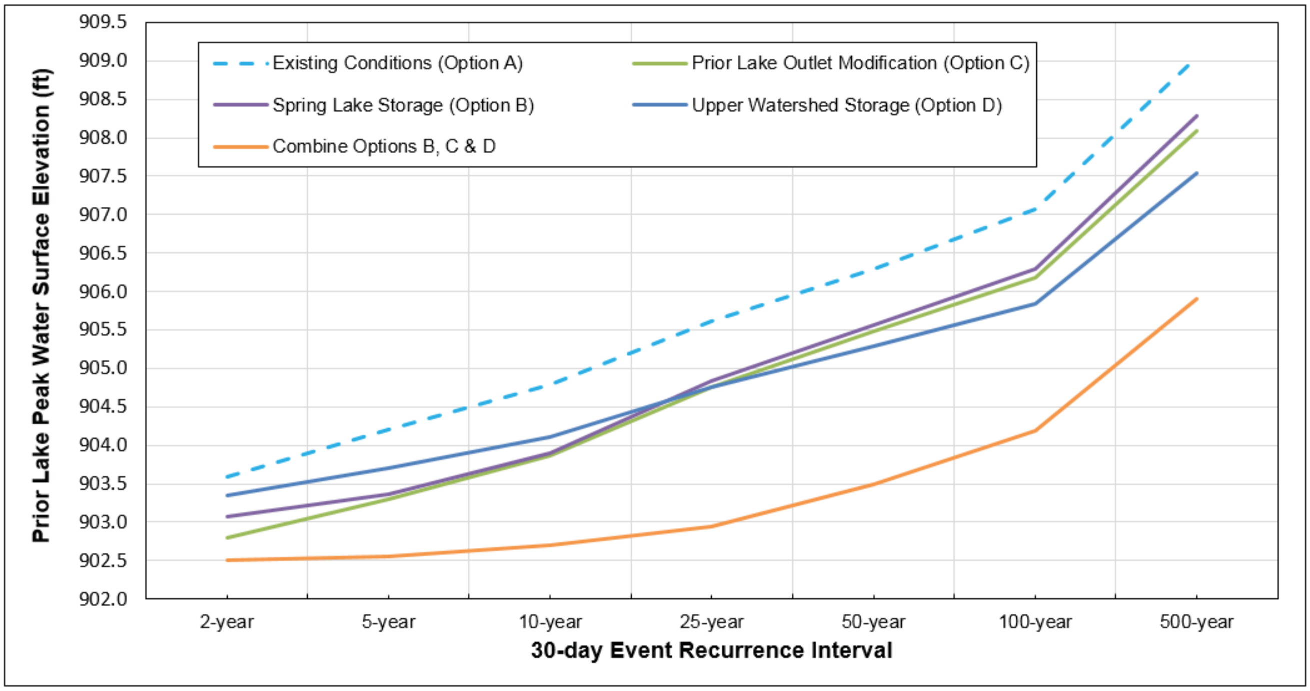


Figure 7-2 Simulated Prior Lake flood levels for existing conditions and flood mitigation options

Table 7-4 summarizes the peak elevations of Spring Lake and Prior Lake, along with the associated planning level cost estimates (which are presented in the appendices), as well as the associated cost-benefit based on the predicted reductions in the Prior Lake peak flood level for each of the potential improvement options. If the conservative cost estimates for securing Spring Lake drainage easements are accurate, then **Table 7-4 indicates that the Spring Lake storage option will not be as cost effective**

(from a flood control perspective) as increasing the Prior Lake outlet capacity or increasing upper watershed storage. A scaled-down version of Option B, that involves less inundation on Spring Lake and less easement cost, may represent a more cost-effective and viable short-term implementation measure.

Table 7-4 indicates that the options involving an increase to the Prior Lake outlet capacity and increasing upper watershed storage are comparable at cost-effectively controlling flooding on Prior Lake. The table also shows that some upper watershed storage locations are significantly more cost-effective for Prior Lake flood reduction than others with the Sutton Lake and S-SPL-094 (airport) sites being the best. Upper watershed storage at Buck Lake and S-BL-020 and S-SPL-080 is also cost-effective, while the relative benefit associated with storage at S-SPL-046, S-SPL-054 and S-SPL-059 does not appear to offset the high cost that was assumed for purchase of the additional inundation area. As discussed in Section 7.1.4, the peak flow reductions associated with Option D have good potential for increasing the total annual phosphorus load from the County Ditch 13 watershed that can be treated by the ferric chloride treatment system as well as the additional treatment that would be realized within each one of the upper watershed storage areas.

Actively managing the Prior Lake outlet low-flow gate (Option G) represents the most cost-effective option, and may provide a solution for some of the more frequent flood events (10-year or less), but would likely need to be combined with other options to meet the study goals for larger storm events. Option C assumed a modest (20 cfs or about 30%) increase in the current discharge capacity of the Prior Lake outlet which resulted in moderate cost-effectiveness for reductions to the Prior Lake flood level. It is expected that more significant increases in discharge capacity would be more cost-effective based on the relative infrastructure costs, but may also be more difficult to permit and rely on during high flow events that do not have downstream capacity.

Table 7-4 shows that the cost-effectiveness of Option E is a composite of Options B, C & D and does not represent an overly economical or expensive option in relation to the others. However, it appears there is good potential to cost-effectively optimize aspects of Options B, C and/or D, and combine it with Option G, to implement an overall solution that results in a peak flood level reduction of at least two feet for Prior Lake during critical 100-year event.

Table 7-4 Summary of Flood Mitigation Option Costs and Simulated Flooding Impacts

Name	Type of Flood Reduction Measure	Spring Lake Peak Elevation Change[1] (ft)	Prior Lake Peak Elevation Change[1] (ft)	Estimated Implementation Cost[2,3,4]	Cost per Prior Lake Peak Elevation Reduction[1,4] ($/ft)
Enhanced Protection (Option A)	Existing (Temporary) Management	No Change	No Change	$ 1,000,000	∞
Spring Lake Storage (Option B)	Outlet Modification and Detention Storage	+ 0.9	- 0.8	$ 4,100,000[5]	$ 5,130,000
Prior Lake Outlet Modification (Option C)	Outlet Modification	No Change	- 0.9	$ 2,800,000	$ 3,110,000
Upper Watershed Storage (Option D)	Upper Watershed Storage	- 1.1	- 1.2	$ 3,900,000	$ 3,250,000
S-BL-001 *(Buck Lake)*	Upper Watershed Storage	- 0.4	- 0.3	$ 670,000[5]	$ 2,230,000
S-BL-020	Upper Watershed Storage	- 0.1	- 0.1	$ 260,000[5]	$ 2,600,000
S-LPL-048 *(Little Prior Lake)*	Gated Detention Storage (Existing Infrastructure)	< - 0.1	< - 0.1	N/A	$ 0
S-SPL-046	Upper Watershed Storage	- 0.2	- 0.1	$ 860,000[5]	$ 8,600,000
S-SPL-054	Upper Watershed Storage	< - 0.1	< - 0.1	$ 390,000[5]	$ 7,800,000
S-SPL-059	Upper Watershed Storage	< - 0.1	< - 0.1	$ 260,000[5]	$ 8,670,000
S-SPL-078	Upper Watershed Storage	- 0.1	- 0.1	$ 300,000[5]	$ 3,000,000
S-SPL-080	Upper Watershed Storage	- 0.1	- 0.1	$ 270,000[5]	$ 2,700,000
S-SPL-094	Upper Watershed Storage	- 0.1	- 0.5	$ 710,000	$ 1,420,000
S-SUL-001 *(Sutton Lake)*	Upper Watershed Storage	< - 0.1	- 0.3	$ 130,000	$ 430,000
Combine Options B, C & D (Option E)	Combines upper watershed storage, Prior and Spring Lake outlet	< - 0.1	- 2.9	$ 10,800,000	$ 3,720,000
Floodproofing (Option F)	Buyouts/Floodproofing (Permanent Management)	No Change	No Change	$ 35,000,000	∞
Actively Manage Prior Lake Outlet (Option G)	Existing Outlet Management	No Change	- 0.3	$ 100,000	$330,000

1) Rounded to the nearest 0.1 feet.
2) Planning level cost estimate
3) 2015 Dollars
4) Rounded to nearest $10,000
5) Assumes full purchase value for any additional inundated area

7.3 Permitting Requirements and Easement Acquisition

It is expected that, at a minimum, most of the proposed improvement options will be subject to the MnDNR Public Waters Permit requirements and associated drainage easement implications. MnDNR staff were contacted to discuss the permit requirements and provided the following feedback based on their interpretation of the applicable rules and statutes:

- Changing the size of an outlet for a public water triggers the public waters permit requirements (as well as construction, repair, reconstruction, or abandonment of any water level control structure)
- While the rule regarding water level controls doesn't explicitly state this, it is DNR policy that flowage easements or consent forms from all affected property owners be obtained prior to any significant change in lake level control elevations [MN Rule 6115.0220 Subp. 2 A. (2)]
- While the improvement options do not propose changes to runout or control elevations, the riparian landowner consent requirement applies since the options involve storing more water and increasing water level bounce, which may shift the OHW level up over time and increase flooding to a greater depth or frequency, which would likely require the purchase of flowage easements
- The permit applicant must own or have easements for the site of the water level control structure

The MnDNR will also need to approve proposed changes to the Operating Plan (previously described in Table 2-1). This permit requirement pertains to the improvement option that involves active management of the existing Prior Lake low-flow gate.

It is also expected that some of the improvement options may need to undertake, or be subject to, the following permit activities as a part of implementing the proposed/recommended plan:

- Fish & Wildlife review/public noticing/meeting
- Corps of Engineers Section 404 permitting
- EAW requirements based on 1 or more acres of public water or public waters wetland area impacted, for projects that will change or diminish the course, current, or cross-section
- Nonpublic waters will be subject to Wetland Conservation Act requirements, with EAW requirements for projects that will change or diminish the course, current, or cross-section of 40 percent or more or five or more acres of types 3 through 8 wetlands of 2.5 acres or more if any part of the wetland is within a shoreland area or delineated flood plain
- If the Spring Lake weir structure is of "State Significance", then it will be subject to Historic Preservation Act requirements (Section 106)
- MPCA Construction Activities NPDES permit for projects that result in an acre or more of disturbance
- City of Prior Lake Conditional Use Permit (CUP) and/or grading permit

7.4 Matrix Comparison of Other Considerations

As previously discussed, the potential mitigation options were narrowed down for further analysis and rated in terms of potential benefit (using flood reduction modeling results and qualitative assessments of potential water quality and natural resources benefits), cost and other selection criteria (such as human impacts, feasibility issues and risk factors).

7.4.1 Rationale for Scoring Detailed Comparison Matrix of Improvement Options

This section describes the rationale for completing the scoring criteria ratings for each of the following improvement options contained in the Detailed Comparison Matrix of Improvement Options, given the basis for rating each criterion:

- Option A—Enhanced Protection (coordinated temporary protection measures)
- Option B—Spring Lake Storage (increases existing Spring Lake 100-year flood level by 0.9 feet)
- Option C—Prior Lake Outlet Modification (increases capacity to 85 cfs, or 20 cfs greater than current conditions)
- Option D—Upper Watershed Storage (combined effect of storage at 9 upper watershed priority sites)
- Option E—Combine Options B, C & D
- Option F—Floodproofing (for at-risk primary structures)
- Option G—Actively Manage Prior Lake Outlet low-flow gate (assumes full capacity above NWL)

7.4.1.1 Flood Reduction Benefits

Increases upper watershed stormwater storage &/or moderates runoff rates [*yes (1) -or- no (0)*]—Weight Factor=10

> The ratings for this scoring criterion are based on whether the runoff rates into Prior Lake area reduced in comparison to existing conditions for any of the improvement options. Upper watershed storage is defined as any storage area upstream of Prior Lake.

Reduction of peak Prior Lake 100-year flood level [*# of inches*]—Weight Factor=10

> Using the modeling results, the ratings for this scoring criterion correspond with the 100-year flood level reduction for Prior Lake, expressed in inches, which reflect the difference between the existing and proposed conditions watershed modeling results for each of the respective options.

Improved level of Prior Lake flood protection [*# of inches*]—Weight Factor=10

> The ratings for this scoring criterion correspond with the improved level of 100-year flood protection for Prior Lake, expressed in inches, which reflect the difference between the existing and proposed conditions watershed modeling results for all of the options, except Options A and F. It should be noted that only primary structures are protected in Option F and streets/public access may or may not be maintained with this category in Option A.

7.4.1.2 Water Quality and Natural Resources Benefits

Mimics natural hydrology [*yes (1) -or- no (0)*]—Weight Factor=5

> Extent to which the options create conditions that are expected to provide benefits similar to natural hydrology.

Provides opportunity for stormwater infiltration &/or improves drought tolerance in upper watershed storage areas [*yes (1) -or- no (0)*]—Weight Factor=5

> This will keep water in upper watershed storage and will enhance the ability to manage soil moisture conditions upstream of Prior Lake.

Minimizes downstream pollution impacts &/or deposition of sediments [*yes (1) -or- no (0)*]—Weight Factor=5

> The ratings for this scoring criterion reflect the expectation that the options that will detain the flood flows in the upper watershed will minimize pollution and deposition impacts, while the other options will not have that effect.

Expands wetland areas [*yes (1) -or- no (0)*]—Weight Factor=5

> Currently, many of the wetlands in the upper watershed are channelized and/or subject to limited fluctuations. Options that promote more water level fluctuations are expected to result in larger areas that would be delineated as a wetland.

Enhances the effectiveness of existing water quality BMPs (improves upon prior investment) [*yes (1) -or- no (0)*]—Weight Factor=10

> Existing BMPs include the ferric chloride treatment system in the County Ditch 13 tributary as well as other ponds/wetlands/lakes that may be providing some water quality treatment under existing conditions. This criterion was scored in the matrix based on whether the improvement option would be expected to provide a significant water quality improvement for the downstream lakes.

Provides additional/improved habitat for fish and/or wildlife [*yes (1) -or- no (0)*]—Weight Factor=5

> Improved habitat for this criterion was based on the ability to maintain higher and/or flowing water for extended durations, which would be expected to improve habitat for waterfowl.

7.4.1.3 Feasibility Issues

Level of effort required to secure permits and necessary approvals [*hi (-1)/med.(0)/low (1)*]—Weight Factor=5

The types of permits and approvals that may be needed are listed/described in Section 7.3, depending on the types of improvements under consideration.

Is there current access to the property in order to implement the project? [*yes (1) -or- no (0)*]—Weight Factor=5

Access for this criterion is based on the ability for construction equipment to access the proposed site without having to secure additional permissions or easements from other landowners.

Will we need to secure property rights? [*# properties affected*]—Weight Factor=-0.5

To implement those options that will need to secure property rights, the number of affected landowners were obtained from the GIS parcel database and entered into the rating column for the respective options.

Project implementation [*less than one year (2), 1-10 years (1) -or- 10+ years (0)*]—Weight Factor=15

Based on expectations for whether implementation of each option could occur within a 1 to 10-year window after accounting for period of time it takes for project funding to become available, along with other factors, such as permitting, feasibility study and property/easement acquisition.

7.4.1.4 Human Impacts

Improves access to area roadways & businesses [*no effects (0), minimal effects (1), large potential effects (2)*]—Weight Factor=10

It is expected some options will have minimal effects to area roadways and businesses, while others will greatly improve access to all areas. Minimal effects would include improved access on up to half of the roadways that would otherwise experience flooding under the current condition, while large potential effects would "greatly improve" access and ensure that almost all roadways are not significantly affected during a 100-year flood event. No effects are for those options that would not represent a significant change from the current condition.

Stakeholder groups impacted [*unaffected (0), positive effects (1), negative effects (-1)*]—Weight Factor=10 for each group

This scoring criterion is intended to describe/address human impacts that aren't already being mitigated by compensation for easements and other loss of property usage (not including access issues). There are four separate entries for this section of the spreadsheet which are specific to the respective stakeholder groups that have the potential to be impacted by each individual option. Impacts summarized for each of the respective criteria are primarily intended to represent an inconvenience factor as it is expected that other, more significant impacts will be mitigated and/or compensated through the purchase of easements or other negotiated forms compensation. Impacts for residents near Prior Lake could include lack of access to properties, road closures, prolonged water pumping, damaged secondary structures, sandbagging, etc.

Impacts for residents near Spring Lake could include inundated land, closure of primary streets, damage to secondary structures, etc. Impacts for upper watershed storage area residents could include extra time and effort spent on cleanup from longer inundation time, damage to agricultural buildings and administration of upper watershed storage agreements, etc. Impacts for residents downstream of Prior Lake could include longer inundation time for high flows.

7.4.1.5 Risk Factors

Potential for the project to cause low lake levels during drought conditions [*no effects (0), minimal effects (1), large potential effects (2)*]—Weight Factor=-10

It is expected that implementation of some options will cause lower lake levels (and associated impacts on recreation, shoreline erosion, etc.) unless the higher discharge rate is limited to periods of flooding.

Potential for the project to cause detrimental effects downstream/upstream [*no effects (0), minimal effects (1), large potential effects (2)*]—Weight Factor=-10

It is expected that implementation of some options will have detrimental effects (i.e., impacts on channel erosion, inundation time, etc.) either upstream or downstream of Prior Lake.

7.4.1.6 Cost of Project and Cost Score

There is one entry for the total cost of the project, in millions. With the exception of Option A, current entries in the spreadsheet are based on independent estimates of the capital costs for each option, which include construction and easement purchase costs (combined with estimates for engineering/design/permitting/contingencies) based on the descriptions and assumptions listed in the appendices. The cost for Option A is an assumed order of magnitude estimate to cover the cost of sandbagging over the course of a 100-year timeframe and upfront installation of backflow prevention on storm sewer outfalls along the Highway 21 crossing of Prior Lake. With the possible exception of Option D, it is expected that all of the remaining options will experience similar lifespans. As a result, operation and maintenance costs have not been estimated, but are expected to represent a small fraction of the capital costs associated with each option. Also, it is unclear at this time whether any of the projects will qualify for other outside funding sources, except for Option D which may qualify for BWSR implementation funds (see Section 8.6).

7.4.2 Results of Detailed Matrix Comparison

Table 7-5 shows that Option G (actively manage Prior Lake outlet low-flow gate) had the highest overall score while Option F (floodproofing) and Option B (Spring Lake storage) had the lowest overall scores. Of the remaining structural measures, Option D (upper watershed storage) and Option C (Prior Lake outlet modification) scored the highest, followed by Option E (combine Options B, C & D). Option A (enhanced protection) had the third lowest overall score in Table 7-5.

The results of the scoring for each individual mitigation option can be summarized as follows (in descending order of the final project scores):

- **#1: Actively Manage Prior Lake Outlet** - Option G [850 score]—represents a good, low-cost option for reducing the risk of flooding for more frequent events, but will not significantly reduce flood damages for a 100-year event on its own
- **#2: Upper Watershed Storage** - Option D [74]—structural measure that scored higher due to more significant flood level reductions and water quality benefits without significantly higher construction costs (in relation to the benefits)
- **#3: Prior Lake Outlet Modification** - Option C [64]—structural measure that scored higher due to more significant flood level reductions without significantly higher costs, but was limited by relative upstream and downstream benefits
- **#4: Combine Options B, C & D** - Option E [46]—composite score was elevated by inclusion of the cost-benefit of upper watershed storage and increased PLO capacity, but was limited by the inclusion of the Spring Lake storage option
- **#5: Enhanced Protection** - Option A [30]—relatively low cost option that provides temporary flood protection, but does not provide flood level reductions
- **#6: Spring Lake Storage** - Option B [17]—structural measure that scored lower due to higher costs (in relation to the benefits) and number of properties affected
- **#7: Floodproofing** - Option F [16]—the highest cost alternative and does not provide flood level reductions.

7.4.2.1 Actively Manage Prior Lake Outlet *(Option G)*

Rank out of 7 Options: **#1**

Summary: The existing low-flow gate, which is manually operated and housed within the Prior Lake Outlet Structure, would be opened in advance of large inflows and would remain open throughout the event. This option represents a good, low-cost option for reducing the risk of flooding for more frequent events, but will not significantly reduce flood damages for a 100-year event on its own.

Flood Reduction Benefits: Matrix Score (0 to 690): **60**

\# of inches reduced in a 100-year flood event: 3

This option would reduce the flooding on Prior Lake by three inches and provide improved level of flood protection. Relative to the other options, this option has minimal flood reduction benefit but overall is more cost effective.

Water Quality and Natural Resource Benefits: Matrix Score (0 to 35): **0**

This option does not provide water quality or natural resource benefits.

Feasibility Issues: Matrix Score (-196 to 40): **35**

\# of properties to acquire rights to: 0

The low-flow gate has already been installed and the property secured. No additional permitting or property acquisitions are necessary. However, in order to change current procedures to more aggressively manage the Prior Lake Outlet, approval must be received from the DNR to update the 2004 Outlet Control Structure for Prior Lake – Management Policy and Operating Procedure. The current document was approved by the DNR in 2005.

Human Impacts: Matrix Score (-10 to 20): **20**

Although minimal, this option would provide a small reduction in lake level which would improve access to area roadways and businesses and provide a benefit to Prior Lake landowners by reducing flooding impacts. There will be no modeled impacts to downstream communities. No impact to landowners on Spring Lake or in the Upper Watershed.

Risk Factors: Matrix Score (-40 to 0): **-30**

As this option would lower lake levels in anticipation of storm events, it has potential risk of causing low lake levels during drought conditions should the predicted rain not come to fruition.

Cost of Project: Estimated Cost of Project: **$100.000**

The cost of the project includes staff time to amend the operating manual for the Prior Lake Outlet Structure and to receive approval from the DNR and support by local partners. The cost also includes the additional staff time required to monitor lake levels and predicted weather, and to open and close the low flow gate as necessary over a 100-year timeframe.

Potential Outside Funding Sources: None

Total Matrix Score = Score/Cost Factor: **850**

Implementation Timeline: 1-3 years

7.4.2.2 Upper Watershed Storage *(Option D)*

Rank out of 7 Options: **#2**

Summary: Potential upper watershed storage sites were identified in locations where modeling showed temporary ponding already occurred, the existing topography allowed for significant storage, and other locations of prior local interest, allowing water to be held back in the upper watershed. This option scored higher due to more significant flood level reductions and water quality benefits without significantly higher costs or number of Prior Lake or Spring Lake properties affected.

Flood Reduction Benefits: Matrix Score (0 to 690): **310**

\# of inches reduced in a 100-year flood event: 15

This option would significantly reduce the flooding on Prior Lake and provide improved level of flood protection. Relative to Spring Lake Storage (Option B) and PLO Modification (Option C), this has relatively similar flood reduction benefits at the 25-year flood event, but has superior flood reduction at the 100-year event. In addition, this option can be implemented incrementally, while Options B and C are "all or nothing" options.

Water Quality and Natural Resource Benefits: Matrix Score (0 to 35): **35**

This option will hold back water, allowing time for sediment and nutrients to settle out of the stormwater. It also includes the restoration and expansion of wetlands. This option provides all of the water quality or natural resource benefits considered, including: mimics natural hydrology, provides stormwater infiltration &/or improves drought tolerance, minimizes downstream pollution &/or deposition of sediments, expands wetland areas, enhances effectiveness of existing water quality BMPs, and provides habitat for fish &/or wildlife.

Feasibility Issues: Matrix Score (-196 to 40): **-65**

\# of properties to acquire rights to: 120

The storage sites were identified solely on storage potential as examples and did not include contacting any of the landowners. Identifying, contacting, educating, and negotiating with willing landowners will be part of the process which will likely take some time. Permits will also need to be acquired for construction of the water control structures. Note: Storage sites implemented may or may not include those areas identified by this study and will be based on opportunities that arise and the ability to identify willing landowners.

Human Impacts: Matrix Score (-10 to 20): **10**

This option would reduce the flood potential on both Prior Lake and Spring Lake, providing a benefit to those landowners. The impact to the upper watershed will be determined on a site-by-site basis. Through negotiations, affected landowners will be compensated for the impacts associated with the use of their land.

Risk Factors: Matrix Score (-40 to 0): **-10**

This option has the potential to cause detrimental effects upstream by causing additional areas to pool with water along upstream tile lines, although these effects would be considered during feasibility studies.

Cost of Project: Estimated Cost of Project: **$3,900.000**

The cost of the project are based on independent estimates of the capital costs for installing upstream storage, including engineering design, construction and easement/fee title purchase costs. The feasibility studies (which are not included in the Cost of Project) will take a closer look at how much storage can be achieved and will also include outreach to landowners to assess willingness to participate in the process and provide a more refined estimate per site. Note: staff time, title costs, appraisal cost and survey work are not included in the Cost.

Potential Outside Funding Sources: MnDNR (FDR, CPL, etc.), BWSR (CWF, MDM, RIM, CRP, etc.), MPCA (CWRF, CWP, etc.), USDA (CRP, CREP, etc.), NRCS (EQIP, ACEP, etc.), HSEM, FEMA, USACOE Flood Programs

Total Matrix Score = Score/Cost Factor: **74**

Implementation Timeline: 30+ years Every storage area will need a feasibility study that will each take 3-4 years to complete. In addition, negotiations with landowners and implementation will take 2-10 years each.

7.4.2.3 Prior Lake Outlet Modification *(Option C)* *Rank out of 7 Options:* **#3**

Summary: The Prior Lake outlet structure is currently limited to a maximum flow of approximately 65 cfs. This option includes an additional, parallel outlet structure, allowing a flow rate of 15-20 cfs, increasing the maximum flow to approximately 85 cfs. This option scored higher due to significant flood level reductions without significantly higher costs, but was limited by potential impacts upstream/downstream.

Flood Reduction Benefits: Matrix Score (0 to 690): **200**

\# of inches reduced in a 100-year flood event: 10

This option would significantly reduce the flooding on Prior Lake and provide improved level of flood protection. Relative to Spring Lake Storage (Option B) and Upper Watershed Storage (Option D), this has relatively similar flood reduction benefits at the 25-year flood event, but has inferior flood reduction at the 100-year event than Options D or E.

Water Quality and Natural Resource Benefits: Matrix Score (0 to 35): **0**

This option does not provide water quality or natural resource benefits.

Feasibility Issues: Matrix Score (-196 to 40): **8**

\# of properties to acquire rights to: 120

This option will require extensive efforts to secure permits and necessary approvals. Modifying the Prior Lake Outlet will trigger the public waters permit requirements (as well as construction, repair, reconstruction, or abandonment of any water level control structure). This option will also require extensive consultations with downstream partners as part of the current PLOC Memorandum of Agreement. In addition, Minnesota River flooding concerns and the Pike Lake TMDL will need to be addressed. Property rights will need to be secured on four parcels.

Human Impacts: Matrix Score (-10 to 20): **10**

This option will improve access to area roadways & businesses, and have positive impacts on Prior Lake landowners. However, there may be impacts to people/communities downstream of Prior Lake.

Risk Factors: Matrix Score (-40 to 0): **-40**

By allowing more water to exit Prior Lake, this option risks causing low lake levels during drought conditions. This project also has the potential to cause detrimental effects downstream of Prior Lake.

Cost of Project: Estimated Cost of Project: **$2,800.000**

The Cost of the Project includes engineering, construction, and land acquisition payments. However, feasibility studies, staff time (including negotiation, administration, etc.), title work, appraisals, and survey work are not included.

Potential Outside Funding Sources: USACOE Flood Programs

Total Matrix Score = Score/Cost Factor: **64**

Implementation Timeline: 10+ years A feasibility study would be completed first along with discussions with downstream partners and landowners. Installing the pipe (including easements) could take 3-4 years.

7.4.2.4 Combine Options B, C & D *(Option E)*

Rank out of 7 Options: **#4**

Summary: This option combines Spring Lake Storage (Option B), Prior Lake Outlet Modification (Option C) and Upper Watershed Storage (Option D) to obtain maximum flood reduction benefits. The composite score was elevated by inclusion of the cost-benefit of upper watershed storage and increased PLO capacity, but was limited by the inclusion of the Spring Lake storage option.

Flood Reduction Benefits: Matrix Score (0 to 690): **690**

\# of inches reduced in a 100-year flood event: 34

This option combines the three most beneficial options, providing the most significant flood reductions benefits of any option.

Water Quality and Natural Resource Benefits: Matrix Score (0 to 35): **35**

The upstream storage portion of this option will hold back water, allowing time for sediment and nutrients to settle out of the stormwater. It also includes the restoration and expansion of wetlands. This option provides all of the water quality or natural resource benefits considered, including: mimics natural hydrology, provides stormwater infiltration &/or improves drought tolerance, minimizes downstream pollution &/or deposition of sediments, expands wetland areas, enhances effectiveness of existing water quality BMPs, and provides habitat for fish &/or wildlife.

Feasibility Issues: Matrix Score (-196 to 40): **-195**

\# of properties to acquire rights to: 381

This option includes the feasibility issues for all three options it combines, including permitting and land acquisition of 381 parcels. See specific options for more information about feasibility issues.

Human Impacts: Matrix Score (-10 to 20): **10**

This option would reduce the flood potential on both Prior Lake and Spring Lake, providing a benefit to those landowners. However, with the Prior Lake Outlet Modification there may be some impacts to downstream landowners. Although they will be compensated for any loss in usable land, the impact to upper watershed landowners was also taken into account here.

Risk Factors: Matrix Score (-40 to 0): **-40**

This option has both the potential to cause low lake levels during drought conditions and to cause detrimental effects downstream/upstream.

Cost of Project: Estimated Cost of Project: **$10,800.000**

The cost of the project includes feasibility studies and then implementation for all three options. Limited by staff capacity, the combination of all three options will likely take a long time to implement fully.

Potential Outside Funding Sources: MnDNR (FDR, CPL, etc.), BWSR (CWF, MDM, RIM, CRP, etc.), MPCA (CWRF, CWP, etc.), USDA (CRP, CREP, etc.), NRCS (EQIP, ACEP, etc.), HSEM, FEMA, USACOE Flood Programs

Total Matrix Score = Score/Cost Factor: **46**

Implementation Timeline: 30+ years

7.4.2.5 Enhanced Protection *(Option A)*

Rank out of 7 Options: **#5**

Summary: This Enhanced Protection Option involves coordinated temporary protection measures, similar to flood control efforts that were utilized during high water in 2014. This is a relatively low cost option that is easier to implement, but does not provide flood level reductions. This option, along with Option G, are the two most feasible short-term options to address flooding issues.

Flood Reduction Benefits: — Matrix Score (0 to 690): **0**
# of inches reduced in a 100-year flood event: 0

This option would not provide any flood reduction benefits.

Water Quality and Natural Resource Benefits: — Matrix Score (0 to 35): **0**
This option does not provide water quality or natural resource benefits.

Feasibility Issues: — Matrix Score (-196 to 40): **40**
# of properties to acquire rights to: 0

Permits, approvals, and property rights are not required to implement this option.

Human Impacts: — Matrix Score (-10 to 20): **-10**
Enhanced protection measures will be implemented on public property only (road right-of-way, public easements, etc.) and will not impact private property. This option would also not impact people/communities downstream of Prior Lake, Spring Lake landowners, or upper watershed landowners. However, there is an inconvenience factor to the Prior Lake landowners for having to coordinate private sandbagging efforts with enhanced protection measures.

Risk Factors: — Matrix Score (-40 to 0): **0**
As this project will not affect the lake levels, there is no potential to cause low lake levels during droughts or detrimental effects downstream/upstream.

Cost of Project: — Estimated Cost of Project: **$1,000,000**
The cost of the project includes staff time, supplies, and other resources necessary to implement enhanced protection. This option can be implemented immediately, but costs are included are relative to a 100-year lifespan. The cost estimate assumes four flood events will happen in a 100 years to a level where enhanced protection efforts will be necessary.

Potential Outside Funding Sources: None

Total Matrix Score = Score/Cost Factor: **30**

Implementation Timeline: 1 year

7.4.2.6 Spring Lake Storage *(Option B)*

Rank out of 7 Options: **#6**

Summary: This option includes installing a permanent embankment with a weir overflow and a 24-inch diameter outlet pipe that would maintain the existing Spring Lake normal water elevation of 909.9 feet MSL during typical flows while allowing for additional storage during high flows. This option is scored lower due to higher costs (in relation to the benefits) and the high number of properties affected.

Flood Reduction Benefits: Matrix Score (0 to 690): **190**

\# of inches reduced in a 100-year flood event: 9

This option would significantly reduce the flooding on Prior Lake and provide improved level of flood protection. Relative to PLO Modification (Option C) and Upper Watershed Storage (Option D), this has relatively similar flood reduction benefits at the 25-year flood event, but has inferior flood reduction at the 100-year event compared to Options D or E (Combination).

Water Quality and Natural Resource Benefits: Matrix Score (0 to 35): **10**

This option will hold back water, allowing time for infiltration. It will also provide additional fish & wildlife habitat, expanding the shoreline of Spring Lake. However, this option scored lower because it does not provide the other water quality or natural resource benefits.

Feasibility Issues: Matrix Score (-196 to 40): **-120.5**

\# of properties to acquire rights to: 261

This project will require MnDNR, US Army Corps of Engineers, and MPCA permits, US Fish & Wildlife review, and permission from all 261 landowners around Spring Lake. In addition, the MnDNR has indicated that it will not allow this option to be installed until greater efforts have been made to secure storage in the upper watershed.

Human Impacts: Matrix Score (-10 to 20): **-10**

This option would reduce the flood potential on both Prior Lake, but would increase flood potential on Spring Lake. Although no primary structures on Spring Lake will be impacted, this option could potentially decrease the amount of dry land available for use by landowners.

Risk Factors: Matrix Score (-40 to 0): **-20**

This project could cause low lake levels on Prior Lake in drought conditions, and could potentially cause detrimental effects upstream by holding back water.

Cost of Project: Estimated Cost of Project: **$4,100.000**

The cost of the project includes feasibility studies and then implementation, including engineering, construction, and land acquisition payments. However, staff time (including negotiation, administration, etc.), title work, appraisals, and survey work are not included.

Potential Outside Funding Sources: USACOE Flood Programs

Total Matrix Score = Score/Cost Factor: **17**

Implementation Timeline: 10+ years A feasibility study would first be completed for the project. The most time-consuming and challenging part of the project will be obtaining permission from the 261 landowners on Spring Lake.

7.4.2.7 Floodproofing *(Option F)*

Rank out of 7 Options: **#7**

Summary: This option primarily involves permanent protection measures for at-risk primary structures only, including buyouts where floodproofing is not feasible or cost-effective. This is the highest cost alternative and does not provide any flood level reductions.

Flood Reduction Benefits: Matrix Score (0 to 690): **535**

\# of inches reduced in a 100-year flood event: 53.5

This option would improve the level of Prior Lake 100-year protection by removing primary structures below that level. However, this option did not receive any points for reduction of peak Prior Lake flood levels.

Water Quality and Natural Resource Benefits: Matrix Score (0 to 35): **0**

This option does not provide any water quality or natural resource benefits.

Feasibility Issues: Matrix Score (-196 to 40): **35**

\# of properties to acquire rights to: 0

This project would require construction permits for the installation of floodproofing measures. The project would also require landowners to sell or alter their property for floodproofing.

Human Impacts: Matrix Score (-10 to 20): **10**

This option would have positive impacts on Prior Lake landowners as it removes primary structures from the 100-year floodplain.

Risk Factors: Matrix Score (-40 to 0): **0**

This project will have no impact on flood levels on the lakes, and therefore will have no impacts during drought conditions or to downstream/upstream homes.

Cost of Project: Estimated Cost of Project: **$35,000,000**

The cost of the project includes the purchase of properties below the 100-year flood level and/or floodproofing homes which is estimated to be similar costs.

Potential Outside Funding Sources: USACOE Flood Programs

Total Matrix Score = Score/Cost Factor: **16**

Implementation Timeline: 10+ years This option will require cooperation from landowners to install floodproofing measures or to purchase their property for buyouts.

Weight Factor	Scoring Criteria	basis for rating	Option A *Enhanced Protection* Rating #	 Score	Option B *Spring Lake Storage* Rating #	 Score	Option C *Prior Lake Outlet Modification* Rating #	 Score	Option D *Upper Watershed Storage* Rating #	 Score	Option E *Combine Options B, C & D* Rating #	 Score	Option F *Floodproofing* Rating #	 Score	Option G *Actively Manage Prior Lake Outlet* Rating #	 Score
	Flood Reduction Benefits															
10	Increases upstream stormwater storage &/or moderates runoff rates	*yes (1) -or- no (0)*	0	0	1	10	0	0	1	10	1	10	0	0	0	0
10	Reduction of peak Prior Lake 100-year flood level	*# of inches*	0	0	9	90	10	100	15	150	34	340	0	0	3	30
10	Improved level of Prior Lake 100-year flood protection	*# of inches*	0	0	9	90	10	100	15	150	34	340	53.5	535	3	30
	Water Quality and Natural Resources Benefits															
5	Mimics natural hydrology	*yes (1) -or- no (0)*	0	0	0	0	0	0	1	5	1	5	0	0	0	0
5	Provides opportunity for infiltration &/or improves drought tolerance	*yes (1) -or- no (0)*	0	0	1	5	0	0	1	5	1	5	0	0	0	0
5	Minimizes downstream pollution impacts &/or deposition of sediments	*yes (1) -or- no (0)*	0	0	0	0	0	0	1	5	1	5	0	0	0	0
5	Expands wetland areas	*yes (1) -or- no (0)*	0	0	0	0	0	0	1	5	1	5	0	0	0	0
10	Enhances the effectiveness of existing water quality BMPs (improves upon prior investmen	*yes (1) -or- no (0)*	0	0	0	0	0	0	1	10	1	10	0	0	0	0
5	Provides additional/improved habitat for fish and/or wildlife	*yes (1) -or- no (0)*	0	0	1	5	0	0	1	5	1	5	0	0	0	0
	Feasibility Issues															
	Legal authority:															
5	Level of effort required to secure permits and necessary approvals	*hi (-1)/med.(0)/low (1)*	1	5	-1	-5	-1	-5	-1	-5	-1	-5	0	0	0	0
5	Is there current access to the property in order to implement the project?	*yes (1) -or- no (0)*	1	5	0	0	0	0	0	0	0	0	1	5	1	5
-0.5	Will we need to secure property rights?	*# properties affected*	0	0	261	-130.5	4	-2	120	-60	381	-190.5	0	0	0	0
15	Project implementation	*less than one year (2)* *1-10 years (1)* *10+ years (0)*	2	30	1	15	1	15	0	0	0	0	1	15	2	30
	Human Impacts															
10	Improves access to area roadways & businesses	*no effects (0)* *minimal effects (1)* *large potential effects (2)*	0	0	1	10	1	10	1	10	2	20	0	0	1	10
	Stakeholder Groups Impacted															
10	People/communities downstream of Prior Lake		0	0	0	0	-1	-10	0	0	-1	-10	0	0	0	0
10	Prior Lake land owners		-1	-10	1	10	1	10	1	10	1	10	1	10	1	10
10	Spring Lake land owners		0	0	-1	-10	0	0	1	10	0	0	0	0	0	0
10	Upper watershed landowners	*unaffected (0)* *positive effects (1)* *negative effects (-1)*	0	0	0	0	0	0	-1	-10	-1	-10	0	0	0	0
	Risk Factors															
-10	Potential for the project to cause low lake levels during drought conditions.	*no effects (0)* *minimal effects (1)* *large potential effects (2)*	0	0	1	-10	2	-20	0	0	2	-20	0	0	2	-20
-10	Potential for the project to cause detrimental effects downstream/upstream.	*no effects (0)* *minimal effects (1)* *large potential effects (2)*	0	0	1	-10	2	-20	1	-10	2	-20	0	0	1	-10
		BENEFIT/RISK SCORE:		30		69.5		178		290		499.5		565		85
	Cost of Project															
	Total cost of project (incl. maintenance costs for Option A)	(millions of dollars)		1		4.1		2.8		3.9		10.8		35		0.1
		COST SCORE (Total cost of project x (100%-Funding Opportunities)		1		4.1		2.8		3.9		10.8		35		0.1
		FINAL PROJECT SCORE (BENEFIT SCORE/COST):		**30**		**17**		**64**		**74**		**46**		**16**		**850**

Table 7-5 Detailed Comparison Matrix of Improvement Options

7.5 Cost/Benefit Analysis and Conclusions

Figure 7-3 shows how each of the potential improvement options are expected to improve the flood impacts for each of the flood frequency events, including summary information pertaining to the total estimated costs and number of primary structures and inaccessible properties at each flood level. **The figure shows that, if the conservative cost estimates for securing Spring Lake drainage easements are accurate, then the Spring Lake storage option will not be as cost effective (from a flood control perspective) as increasing the Prior Lake outlet capacity or increasing upper watershed storage.**

Figure 7-3 also indicates that the options involving an increase to the Prior Lake outlet capacity and increasing upper watershed storage are comparable at cost-effectively controlling flooding on Prior Lake. Upper watershed storage provides better flood control for the larger flood events than any of the other individual options. **For the 100-year event, the upper watershed storage option would protect an additional 30-35 primary structures and maintain accessibility to an additional 50 properties.**

Implementing a combination of the first three options would drop the 100-year flood level to within a half-foot of the OHW for Prior Lake (see Figure 7-3), which is likely more protection than would be necessary for this event. However, Figure 7-3 shows that the predicted 500-year flood level for Option E would still approach the high water level experienced during 2014.

Implementation of some combination of upper watershed storage (Option D), increased Prior Lake outlet capacity (Option C) and actively managing the Prior Lake outlet low-flow gate (Option G) is expected to provide the greatest flood protection in the most cost-effective manner. The biggest limitation of this combination of options is that it may take several years for full implementation. **As a result, it is expected that some combination of Options G and A will need to represent the short-term implementation measures. A scaled-down version of Option B, that involves less inundation on Spring Lake and less easement cost, may also represent a more cost-effective and viable short-term implementation measure. It is also expected that floodproofing (Option F) and/or buyouts will be a cost-effective measure for the lowest primary structures.**

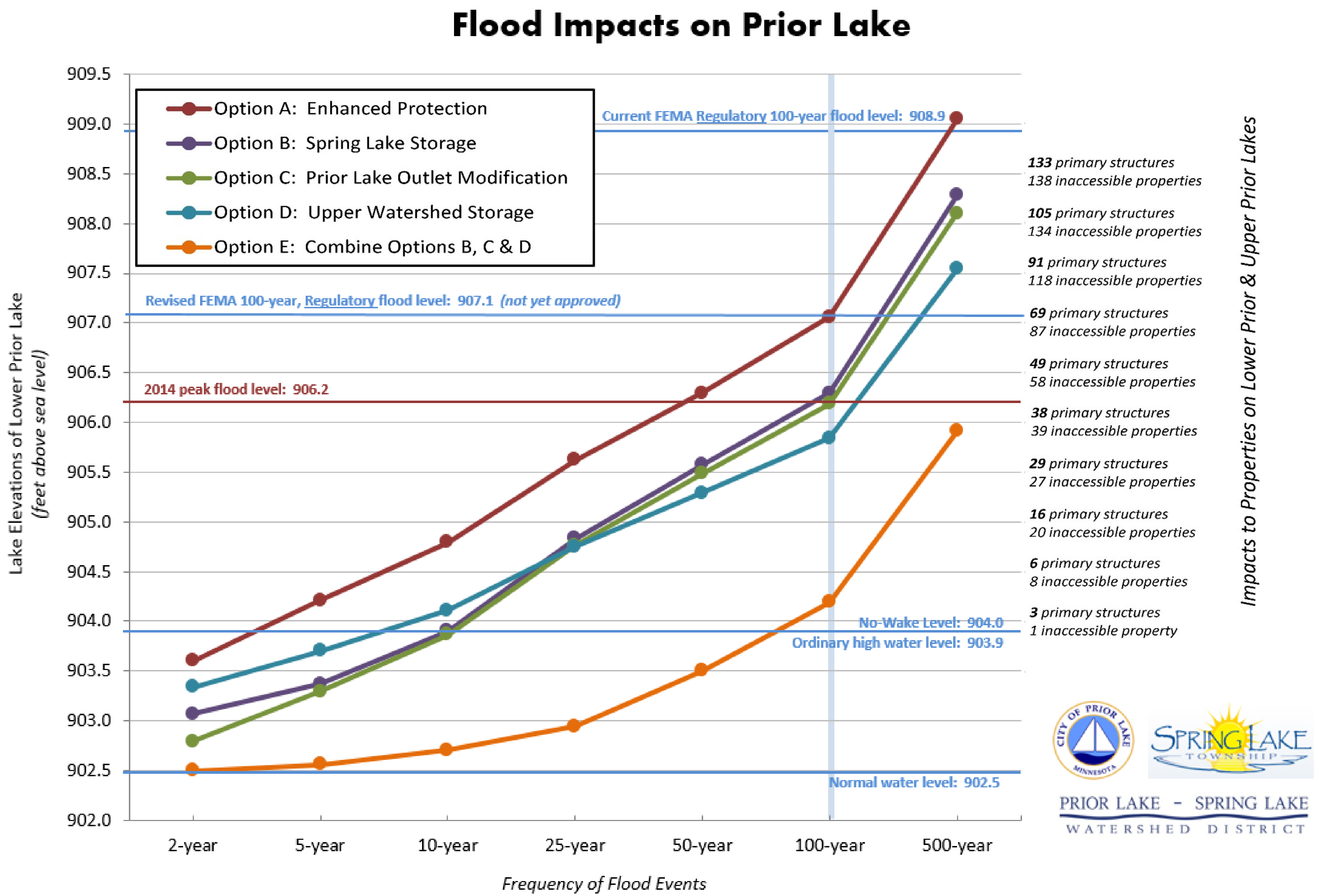


Figure 7-3 Cost/Benefit Summary of Potential Improvement Options

8.0 Preferred Option and Implementation Plan

In the wake of the major flooding event that occurred during the summer of 2014, the City of Prior Lake and the Prior Lake-Spring Lake Watershed District came together to commission this study. Previous sections addressed the goals of the study, reviewed the updated watershed modeling, and identified and evaluated a suite of potential flood reduction strategies. This section addresses details of the suite of solutions that will best meet the study goals and provides a road map for implementation of these strategies.

8.1 Policymaker Goals

Study results point to short-term and long-term solutions that will address flood protection levels. Policymakers were asked to provide direction on flood mitigation goals and flood protection levels.

8.1.1 Flood Mitigation Goals

As summarized in Section 4, policymakers met on two occasions to discuss this study and to determine flood protection goals. The policymakers prioritized the following policy goals (also listed in Section 3.3):

1. Protection of Public Safety - Maintain emergency vehicle access at all times
2. Protection of Health and Safety - Protect public utility infrastructure (i.e. sanitary sewer and water distribution)
3. Maintain traffic flow through the County Road 21 corridor
4. Maintain access to private properties

8.1.2 Flood Protection Level

A major policymaker-driven outcome was determining an acceptable flood level for Prior Lake. Policymakers settled on a two-tiered approach to address flood protection levels based on prioritized goals. Meeting a high-priority, first-tier protection level will reduce the flood level of Prior Lake to 905.5 for the 25-year return period. Accomplishing this prioritized flood protection level will protect six out of eight public right-of-way areas that would otherwise become inundated with flood water under existing conditions during this return period. The second-tier flood protection level will be determined by future assessments as part of an adaptive management strategy after the first-tier protection level has been achieved.

8.2 Implementation Partners

The PLSLWD and City of Prior Lake will work closely with a core group of partners to implement both short-term and long-term flood mitigation options. These core partners include:

- Spring Lake Township
- City of Shakopee

- Shakopee Mdewakanton Sioux Community (SMSC)

Other stakeholder groups and government agencies will have various roles within the study area during implementation, including landowner coordination, permitting, and funding. Other key implementation partners include (but are not limited to):

- The PLSLWD's Farmer-Led Council
- Scott County
- Lower Minnesota River Watershed District
- Scott Soil and Water Conservation District (SWCD)
- Board of Water and Soil Resources (BWSR)
- Minnesota Department of Natural Resource (DNR)
- Minnesota Pollution Control Agency (MPCA)

8.3 Recommended Implementation Options

To achieve flood protection and to meet the prioritized goals determined by the policymakers, a combination of solutions is required. Multiple partners will be involved in this implementation process, and a coordinated effort will be needed to successfully carry out the implementation plan.

Section 7 outlines the suite of options evaluated during the study. Of these options, two had a higher feasibility and could be easily implemented on a short timeline with relatively minimal cost. Policymakers provided direction to move forward with the short-term options Enhanced Protection (Option A) and Actively Managed Prior Lake Outlet (Option G). The remaining options have a longer timeline to implement. Policymakers agreed that Upper Watershed Storage (Option D) is the most feasible of the long-term options considering all the factors in the decision matrix (Figure 7-3).

8.3.1 Short-Term Implementation

Providing interim solutions to address flooding will help to address all listed policy goals but will not address the protection level goal. Implementing these solutions will be necessary in the short-term as project partners work to provide additional permanent flood reduction measures as part of the long-term implementation strategy.

8.3.1.1 Enhanced Protection (Option A)

The City of Prior Lake will lead efforts to coordinate temporary enhanced protection measures during flood events. Enhanced Protection was identified as Option A during the study process and is outlined in Section 7.4.2.5. A written plan is required for this option, which must be reviewed and adopted by the Prior Lake City Council. The City anticipates that the review and adoption process will be completed in 2017. It is further anticipated that future City budgets will include funding requests to support Enhanced Protection planning and implementation.

8.3.1.2 Actively Manage the Prior Lake Outlet (Option G)

Identified as Option G during the study process and outlined in Section 7.4.2.1, this option addresses policy goals by reducing the flood levels on Prior Lake. The option will involve more deliberate operation of the Prior Lake Outlet Structure's existing low-flow gate, releasing water from Prior Lake in anticipation of significant rainfall or snowmelt events. It represents a low-cost strategy for flood risk reduction for more frequent events, but on its own will not significantly reduce flood damage for a larger 100-year event.

PLSLWD will lead efforts to actively manage the Prior Lake outlet in 2017, which will include working with the DNR and the Prior Lake Outlet Channel Project Cooperators (SMSC and the Cities of Shakopee and Prior Lake) to update the 2004 Outlet Control Structure for Prior Lake – Management Policy and Operating Procedure. The DNR requires this policy, which authorizes the process for granting DNR approval to open the low-flow gate. The policy update will include creating a process that will determine when the low-flow gate should be opened. The new PCSWMM model, created as part of this study, will be used when developing the updated policy.

There is no timeline for the DNR approval process after the PLSLWD submits the plan, but since the DNR will be involved in the revision process, expedient action is anticipated.

8.3.2 Long-Term Implementation

The project partners will implement long-term solutions to address flooding over a 30-year timeframe. The PLSLWD will lead efforts to implement Upper Watershed Storage (Option D, Section 7.4.2.2) to meet the first-tier, high-priority Prior Lake protection level of 905.5 for the 25-year return period. To achieve the second-tier flood level goal, the PLSLWD will also lead efforts to cost-effectively provide additional flood protection above the high-priority protection level of 905.5 based on future assessments as part of an adaptive management strategy.

8.3.2.1 Upper Watershed Storage (Option D)

All other long-term options that were under consideration would take significant time to be fully implemented and would not provide any benefits until completely installed. The Upper Watershed Storage option can be implemented incrementally, therefore some benefit will be achieved as each storage project is completed. In addition to flood damage reduction, the Upper Watershed Storage option has the most potential to provide water quality improvement benefits. The location of potential projects to be implemented as part of Option D will not be limited to the conceptual storage areas identified in Section 7.1.4; these areas were selected during the model development phase of this study only as examples to demonstrate the feasibility of Option D, and not as an early version of any project location planning.

Implementation of Upper Watershed Storage projects must include careful consideration of many factors, including:

- Agreement/acquisition options – It will be necessary to secure property rights/access to implement and operate projects on private property. There are numerous potential approaches including temporary/permanent easements, land acquisition, and incentive payments. Agreements will include long-term operational standards and conditions of use.
- Willing landowners – Policymakers agreed that the priority is to work with willing landowners to implement projects that address the priority protection level goals of the study. The PLSLWD will document methods used to reach landowners and secure projects. This information will supplement the overall adaptive management strategy.
- Development opportunities – Land for Upper Watershed Storage projects could be secured through the subdivision platting process. Stormwater management will be required for all future development projects; additional flood protection could be incorporated into stormwater designs, similar to the oversizing approach Cities and Townships can exercise with trunk utility infrastructure. The PLSLWD, the City of Prior Lake, and Spring Lake Township will work together to ensure that these opportunities are identified early during the platting process.
- Potential effects upstream/downstream – Potential upstream and downstream effects were considered during the Technical Advisory Committee process that included review of seven different implementation options. All implementation efforts will include mitigation for any potential detrimental effects. The mitigation strategy will depend on the specifics of each site and negotiations with landowners. Developing a mitigation package to negate upstream/downstream effects will involve working with stakeholder groups, including farmers, the PLSLWD's Farmer-led Council, PLOC Project Cooperators (PLSLWD, SMSC, City of Shakopee, City of Prior Lake), and other individual landowners.

8.4 Additional Studies

All potential projects will require additional study and technical evaluation before moving into a design process. This may take the form of a feasibility or preliminary design study or other analysis to determine project scope, funding, cost/benefit ratio, and any other information necessary for approval. In addition, these studies will include stakeholder involvement to ensure coordination and support for the study outcomes. Studies will typically include the following components:

- Project Scope and Concept – The lead organization for a project will gather initial information about the project and outline how it could meet overall study goals. It includes project level options, concept-level design work/modeling, and project cost to establish a cost/benefit estimate. The potential for specific upstream/downstream impacts will be evaluated during this phase (e.g., impacts to existing drainage tiling systems).
- Regulatory Summary – Federal, state, and local regulations establish standards for wetlands, construction site management, stormwater management, and ongoing stormwater system maintenance. Each individual project will require regulatory analysis early in the planning process. It can take over a year to secure certain types of wetland project approvals. Regulatory coordination will be the responsibility of the lead partner for each project.
- Project Funding – A combination of funding mechanisms will be needed to implement the projects and programs identified in the study. The PLSLWD has identified related projects,

programs, and capital improvements within the *Water Resources Management Plan for the Prior Lake-Spring Lake Watershed District 2010-2019* (April 2010). The City of Prior Lake and Spring Lake Township also have defined relevant projects, programs, and capital improvements in their plans. Projects identified for implementation may be funded locally by the partners through in-kind staff time, capital improvement plans, and other mechanisms. Partners will also identify and pursue grants and other outside funding opportunities that align best with different project types.

- Findings and Recommendations – The studies will include enough information to move projects into the design phase, including a summary of findings and a final recommendation.
- Project Design, Construction, and Maintenance – These steps will take place after additional studies are completed and will rely on study findings as the projects move forward. Communication between implementing partners, landowners, and regulatory agencies will be critical during this phase.

8.5 Study Review and Updates

As projects are implemented, the project partners will update the flood model and collect monitoring data to evaluate progress. Using adaptive management concepts, regular updates on overall progress are required so that upcoming projects can be situated and designed to have the most benefits. The flood study will be updated with supplements as projects are implemented. Coordination between project partners will occur at regular intervals. A technical advisory meeting will be held at the staff level a minimum of once per year to assess progress toward project goals and to update other partners of ongoing activities. Monitoring data evaluation, modeling updates, and project performance evaluation should occur at least once every five years. Policymakers will also be asked to provide additional guidance at regular five-year intervals.

8.6 Funding/Financing Options

Watershed districts and cities finance and incentivize capital improvement projects using a variety of tools, including:

- watershed district levy
- water management and storm sewer improvement districts
- bonds
- tax increment financing district
- tax abatement
- stormwater utility fees
- insurance
- outside funding sources and local cost sharing

The above financing and incentive methods are described in the following sections.

8.6.1 Watershed District Levy

Under statutory authority, PLSLWD has the ability to collect taxes. PLSLWD uses an ad valorem tax (a uniform tax on all taxable parcels within a jurisdiction based on property values) to tax parcels within the watershed based upon PLSLWD's legal boundaries. By law, watershed districts are allowed to establish a number of funds for the purpose of carrying out their powers and duties, including the following levies that may be applicable for implementation of the preferred option:

- Bond Fund (M.S. Chapter 103D.905, Subd. 4)
- Construction or Implementation Fund (M.S. Chapter 103D.905, Subd. 5)
- Project Tax Levy (M.S. Chapter 103D.905, Subd. 9)
- Certain Projects of Common Benefit Involving Municipalities Fund (M.S. 103D.905, Subd. 3)
- Emergency Projects of Common Benefit Fund (M.S. 103D.615, Subd. 3)
- Planning and Implementation Fund (M.S. 103B.241)

8.6.2 Water management and storm sewer improvement districts

Funding by special assessments does not address watershed-wide stormwater management needs. However, a water management (special benefit) district can be created within the watershed district to provide an equitable mechanism for funding targeted and specific watershed projects that address local resource concerns and priorities. The fee and funding mechanism for water management districts is developed on the basis of benefitor contribution as it relates to a particular water resource issue (e.g., water volume for flooding). Water management districts must be established only for projects that are initiated and ordered to be implemented through formal hearing and adoption processes. Water management districts should not resemble an ad valorem tax, be based on property values or be collected in anticipation of projects not formally established and ordered by the watershed district managers.

Cities may fund specialized city infrastructure by creating a storm sewer improvement district (SSID). Cities must pass an ordinance to create an SSID. Once established, the City "may acquire, construct, reconstruct, extend, maintain, and otherwise improve storm sewer systems and related systems" within the SSID. The City "may also acquire, maintain and improve stormwater holding areas and ponds" for the benefit of the SSID. The City pays for the improvements in the SSID by levying taxes on the property in the district. Tax levies also pay for principal and interest on bonds.

8.6.3 Bonds

Cities borrow money by issuing and selling municipal bonds, also known as general obligation bonds. The watershed district also engages in bonding for special or large scale projects. Cities have limits on the amount of debt they can take on through issuing and selling bonds. The current "net debt" limit is 3% of the estimated market value of taxable property in the city (from 2014 Handbook for Minnesota Cities, League of Minnesota Cities).

Other types of bonds include:

- **Revenue bonds** – these bonds are tied to a specific funding stream
- **General obligation revenue bonds** – these bonds are tied to both the "full faith and credit" of the City and a specific funding stream
- **Bonds by purpose** – general obligation bonds issued for a specific purpose – not a legal requirement, but used to conveniently identify bonds to a specific project
- **Bonds by user** – these are also called "private activity bonds" and are used partially or entirely for private purposes, but are still tax exempt.

In some situations, city residents must vote in favor of a bond before City issuance of a bond, but there are many exceptions to this requirement.

The Cities could sell bonds to help pay for the projects. The amount each City would need to fund through bonding would depend on the amount of funds available in its stormwater fund (fund balance) – i.e., the smaller the fund balance, the more bonding that would be required. The bonds are rated based on the City's bond rating.

8.6.4 Tax increment financing district

Cities may use tax increment financing (TIF) to fund more than local improvements. The TIF tool segregates tax dollars from a defined area for use in developing and improving the area, which can include local improvements. The following is from the Handbook for Minnesota Cities (2014, League of Minnesota Cities):

> *TIF takes advantage of the increases in tax capacity and property taxes from development or redevelopment before the development actually occurs to pay for public development or redevelopment costs. The difference in the tax capacity and the tax revenues the property generates after new construction has occurred, compared with the tax capacity and tax revenues it generated before the construction, is the captured value. The taxes paid on the captured value are called "increments." Unlike property taxes, increments are not used to pay for the general costs of Cities, Counties, and Schools. Instead, increments go directly to the development authority to repay public indebtedness or upfront costs the City incurs in acquiring the property, removing existing structures, or installing public services.*

8.6.5 Tax abatement

Through this financing tool, Cities can authorize the issuance of bonds, which are paid back with funds collected by tax abatements. The tax is not actually forgiven (abated), but is paid normally, with the amount of property tax levied by the City used to pay for the bonds. The following example is from the Handbook for Minnesota Cities (2014, League of Minnesota Cities):

> *A City may "abate" all or a portion of City property tax on one or more parcels of real or personal property, including machinery, for economic development purposes. And Cities may issue general*

obligation or revenue bonds to construct public improvements. As the property owners pay the abated taxes, rather than the local property taxes, the payments go directly to paying off the bonds.

Tax abatement bonds do not require a referendum approval and are excluded from debt limits. However, in any year, the total amount of property taxes abated by a City may not exceed 10 percent of the net tax capacity of the City for the taxes payable year applicable to the abatement or $200,000, whichever is greater.

8.6.6 Stormwater utility fees

The city of Prior Lake has a stormwater utility in place that generate fees that could be used to help pay for some of the identified projects. Stormwater utility fees may be based on the size of the property, the type of property, or the quantity and quality of runoff and disposal difficulties.

Cities could impose a "user surcharge" for flood mitigation on top of the usual stormwater utility fee for properties within the watershed or spread over a larger area such as an entire City. An advantage of the user surcharge is that it would start generating the funds immediately.

8.6.7 Insurance

Balancing flood management with agricultural productivity will require an integrated approach to manage crop production risk. The Federal Crop Insurance program provides a mechanism for producers to insure their crops for events, including losses or prevented planting due to flooding. While intentional flooding of agricultural land is not covered, the Agricultural Risk Protection Act of 2000 provides a mechanism under which the Federal Crop Insurance Corporation may reimburse approved insurance developers for the development of a new crop insurance product. In addition to delivery of Federal programs, private companies may also provide producers with insurance products (a rider policy) that add coverage or features to the basic Federal Crop Insurance products. These insurance products may be used in place of, or may reduce the cost of purchasing drainage easements. Alternatively, the project partners could choose to offer their own internal insurance coverage to affected producers or use a combination of the above solutions on a case-by-case basis, depending on the characteristics of each upstream storage area.

8.6.8 Outside funding sources

Ideally, the largest possible percentage of the project implementation costs would be paid for through outside sources of funding—e.g., grants, state funding (legislation), and other outside funding sources. The following paragraphs outline several of the potential funding sources to help implement the flood mitigation projects identified in this plan; however, this is not an all-inclusive list and there may be additional funding sources not identified below.

8.6.8.1 Minnesota Department of Natural Resources

Grants for flood reduction/management projects are more limited than for water quality improvement projects. The Minnesota Department of Natural Resources' (MnDNR) Flood Damage Reduction grant (FDR) is the only state grant available for flood reduction projects. Under this program, the state can provide cost-share grants to local units of government for up to 50 percent of the total cost of a project. Cities, counties, towns, watershed districts and watershed management organizations, lake improvement districts, soil and water conservation districts, and joint powers organizations composed of any of these units may apply.

Currently, there are two different classes of grants available through the FDR Program:

1. **Small grants—**these grants are for projects with a total cost up to $300,000 (maximum state share $150,000). The MnDNR grants these funds directly from general funds appropriated by the Minnesota State Legislature. These are competitive, and are limited to available funds. Small projects and studies are covered through this grant program.
2. **Large grants—**these grants are for projects with a total cost greater than $300,000 (state share greater than $150,000). Large grant applications are received and prioritized by the MnDNR and then presented to the Governor and the Legislature for consideration in a capital bonding bill. A project will be funded based on its rank after prioritization and the amount of program funding made available by the Legislature. (Note: every biennium, the Legislature appropriates funds for these larger grants.) For flood mitigation/reduction projects to receive these funds, the projects must be approved by the legislature (i.e., they must go through the legislative process).

The types of projects eligible for FDR grants include:

- structural acquisition in the 100-year floodplain
- levees, ring dikes, and flood walls
- elevating existing structures
- flood warning systems
- public education
- flood insurance studies
- floodplain mapping
- comprehensive watershed plans
- flood storage easements

The implementation projects in this flood mitigation study would likely require a large grant (and legislative approval). If a presidential declaration has been issued in Minnesota, FEMA pays for 75 percent of the cost of structural acquisition, with the remaining 25 percent to be provided by the local governments. The FDR program will pay half the local share, leaving the local government unit with only a 12.5 percent share. The FDR program will also pay for half of the 35 percent nonfederal share of federal flood hazard mitigation projects.

The Conservation Partners Legacy (CPL) Grant Program funds conservation projects that restore, enhance, or protect forests, wetlands, prairies, and habitat for fish, game, and wildlife in Minnesota. Funding for the CPL grant program is from the Outdoor Heritage Fund. The MN DNR manages this reimbursable program to provide competitive matching grants from $5,000 to $400,000 to local, regional, state, and national nonprofit organizations, including government entities.

The Wetland Tax Exemption Program was created to provide a financial incentive to maintain wetlands in their natural state and to promote an awareness of wetland values. Eligible projects include wetlands inventoried as Public Waters Wetlands (as defined in M.S. 103G); lands mostly under water that produce little if any income and have no use except for wildlife or water conservation purposes; land in a wetland preservation area. Private landowners may apply for this program such that qualifying areas are exempt from property taxes. The exemption should remain in effect as long as the wetland meets the requirements set forth in the statutes.

8.6.8.2 Minnesota Board of Water and Soil Resources (BWSR)

BWSR receives appropriations from the Clean Water, Land & Legacy Amendment to pay for on-the-ground conservation projects that provide multiple benefits for water quality and wildlife habitat, which include appropriations from the Clean Water Fund. BWSR allocates Clean Water Fund monies through a grant program to fund projects that protect, enhance, and restore water quality in lakes, rivers, and streams in addition to protecting ground water and drinking water sources from degradation. Eligible applicants for the BWSR Projects and Practices grant include soil and water conservation districts, watershed districts, joint powers watershed management organizations, counties, cities, and joint powers boards of these organizations. The Multipurpose Drainage Management (MDM) grant program is intended to implement management practices to reduce erosion and sedimentation, reduce peak flows and flooding, and improve water quality, while protecting drainage system efficiency and reducing drainage system maintenance for priority Chapter 103E drainage systems. Both grants require a 25% local match. A flood mitigation project that also incorporates water quality treatment could be eligible for funding through the Projects and Practices grant and on-field, on-farm, and on-drainage system practices within the watershed of a priority Chapter 103E drainage system are eligible for the MDM grant.

BWSR has established a Reinvest in Minnesota (RIM) subprogram—RIM Wetlands, which is intended to identify and enroll under permanent easement, private lands that contain drained/altered wetland systems and adjoining buffers where the functions and values of those wetland systems can be restored. The program provides the opportunity for limited duration Conservation Reserve Program (CRP) contracts to be converted into perpetual easements. All wetland restorations must meet NRCS Practice Standard 657 and may include either hydrology restoration and/or cropping system cessation on those altered wetlands that were only cropped under natural conditions.

8.6.8.3 Minnesota Pollution Control Agency

The Clean Water Revolving Fund, also known as the State Revolving Fund (SRF) was established by the federal Clean Water Act to replace the federal Construction Grants Program. Minnesota's SRF is managed by the Minnesota Public Facilities Authority (PFA). PFA and MPCA staff jointly administer the wastewater and stormwater components of the SRF. The PFA is responsible for the financial elements of the program, while the MPCA is responsible for its environmental and technical components. One of the MPCA's primary responsibilities is to score and rank proposed construction projects in accordance with the environmental criteria contained in Minn. R. 7077.0117 to 7077.0119. The result of this ranked list is called the Project Priority List (PPL). Storm sewer collection, conveyance, and treatment systems are eligible for loans from this funding source.

The MPCA provides financial and technical assistance to local government and other water resource managers to address nonpoint-source water pollution through the state Clean Water Partnership (CWP) loan and federal Clean Water Act Section 319 (Section 319) programs. Section 319 funds are being used for total maximum daily load (TMDL) and implementation projects for watershed restoration and protection strategies (WRAPS). CWP loan funds are used for development or implementation projects that protect water bodies currently meeting Minnesota's water quality standards.

The CWP and Section 319 programs address nonpoint sources of pollution, which may come from agricultural fields, storm sewers, construction sites, animal feedlots, paved surfaces, failing septic systems and over-fertilized lawns. A local unit of government able to generate revenue and adopt and enforce official controls must sponsor a CWP project and act as its fiscal agent. These applicants may be a tribe, township, city, county, watershed district, watershed management organization or joint powers board whose members are townships, cities or counties. While the CWP is limited to local units of government, Section 319 is open to all entities except federal agencies.

8.6.8.4 USDA Farm Service Agency

The Conservation Reserve Program (CRP) is a cost-share and rental payment program under the United States Department of Agriculture (USDA), and is administered by the USDA Farm Service Agency (FSA). The Conservation Reserve Program (CRP) pays a yearly rental payment in exchange for farmers removing environmentally sensitive land from agricultural production and planting species that will improve environmental quality. Contracts for land enrolled in CRP are 10-15 years in length.

A sub-program of the Conservation Reserve Program, the Conservation Reserve Enhancement Program (CREP) is a state-federal multi-year land retirement United States Department of Agriculture (USDA) program developed by states and targeted to specific state and nationally significant water quality, soil erosion, and wildlife habitat problems. CREP uses the state funds to offer higher payments per acre to participants than the CRP.

8.6.8.5 Natural Resources Conservation Service (NRCS)

The Environmental Quality Incentives Program (EQIP) is a voluntary program that provides financial and technical assistance to agricultural producers to plan and implement conservation practices that improve soil, water, plant, animal, air and related natural resources on agricultural land and non-industrial private forestland. EQIP may also help producers meet Federal, State, Tribal, and local environmental regulations. Eligible land includes cropland, rangeland, pastureland, non-industrial private forestland and other farm or ranch lands. Financial assistance payments through EQIP are made to eligible producers, to implement approved conservation practices on eligible land or to help producers develop Conservation Activity Plans (CAP) to address specific land use issues. Payments are made on completed practices or activities identified in an EQIP contract that meet NRCS standards. Payment rates are set each fiscal year and are attached to the EQIP contract when it is approved.

The Agricultural Conservation Easement Program (ACEP) provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits. Under the Agricultural Land Easements component, NRCS helps American Indian tribes, state and local governments and non-governmental organizations protect working agricultural lands and limit non-agricultural uses of the land. Under the Wetlands Reserve Easements component, NRCS helps to restore, protect and enhance enrolled wetlands. Under the Agricultural Land component, NRCS may contribute up to 50 percent of the fair market value of the agricultural land easement. Where NRCS determines that grasslands of special environmental significance will be protected, NRCS may contribute up to 75 percent of the fair market value of the agricultural land easement.

8.6.8.6 Minnesota Division of Homeland Security and Emergency Management

The Hazard Mitigation Grant Program provides funding with the aim to reduce or eliminate risk to property and loss of life from future natural disasters. HMGP funds become available after a Presidential disaster declaration. Mitigation funding is available to all eligible entities in the state; however priority is given to those in the declaration. The amount of HMGP funds availability is based on a percent of Public Assistance provided by Federal Emergency Management Agency (FEMA).

The federal share of HMGP is 75% of total eligible project reimbursement costs. The local applicant is responsible for 25% of the project costs. All projects must be eligible, technically feasible, and cost-effective and subject to environmental and cultural resource review. Example projects include property acquisition and structure demolition or relocation and infrastructure retrofit projects.

8.6.8.7 Federal Emergency Management Agency (FEMA)

The Pre-Disaster Mitigation (PDM) grant program is designed to assist states, U.S. Territories, Federally-recognized tribes, and local communities in implementing a sustained pre-disaster natural hazard mitigation program. The goal is to reduce overall risk to the population and structures from future hazard events, while also reducing reliance on Federal funding in future disasters. This program awards planning and project grants and provides opportunities for raising public awareness about reducing future losses before disaster strikes. PDM grants are funded annually by Congressional appropriations and are awarded on a nationally competitive basis.

FEMA requires state, territorial, tribal, and local governments to develop and adopt hazard mitigation plans as a condition for receiving certain types of non-emergency disaster assistance, including funding for PDM mitigation projects.

8.6.8.8 US Army Corps of Engineers

Section 205 of the 1948 Flood Control Act authorizes the Corps of Engineers to study, design, and construct small flood control projects in partnership with non-Federal government agencies, such as cities, counties, special authorities, or units of state government. Projects are planned and designed under this authority to provide the same complete flood control project that would be provided under specific congressional authorizations. The maximum Federal cost for planning, design, and construction of any one project is $10 million. Each project must be economically justified, environmentally sound, and technically feasible. Flood control projects are not limited to any particular type of improvement. Levee and channel modifications are examples of flood control projects constructed utilizing the Section 205 authority. Final design (plans and specifications) and construction costs are 65 percent Federal and 35 percent non-Federal.

8.6.8.9 Other Grant Sources

There are other potential grant sources available through different organizations that can be used to offset some of the costs related to the flood mitigation projects, including the Metropolitan Council and the Minnesota Department of Employment and Economic Development. Both of these agencies provide funding for assessing and/or cleanup of contaminated (brownfields) sites. Additionally, the Metropolitan Council has a stormwater grant program that can be used for the implementation of innovative stormwater management practices that improve water quality. Depending on the elements of an implementation project, private grant sources may also represent a viable source for partial funding.

Appendix A—Modeling Technical Memoranda

Technical Memorandum

To: Prior Lake-Spring Lake Watershed District Managers
From: Greg Fransen and Greg Wilson, Barr Engineering
Subject: Analysis of Flood Damage Reduction Measures for Prior Lake
Date: March 22, 2016
Project: 23701048.00

1.0 Introduction

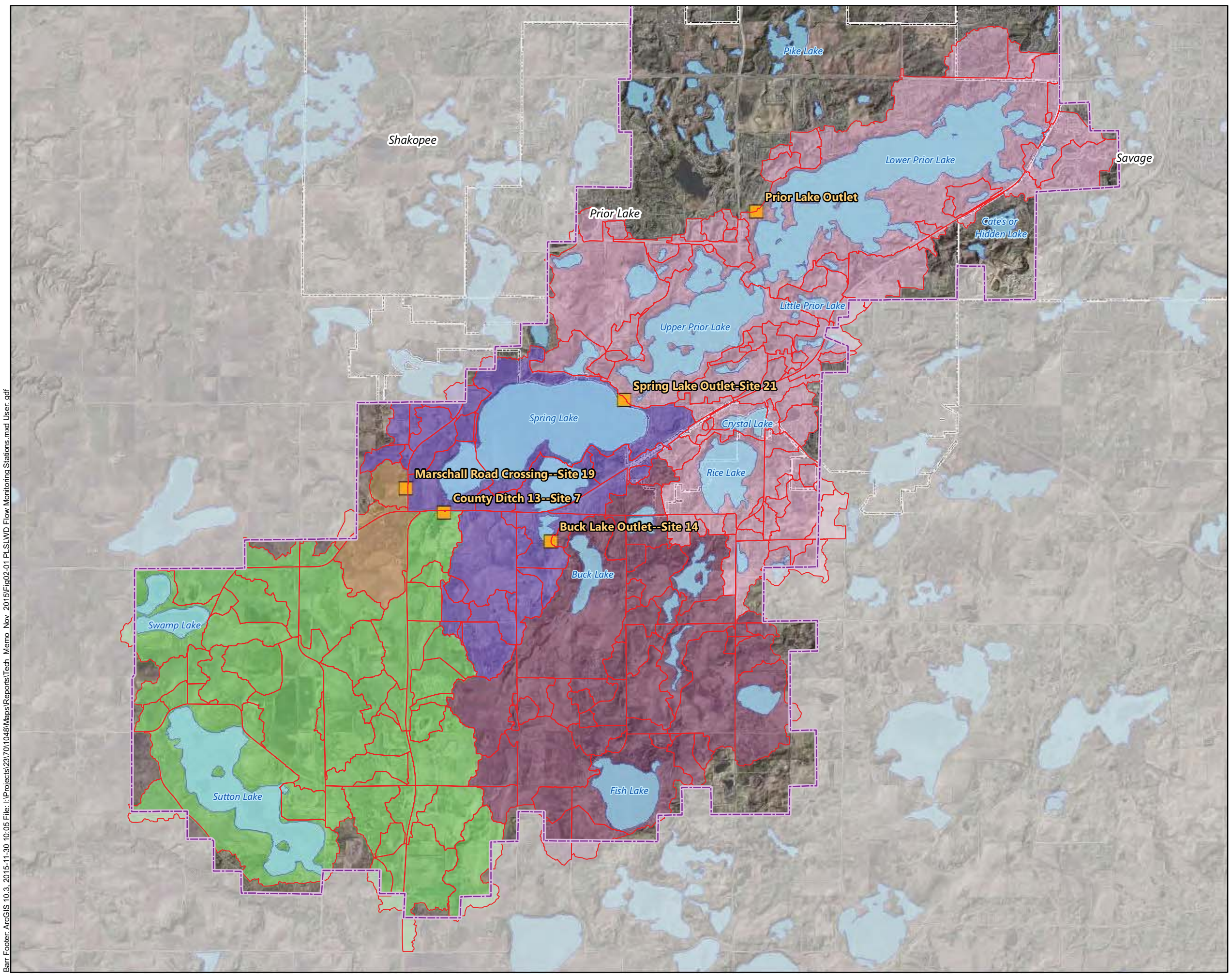
The purpose of this memorandum is to document the methodology used by Barr Engineering (Barr) to evaluate potential flood reduction measures for Prior Lake and to summarize the results of that analysis.

Barr used a hydrologic and hydraulic model of the Prior Lake watershed calibrated for the 2014 Prior Lake flooding event to simulate the effects of the 100-year, 30-day Atlas 14 rainfall event on the peak water surface elevations of Prior Lake and Spring Lake. Barr, working with the Technical Advisory Committee (TAC) then identified potential flood reduction measures, modeled their simulated impacts on the peak elevations of Prior Lake and Spring Lake, and developed planning level cost estimates to implement the potential projects.

2.0 Analysis of the Prior Lake 2014 Flooding Event

PLSLWD staff members collected continuous (15-minute interval) stage monitoring data at five sites during the 2014 monitoring season – two major tributaries and one minor tributary to Spring Lake, along with Spring Lake and Prior Lake (**Figure 2-1**). PLSLWD staff used rating curves to convert stage measurements to discharge at each site. In addition, the Shakopee Mdewakanton Sioux Community (SMSC) provided Arctic Lake outlet synoptic flow monitoring data which Barr used to generally determine whether the Arctic Lake portion of the watershed was contributing flow during the calibration time period. Most of the available monitoring data covered the time period from March 28th through October, 2014, with some synoptic measurements prior to March 28, 2014.

Table 2-1 summarizes drainage characteristics for each of the five PLSLWD monitoring stations. The combined drainage area of the Buck Lake and County Ditch 13 monitoring sites accounts for 76 percent of the Spring Lake watershed and 52 percent of the Prior Lake watershed.



Monitoring Station
Subwatershed Boundary

Monitoring Station Watersheds

Buck Lake Outlet
County Ditch 13
Marschall Road Crossing
Prior Lake
Spring Lake

Public Water Inventory Basin
Prior Lake-Spring Lake Watershed District
Municipal Boundary

N

Feet
4,500 0 4,500

Meters
1,500 0 1,500

Figure 2-1

PLSLWD FLOW MONITORING STATIONS

PCSWMM Modeling Technical Memo
Prior Lake-Spring Lake Watershed District
Scott County, Minnesota

Table 2-1 2014 PLSLWD Flow Monitoring Sites

Monitoring Site—Site #	Watershed Area (acres)[1]	Percent of Spring Lake Watershed Area	Percent of Prior Lake Watershed Area
Marschall Road Crossing—Site 19	401	3%	2%
Buck Lake Outlet—Site 14	4,036	32%	21%
County Ditch 13—Site 7	5,526	44%	29%
Spring Lake Outlet—Site 21	12,703	100%	66%
Prior Lake Outlet	19,239	--	100%

[1] Watershed areas include potentially landlocked or non-contributing areas.

Figure 2-2 shows the measured hydrograph data for the five watershed monitoring sites for the period between the end of April and July, 2014. More than seven inches of rainfall fell across most of the watershed between June 15th and the 20th, which contributed to the peak discharge rates observed at all five monitoring sites. While all three of the tributary stations experienced peak flow on June 19th, the flow monitoring results show that the tributary stations experienced varying levels of flashiness and relative magnitudes of peak discharge. All of the storm flow at Site 19 discharged within two days, while flow at Sites 7 and 14 returned to pre-storm levels within six days after peak discharge. For the Spring Lake outlet, peak discharge occurred on June 22nd – three days after the peak discharge rates occurred at the three tributary monitoring stations. Flow out of the Spring Lake outlet returned to pre-storm levels within 14 days of the peak discharge. On July 25th temporary sandbagging at the Spring Lake outlet reduced the Spring Lake discharge to zero. The peak Prior Lake level and outlet discharge rate occurred on June 30th and Prior Lake did not return to pre-storm levels for more than 40 days.

It is important to note that flow out of the Prior Lake outlet did not begin until April 29, 2014 because the beginning lake elevation was 900.10 feet MSL on March 28th, which would have required approximately 3,460 acre-feet of inflow to raise the Prior Lake elevation to the control elevation of 902.5 feet MSL. In addition, lake level and outflow estimates from the Spring Lake outlet do not begin until April 29th, when the estimated outflow rate already exceeded 50 cfs.

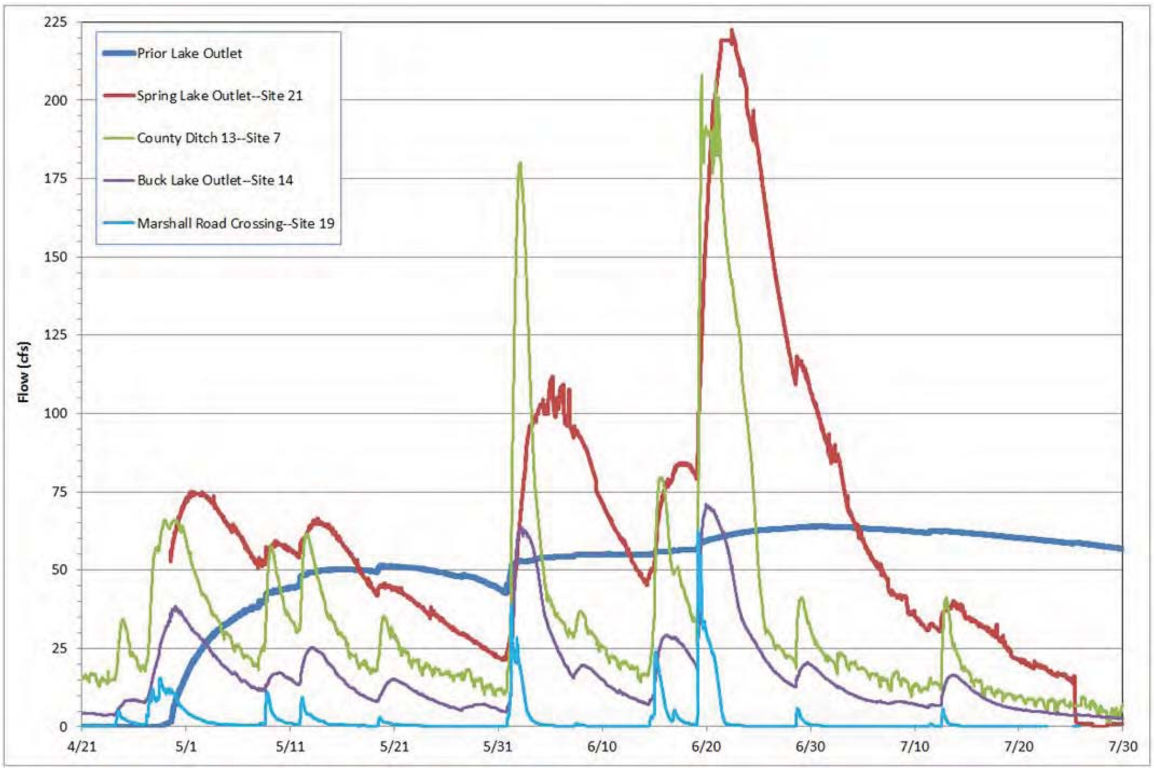


Figure 2-2 Observed Flow Data for 2014

Figure 2-3 shows how the combined hydrograph of the three monitored tributaries compares to the flow discharging from the Spring Lake and Prior Lake outlets. This figure allows for a more direct comparison of the magnitude and timing of the Spring Lake inflow hydrographs to the resulting discharges from each of the lake outlets. The peak Spring Lake elevation occurred three days after the peak discharge rates occurred in the upper watershed, while Prior Lake did not reach its peak flood level until 11 days after the peak discharge occurred in the upper portion of the Spring Lake watershed.

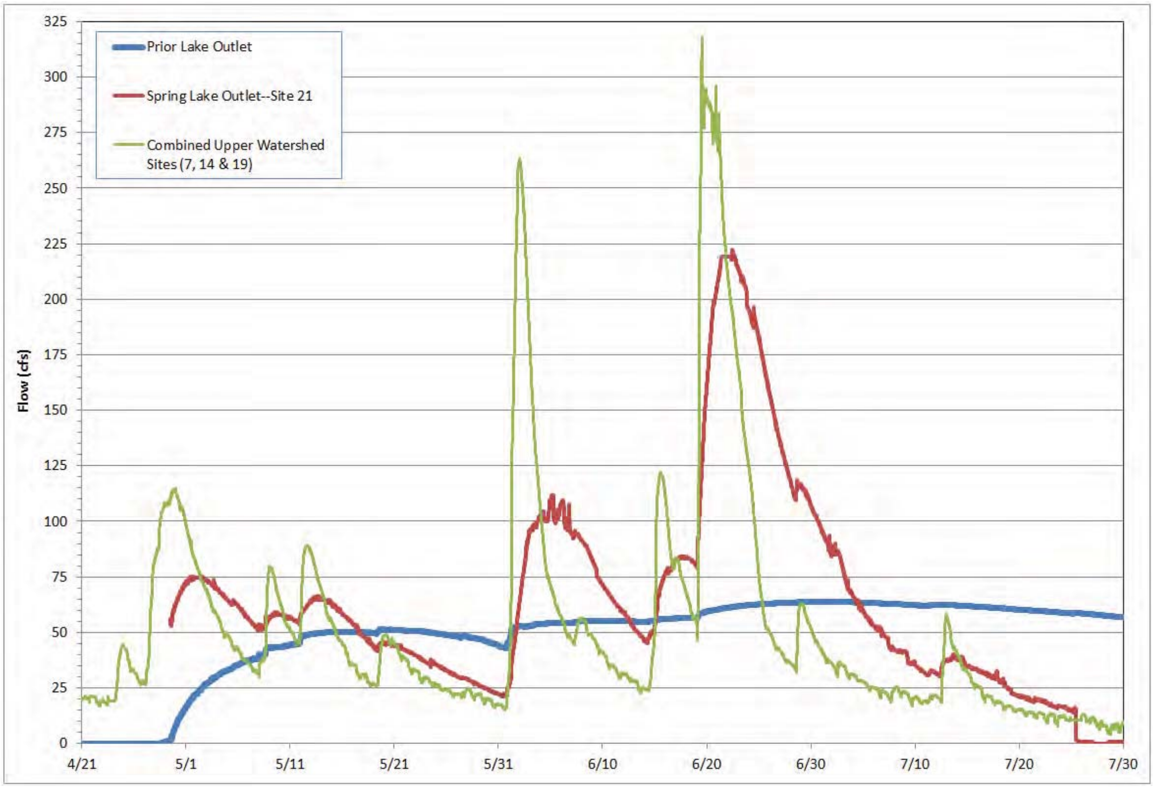


Figure 2-3 Observed Flow Data for 2014 with Upper Watershed Sites Combined

Table 2-2 summarizes the measured flow volume through September 10th, expressed both in acre-feet and as the yield (volume divided watershed area) in inches, as well as two expressions of the peak discharge rates at the five monitoring stations (with the last column normalized to watershed area).

Table 2-2 2014 Flow Monitoring Summary

Monitoring Site—Site #	Measured Flow Volume—thru 9/10/14 (acre-feet)	Watershed Yield (inches)	Peak Discharge Rate (cfs)	Area-Normalized Peak Discharge Rate (cfs/acre)
Marschall Road Crossing—Site 19	468	13.5	62	0.155
Buck Lake Outlet—Site 14	3,732	10.8	71	0.018
County Ditch 13—Site 7	8,259	17.6	207	0.038
Combined Upper Watershed—Sites 7, 14 & 19	12,458	14.6	318	0.032
Spring Lake Outlet—Site 21	12,021[1]	11.4	222	0.018
Prior Lake Outlet	15,485[2]	9.7	64	0.003

[1] Does not include unmonitored volume associated with the Spring Lake outlet discharge prior to April 29, 2014.

[2] Includes water volume associated with lake level rise in advance of discharge from the Prior Lake outlet.

The following conclusions can be drawn from the 2014 monitoring data:

- The upper Spring Lake watershed, which represents 52% of the Prior Lake watershed, contributed more than 80% of the flow volume that discharged from the Prior Lake outlet in 2014
- The County Ditch 13 watershed, which represents 29% of the Prior Lake watershed, contributed more than 53% of the flow volume that discharged from the Prior Lake outlet in 2014
- The Buck Lake watershed, which represents 21% of the Prior Lake watershed, contributed 24% of the flow volume that discharged from the Prior Lake outlet in 2014
- The Marschall Road Crossing watershed, which represents 2% of the Prior Lake watershed, contributed 3% of the flow volume that discharged from the Prior Lake outlet in 2014
- Watershed yield from the County Ditch 13 watershed was significantly higher (more than 30% higher) than any of the other watershed monitoring stations
- Watershed yield from the Buck Lake tributary was significantly lower than the other upper Spring Lake watershed tributaries, but higher than the areas draining directly to Prior Lake
- The available lake and wetland storage in the Buck Lake Outlet watershed results in less than half the normalized peak discharge rate computed for the County Ditch 13 watershed
- The normalized peak discharge rate for the Buck Lake tributary was approximately equal to the Spring Lake outlet, which was six times higher than the normalized peak discharge rate for the Prior Lake outlet in 2014

Barr's analysis of the 2014 monitoring data indicated that enhanced upper watershed storage – particularly in the County Ditch 13 watershed – and better control of peak discharge from the Spring Lake outlet have the highest potential for reducing peak elevations in Prior Lake. The peak 100-year Prior Lake elevation determined by this study occurred approximately 14 days after the peak rainfall intensity of the 100-year, 30-day Atlas 14 rainfall event. To have a noticeable effect on the peak Prior Lake elevation, detention storage areas would need to detain water until after Prior Lake had reached its peak.

3.0 Flood Reduction Measures

Barr modeled a number of potential flood-reduction measures. Each measure was evaluated separately (i.e. as if it was the only measure that was implemented) and then all of the potential flood-reduction measures were implemented together (i.e. as if they were all implemented). Those measures that were judged to be reasonable and to have a measurable impact on the peak flood elevation of Prior Lake are described in more detail below.

3.1 Upland Detention Storage Areas

Working with the Technical Advisory Committee (TAC), Barr identified a number of potential upland detention storage areas. The sites selected for further evaluation included locations where modeling showed temporary ponding already occurred under existing conditions, locations where the existing topography allowed for significant increased storage by adding limited additional infrastructure, and other locations where local interest had previously been shown.

Barr screened the potential sites using the 100-year, 30-day event and selected ten sites for more-detailed modeling, nine of which include the development of additional storage volume. An option including Little Prior Lake was included in the analysis to account for additional storage that could be provided with existing infrastructure. Barr modeled each area with a restrictive outlet that would decrease its discharge rate and assumed that berms would be constructed as needed to increase the area's storage volume in order to achieve the required detention time. **Table 3-1** summarizes the existing and proposed outlet characteristics for each of the upland detention storage areas. **Figures 3-1 through 3-10** show the existing conditions 100-year, 30-day event hydrographs and the proposed conditions 1-, 2-, 5-, 10-, 50-, 100-, and 500-year, 30-day event hydrographs for each of the nine sites. Figures showing the location of the detention areas and comparing the existing and proposed conditions 100-year inundation extents are shown in **Appendix A**.

Table 3-1 Upland Detention Storage Summary

Detention Site Name	Existing Outlet	Proposed Restrictive Outlet and Overflow Structure	Proposed Overflow Elevation (NGVD29)	Proposed Embankment Length (ft)
S-BL-001 (Buck Lake)	Open channel	2-ft diameter orifice 6 x 6 ft box	921.8	110
S-BL-020	Open channel	0.5-ft diameter orifice 6 x 6 ft box	959.0	165
S-LPL-048 (Little Prior Lake)	1.5-ft diameter storm sewer pipe with skimmer (gate open)	1.5-ft diameter storm sewer pipe with skimmer (gate closed)	925.2	N/A
S-SPL-046	30-ft weir	2-ft diameter orifice 30-ft weir	922.0	650
S-SPL-054	Open channel	0.3-ft diameter orifice 6 x 6 ft box	934.5	430
S-SPL-059	Open channel	0.5-ft diameter orifice 6 x 6 ft box	943.6	410
S-SPL-078	4-ft diameter culvert	0.5-ft diameter orifice 6 x 6 ft box	943.5	219
S-SPL-080	2-ft diameter culvert (estimated)	0.5-ft diameter orifice 6 x 6 ft box	951.5	500
S-SPL-094	5-ft diameter culvert	2-ft diameter orifice 6 x 6 ft box	936.5	N/A
S-SUL-001 (Sutton Lake)	4-ft diameter culvert	1-ft diameter orifice 6 x 6 ft box	945.3	N/A

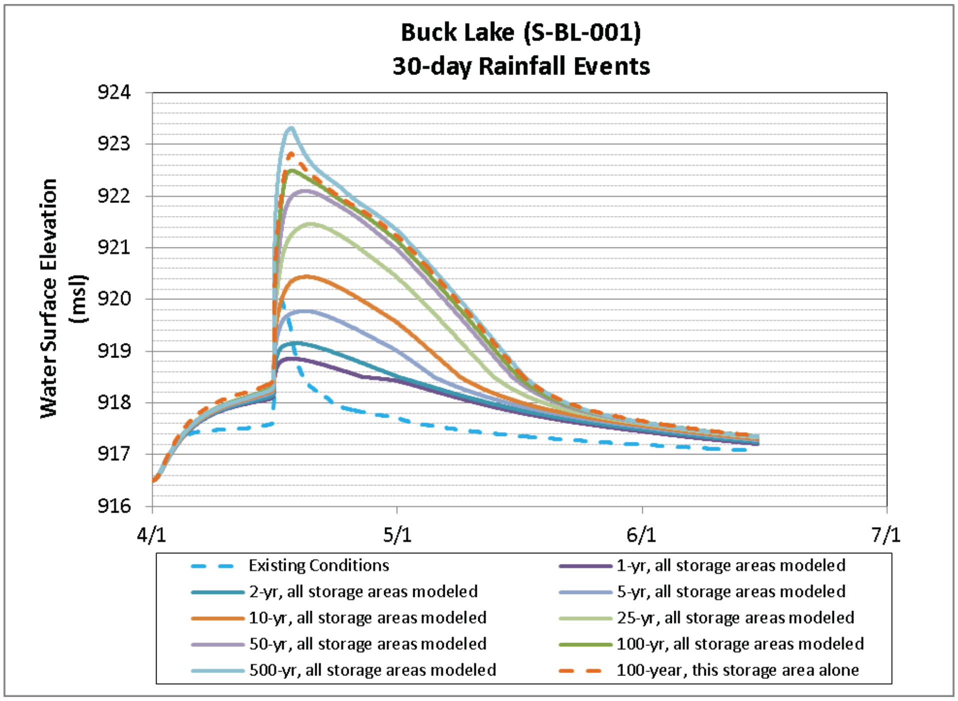


Figure 3-1 Existing and Proposed Conditions Elevation for Potential Storage Area S-BL-001

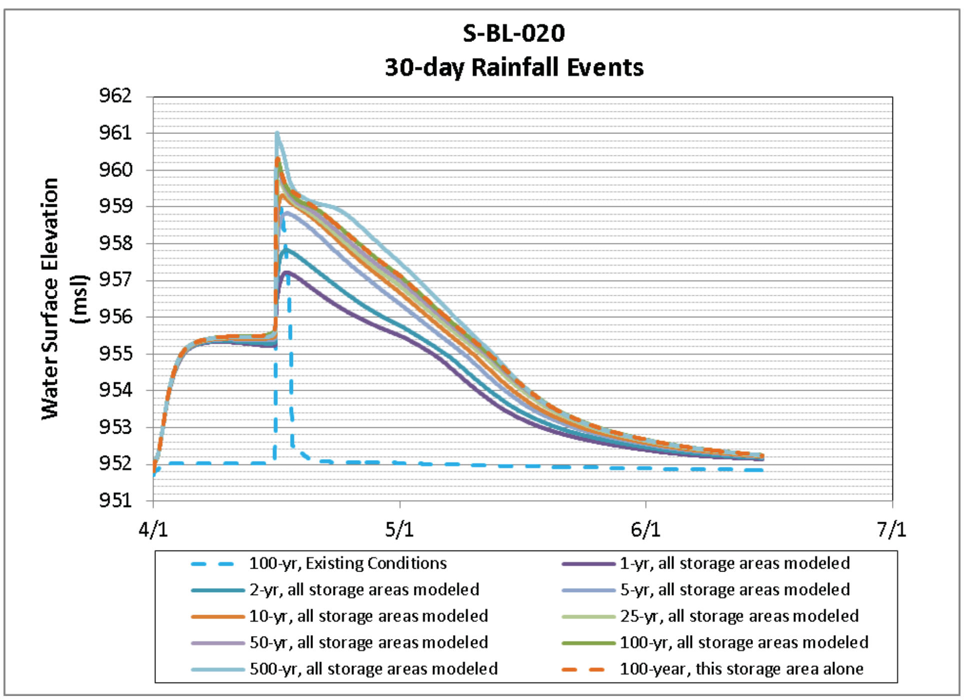


Figure 3-2 Existing and Proposed Conditions Elevations for Potential Storage Area S-BL-020

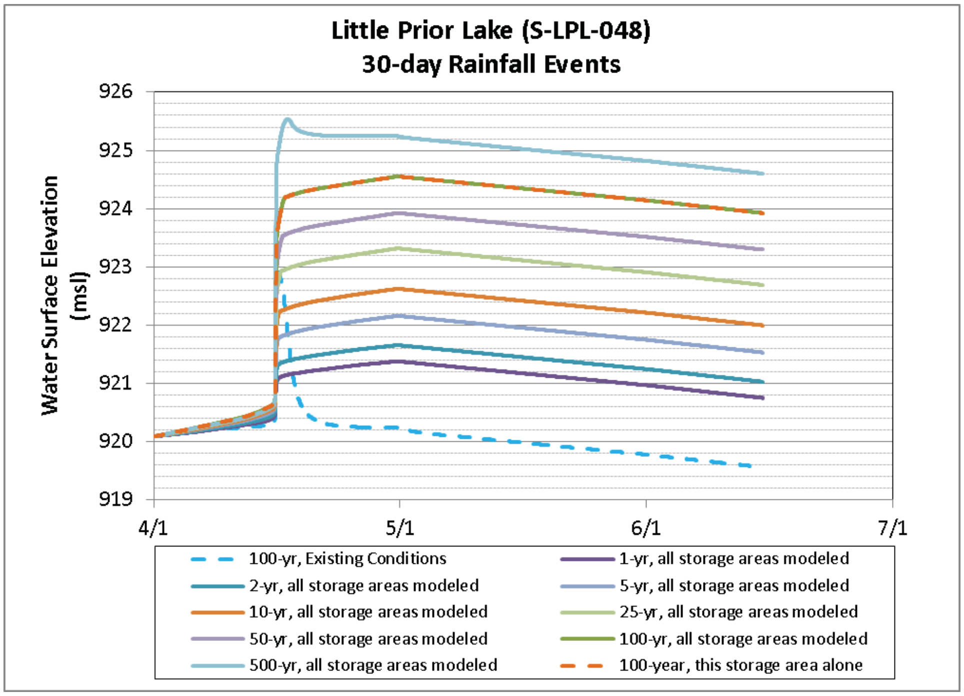


Figure 3-3 Existing and Proposed Conditions Elevations for Potential Storage Area S-LPL-048

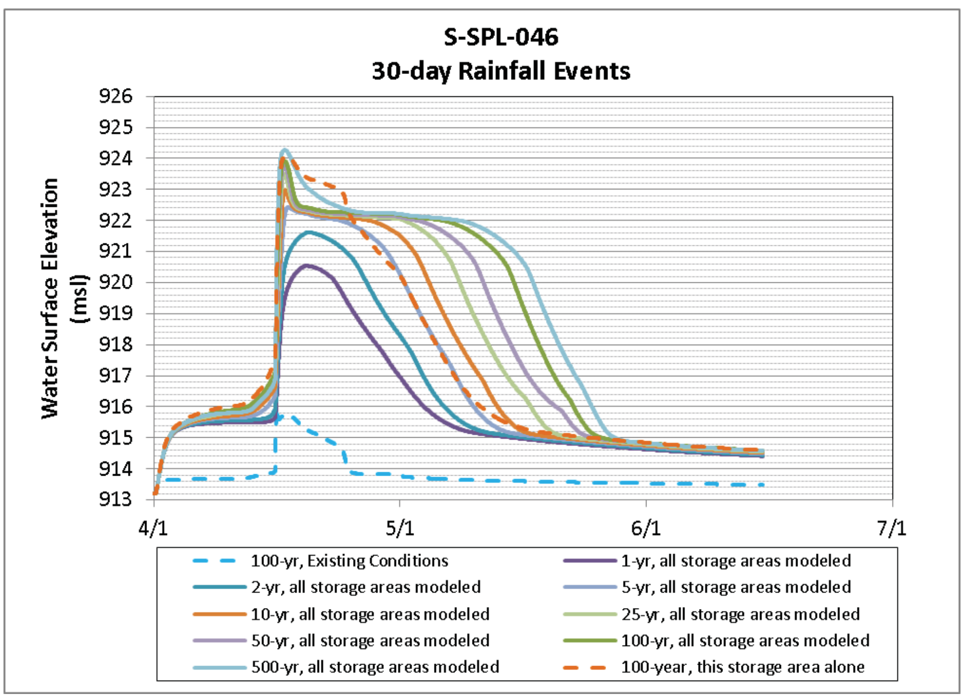


Figure 3-4 Existing and Proposed Conditions Elevations for Potential Storage Area S-SPL-046

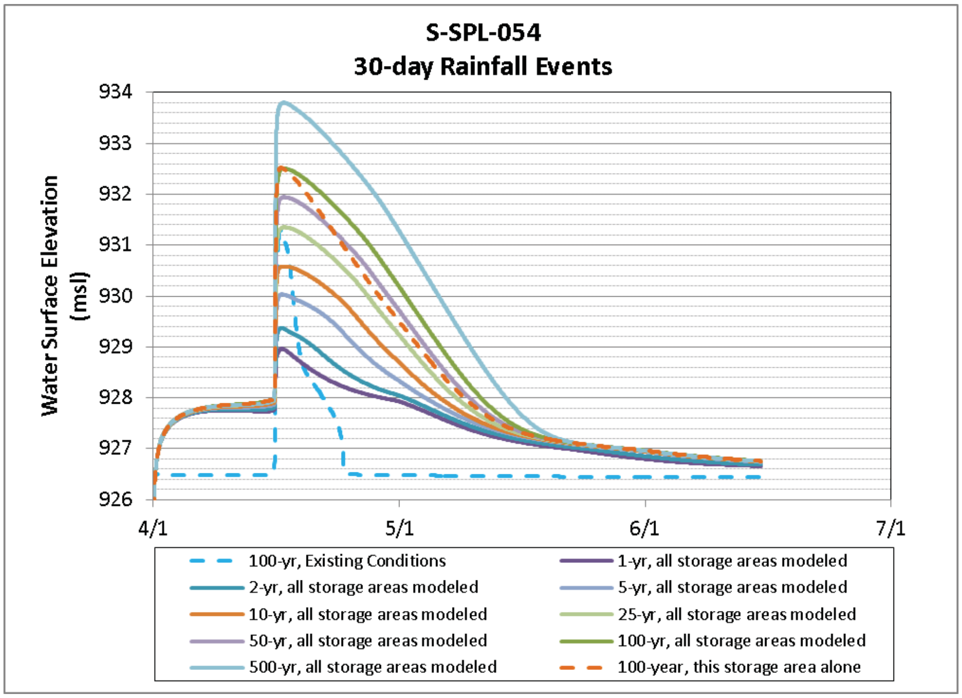


Figure 3-5 Existing and Proposed Conditions Elevations for Potential Storage Area S-SPL-054

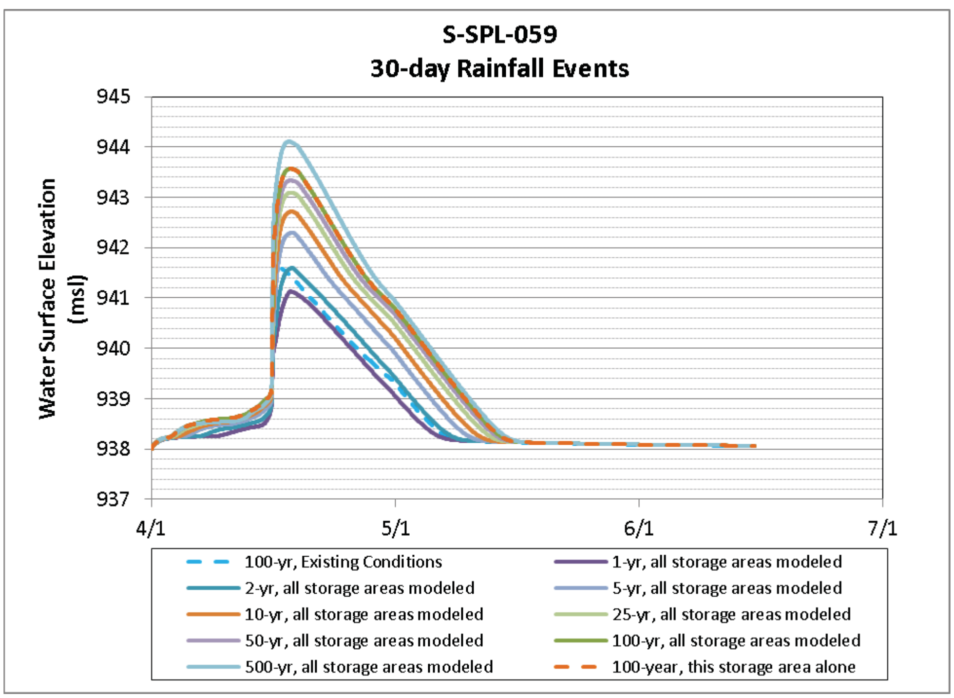


Figure 3-6 Existing and Proposed Conditions Elevations for Potential Storage Area S-SPL-059

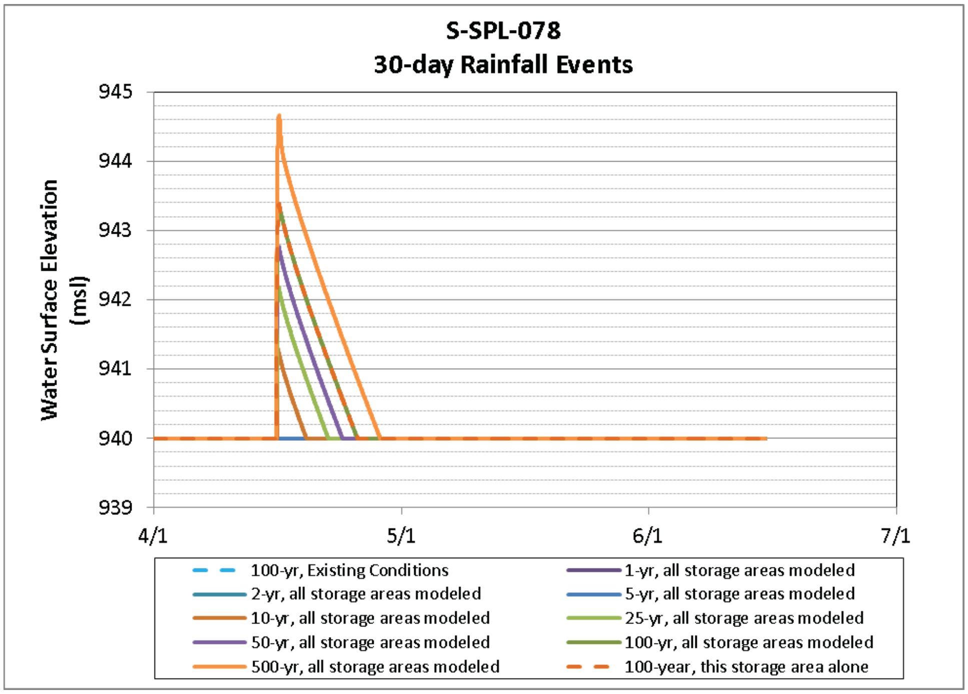


Figure 3-7 Existing and Proposed Conditions Elevations for Potential Storage Area S-SPL-078

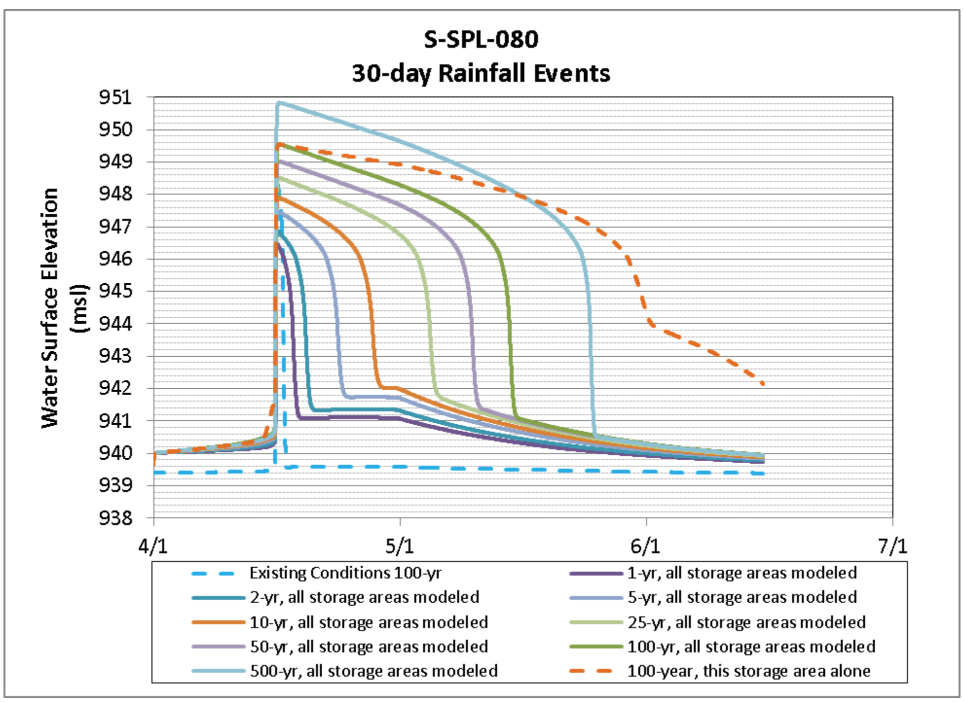


Figure 3-8 Existing and Proposed Conditions Elevations for Potential Storage Area S-SPL-080

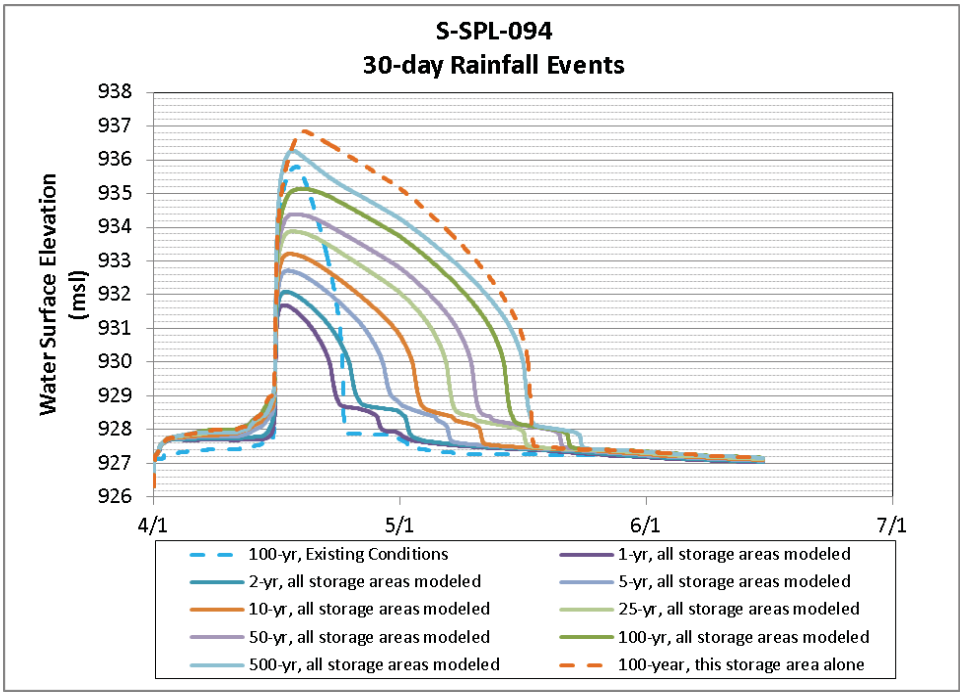


Figure 3-9 Existing and Proposed Conditions Elevations for Potential Storage Area S-SPL-094

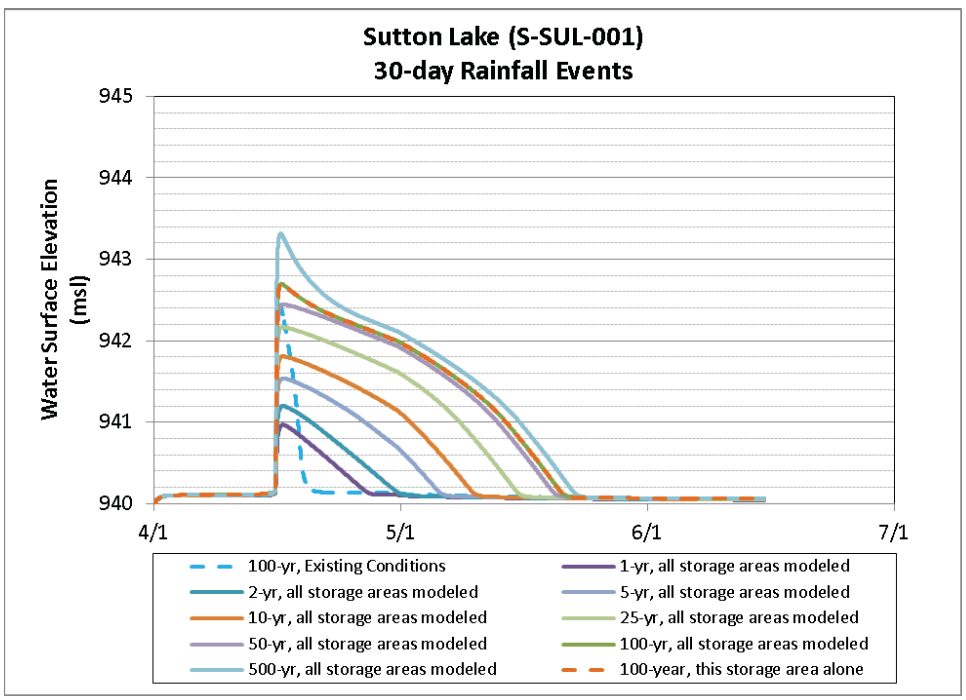


Figure 3-10 Existing and Proposed Conditions Elevations for Potential Storage Area S-SUL-001

3.2 Spring Lake Outlet Modification

The existing Spring Lake Outlet structure is a concrete sill with a bottom width of 16 feet and invert elevation of 909.9 ft msl. In low flow conditions, a sand bar has been observed to form at a higher elevation within Spring Lake, near the structure (**Figure 3-11**). In high flow conditions, it is likely that the sand bar is washed away and the sill becomes the lake elevation control.

Figure 3-11 Spring Lake Outlet During Low Flow Conditions

During extreme Prior Lake flooding events, temporary sandbagging at the Spring Lake outlet has been implemented to increase the available storage within Spring Lake. Barr evaluated a permanent embankment with a weir overflow and a 24-inch diameter outlet pipe that would maintain the existing Spring Lake normal water elevation of 909.9 during typical flows while allowing for additional storage during high flows. Figure 3-12 shows the existing conditions 100-year, 30-day event hydrographs and the proposed conditions 1-, 2-, 5-, 10-, 50-, 100-, and 500-year, 30-day event hydrographs.

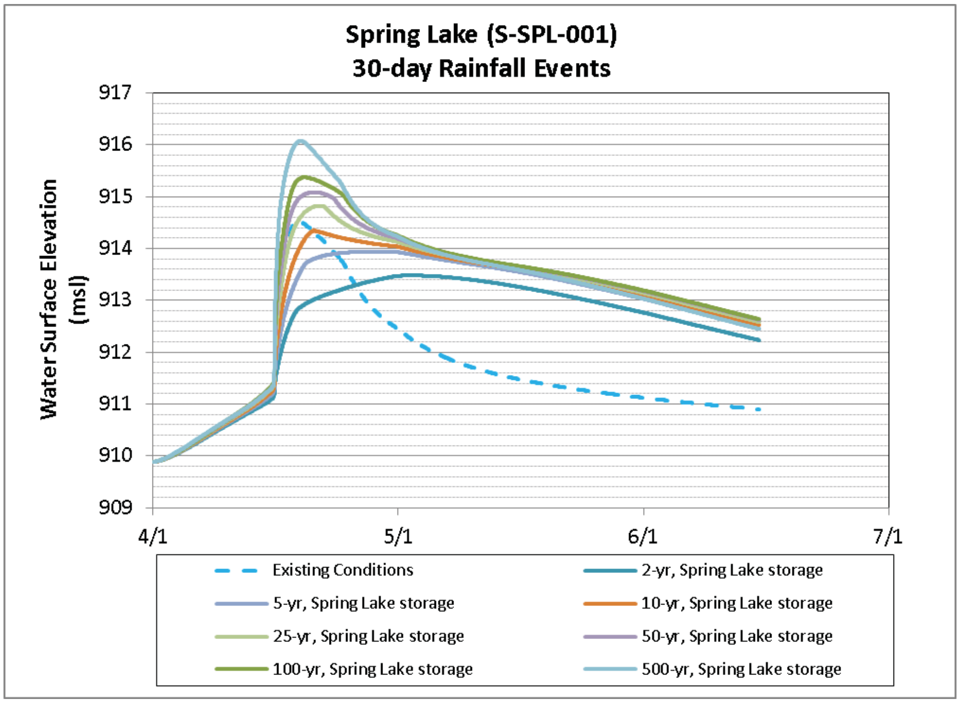


Figure 3-12 Existing and proposed conditions elevations for Spring Lake with modified outlet

3.3 Arctic Lake Alternatives

Arctic Lake lies to the north of Spring Lake and west of Upper Prior Lake. Arctic Lake has a watershed of approximately 560 acres and discharges to Upper Prior Lake through an uncontrolled outlet channel located at its north end. Arctic Lake's normal water elevation is variable due to occasional beaver dam construction within the outlet channel. For the purposes of the simulations the Arctic Lake normal water elevation was modeled at 909.7.

Two alternatives were modeled for increasing detention storage in Arctic Lake:

1) A weir with a trapezoidal notch at 909.7 to maintain the existing normal water elevation and a 20 foot long crest at 912.7.
2) A weir with a trapezoidal notch at 909.7 and a 20 foot long crest at 915.7, and a 48-inch diameter storm sewer pipe system that would convey water from Spring Lake to Arctic Lake during high flow periods, effectively increasing Arctic Lake's contributing area. **Figure A-1** shows the potential 5,400-foot route evaluated by Barr. The Arctic Lake diversion pipe would require raising the 100-year elevation of Spring Lake using the Spring Lake Outlet modification as previously described in Section 3.2 to create sufficient head to divert flow from Spring Lake through the pipe to Arctic Lake.

Figure 3-13 shows the Arctic Lake water surface elevations resulting from the 100-year, 30-day design storm simulations for the Arctic Lake alternatives.

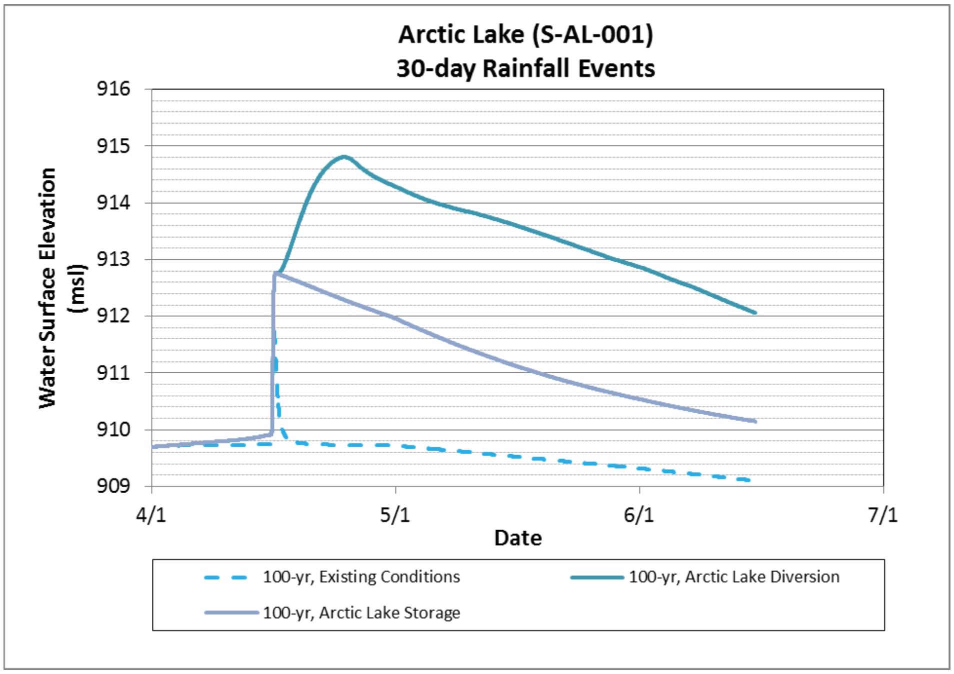


Figure 3-13 Arctic Lake 100-year, 30-day water surface elevations for existing conditions and for proposed conditions with the two Arctic Lake alternatives

3.4 Prior Lake Outlet Modification

The Prior Lake outlet structure is limited to a maximum flow of approximately 65 cfs through its design and through legal agreements with downstream communities. A key factor in the 2014 flooding caused by Prior Lake was the occurrence of several consecutive rainstorms separated by intervals that were too short for Prior Lake to return to its normal water elevation before the next storm. To achieve a higher discharge rate, the existing outlet pipe system would need to be replaced with a larger pipe or an additional pipe outlet would need to be constructed. The existing outlet structure design could make it difficult to retrofit the outlet with a second pipe, so a second outlet structure may also need to be constructed.

Barr modeled an additional pipe system consisting of a 24-inch diameter pipe that would be constructed with an upstream invert elevation of 898.5, or four feet below Prior Lake's normal water elevation of 902.5. The proposed pipe system would be approximately 2,600 feet long and would be equipped with a gate valve that would be left closed during normal flow conditions and opened during flood flow conditions. This conceptual design would allow for a flow rate of approximately 15 cfs though the new pipe with the headwater at 902.5, while the pipe size would limit the peak flow to approximately 20 cfs at higher water elevations. With both outlets operating, the maximum operating discharge during high water elevations would be approximately 85 cfs.

Barr created a rating curve that combined the existing and proposed outlet pipes. Barr assumed that the existing gate in the Prior Lake Outlet Structure would be opened prior to the start of the simulation ("managed discharge") and would remain open throughout the event. Barr assumed that the proposed gate controlling the proposed additional outlet pipe would be closed if the Prior Lake elevation fell to 902.0 or below. This simulation resulted in Prior Lake being drawn down to 902.0 in most cases at the start of the simulation.

4.0 Results and Conclusions

Barr evaluated each potential flood damage reduction measure by modeling it using the calibrated Prior Lake model and the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year, 30-day Atlas 14 rainfall events. Barr also evaluated all of the potential upland detention storage areas together, and all of the flood damage reduction measures together. **Table 4-1** and **Figure 4-1** summarize the resulting simulated peak water surface elevations for Prior Lake. **Table 4-2** summarizes the peak elevations of Spring Lake and Prior Lake along with the associated planning level cost estimates. **Figure 4-2** through **Figure 4-15** compare the simulated existing conditions stage hydrographs for Spring Lake and Prior Lake to the Upland storage alternative (all 11 alternatives), Spring Lake storage alternative, Prior Lake Outlet modification alternative (with managed discharge) , and the combination of alternatives for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year, 30-day events.

Table 4-1 Simulated Prior Lake Peak Elevations for flood damage reduction measures

Simulation	Peak Water Surface Elevation (ft) (Change from Existing Conditions in ft)						
	2-year	5-year	10-year	25-year	50-year	100-year	500-year
Existing Conditions	903.6	904.2	904.8	905.6	906.3	907.1	909.0
Modify Prior Lake Outlet	902.8 (-0.8)	903.3 (-0.9)	903.9 (-0.9)	904.8 (-0.9)	905.5 (-0.8)	906.2 (-0.9)	908.1 (-1.0)
Increase Spring Lake Storage	903.1 (-0.5)	903.4 (-0.8)	903.9 (-0.9)	904.8 (-0.8)	905.6 (-0.7)	906.3 (-0.8)	908.3 (-0.8)
Upper Watershed Storage	903.3 (-0.3)	903.7 (-0.5)	904.1 (-0.7)	904.8 (-0.9)	905.3 (-1.0)	905.8 (-1.2)	907.5 (-1.5)
Combination of Three Options	902.5 (-1.1)	902.6 (-1.7)	902.7 (-2.1)	902.9 (-2.7)	903.5 (-2.8)	904.2 (-2.9)	905.9 (-3.1)

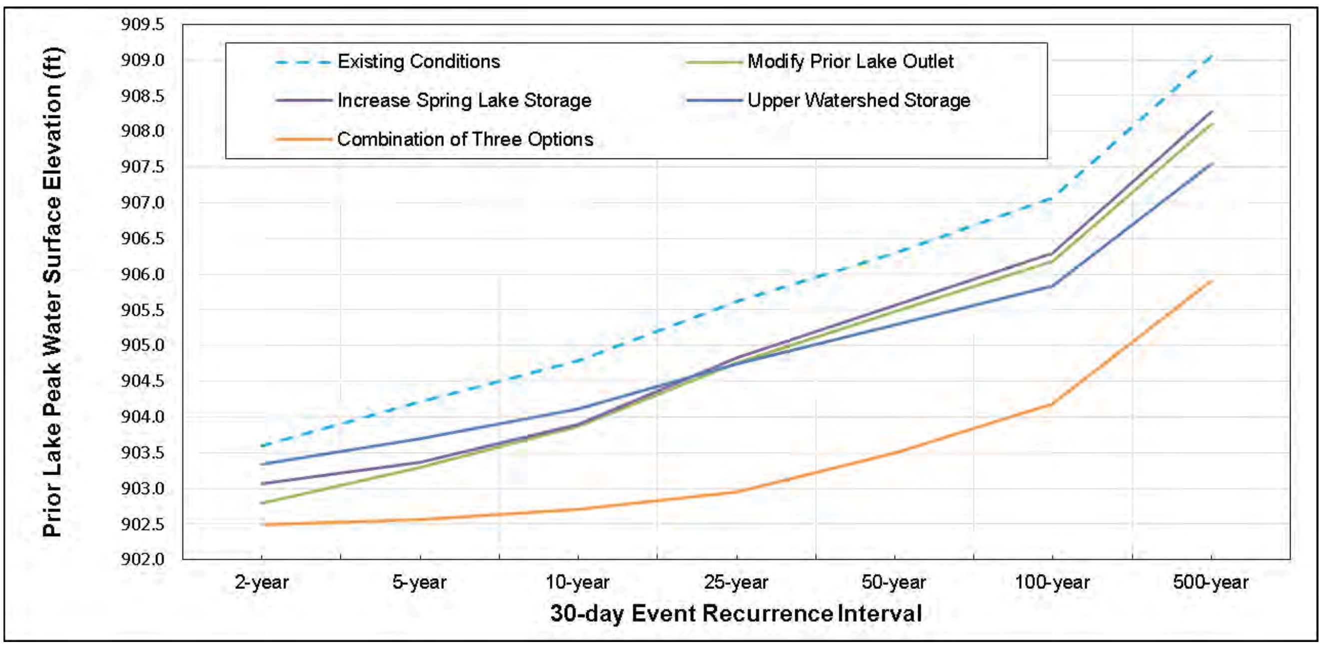


Figure 4-1 Comparison of simulated Prior Lake Peak Elevations for existing conditions and flood damage reduction measures

Table 4-2 Summary of Flood Damage Reduction Measure Planning Level Costs and Simulated Impacts on the Peak Water Surface Elevations for the 100-year, 30-day event

Name	Type of Flood Reduction Measure	Spring Lake Peak Elevation Change[1] (ft)	Prior Lake Peak Elevation Change[1] (ft)	Estimated Implementation Cost[2,3,4]
Arctic Lake Diversion	Outlet Modification, Diversion, and Detention	+ 0.8	- 1.0	$ 7,400,000[5,6]
Spring Lake Outlet Modification	Outlet Modification and Detention Storage	+ 0.9	- 0.8	$ 4,100,000[6]
Prior Lake Outlet Managed Discharge	Existing Outlet Management	No Change	-0.3	N/A
Modify Prior Lake Outlet	Outlet Modification	No Change	- 0.9	$ 2,800,000
S-BL-001 (Buck Lake)	Upland Detention Storage	- 0.4	- 0.3	$ 630,000
S-BL-020	Upland Detention Storage	- 0.1	- 0.1	$ 250,000
S-LPL-048 (Little Prior Lake)	Gated Detention Storage (Existing Infrastructure)	< - 0.1	< - 0.1	N/A
S-SPL-046	Upland Detention Storage	- 0.2	- 0.1	$ 840,000
S-SPL-054	Upland Detention Storage	< - 0.1	< - 0.1	$ 380,000
S-SPL-059	Upland Detention Storage	< - 0.1	< - 0.1	$ 250,000
S-SPL-078	Upland Detention Storage	- 0.1	- 0.1	$ 300,000
S-SPL-080	Upland Detention Storage	- 0.1	- 0.1	$ 260,000
S-SPL-094	Upland Detention Storage	- 0.1	- 0.5	$ 130,000
S-SUL-001 (Sutton Lake)	Upland Detention Storage	< - 0.1	- 0.3	$ 70,000
All Ten Detention Storage Sites	Upland Detention Storage	- 1.1	- 1.2	$ 3,100,000
All Flood Reduction Measures (not incl. Arctic Lake diversion)	**Includes all detention storage, Prior and Spring Lake outlet modifications**	**< - 0.1**	**- 2.9**	**$ 10,000,000**

1) Rounded to the nearest 0.1 feet.
2) Planning level cost estimate
3) 2015 Dollars
4) Rounded to nearest $10,000
5) Includes cost for Spring Lake Outlet Modification
6) Assumes full purchase value for any additional inundated area

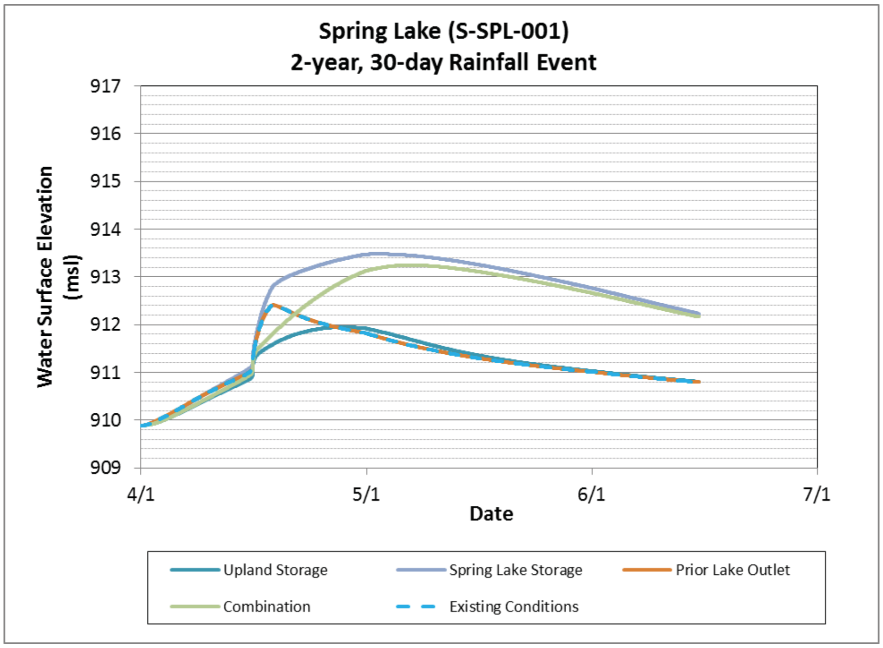


Figure 4-2 Comparison of 2-year, 30-day Spring Lake water elevations resulting from flood damage reduction scenario simulations

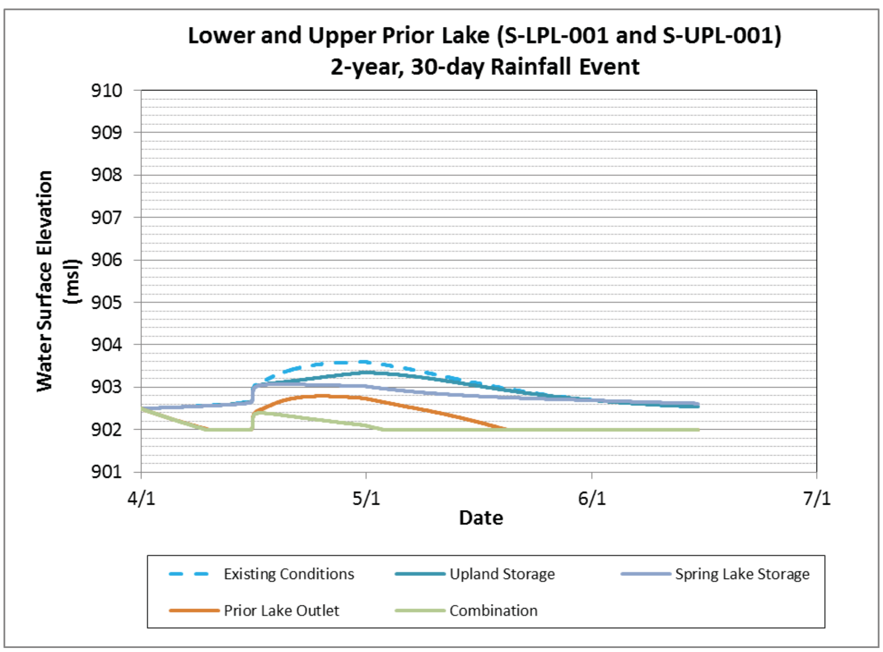


Figure 4-3 Comparison of 2-year, 30-day Prior Lake water elevations resulting from flood damage reduction scenario simulations

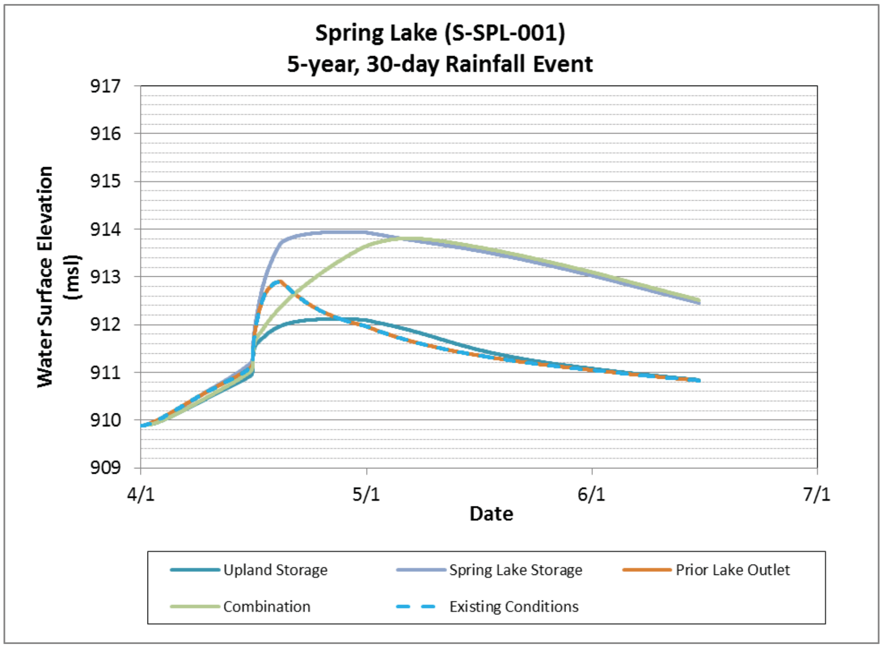


Figure 4-4 Comparison of 5-year, 30-day Spring Lake water elevations resulting from flood damage reduction scenario simulations

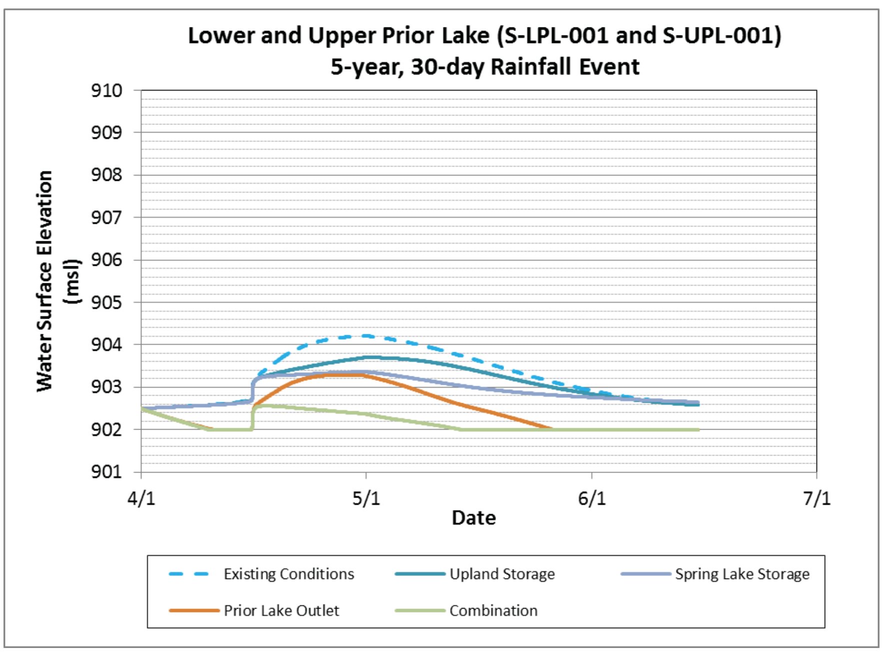


Figure 4-5 Comparison of 5-year, 30-day Prior Lake water elevations resulting from flood damage reduction scenario simulations

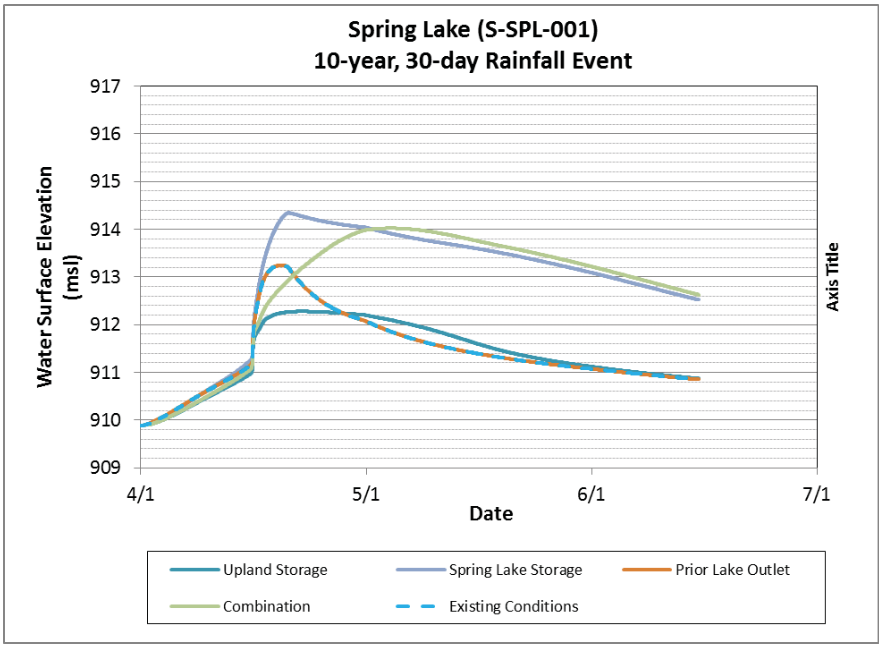


Figure 4-6 Comparison of 10-year, 30-day Spring Lake water elevations resulting from flood damage reduction scenario simulations

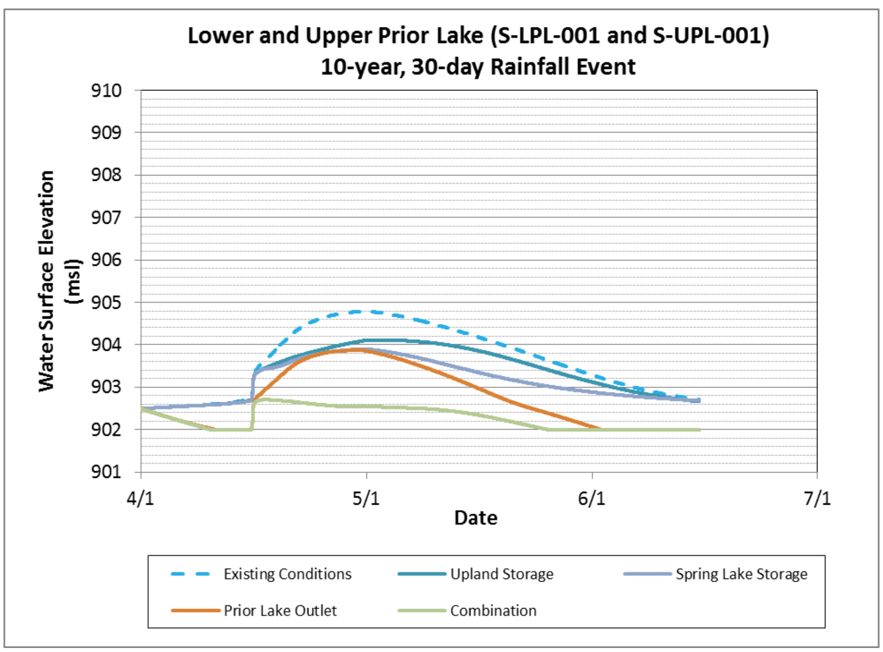


Figure 4-7 Comparison of 10-year, 30-day Prior Lake water elevations resulting from flood damage reduction scenario simulations

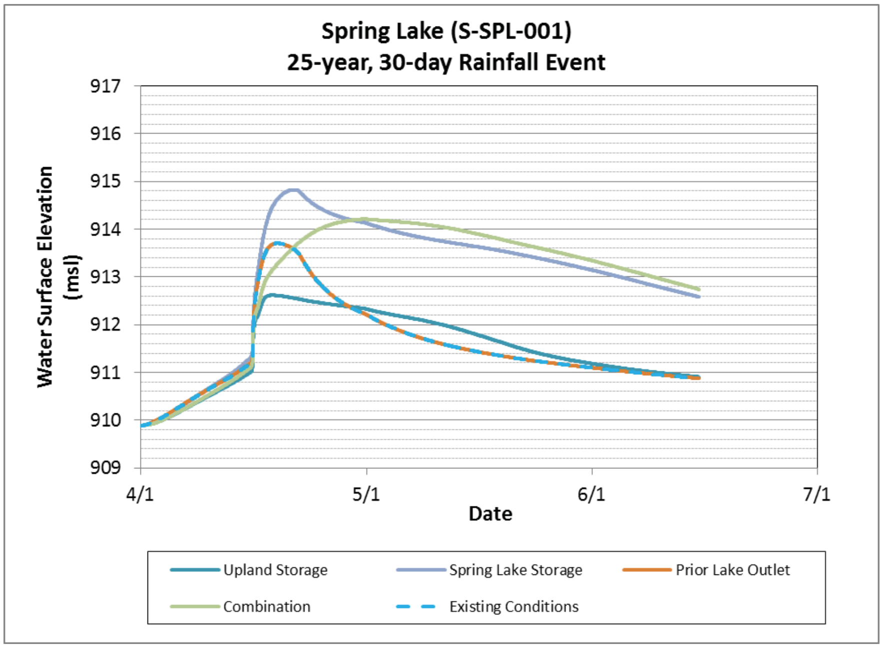


Figure 4-8 Comparison of 25-year, 30-day Spring Lake water elevations resulting from flood damage reduction scenario simulations

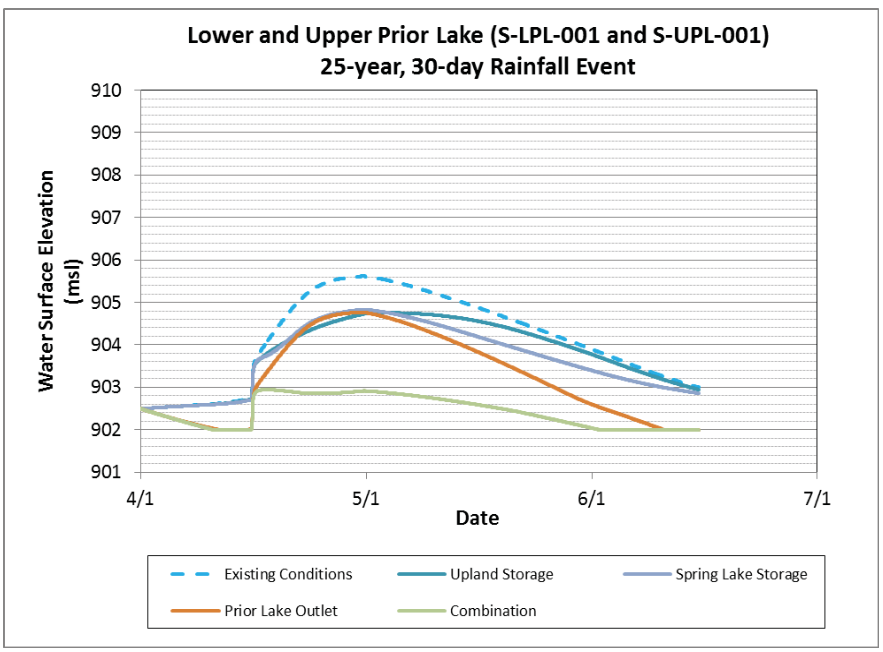


Figure 4-9 Comparison of 25-year, 30-day Prior Lake water elevations resulting from flood damage reduction scenario simulations

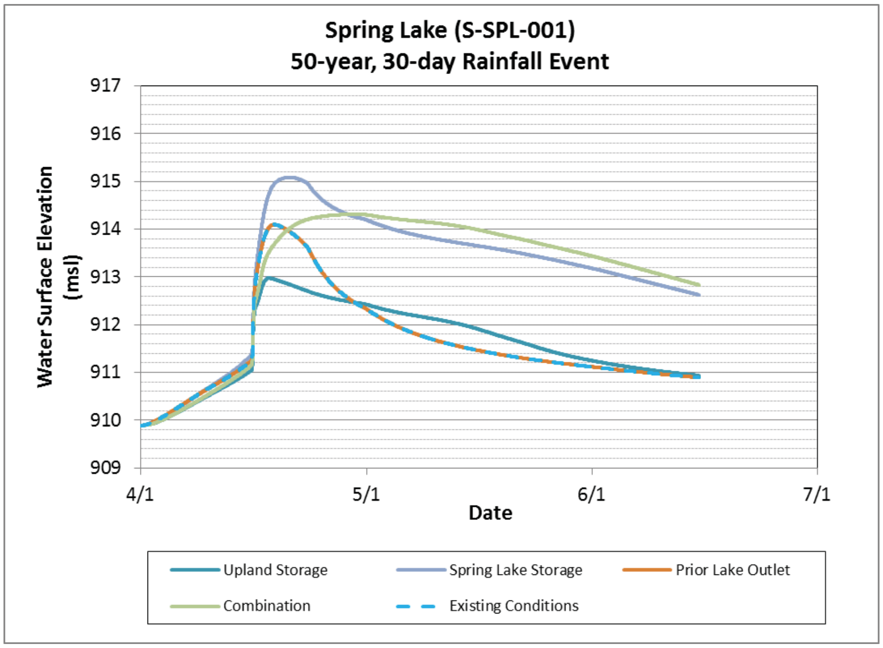


Figure 4-10 Comparison of 50-year, 30-day Spring Lake water elevations resulting from flood damage reduction scenario simulations

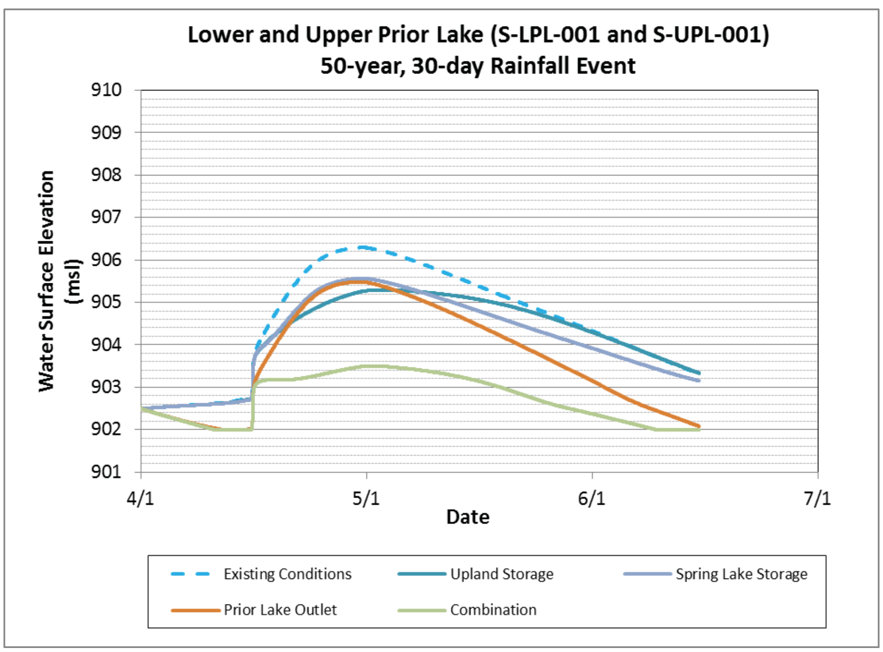


Figure 4-11 Comparison of 50-year, 30-day Prior Lake water elevations resulting from flood damage reduction scenario simulations

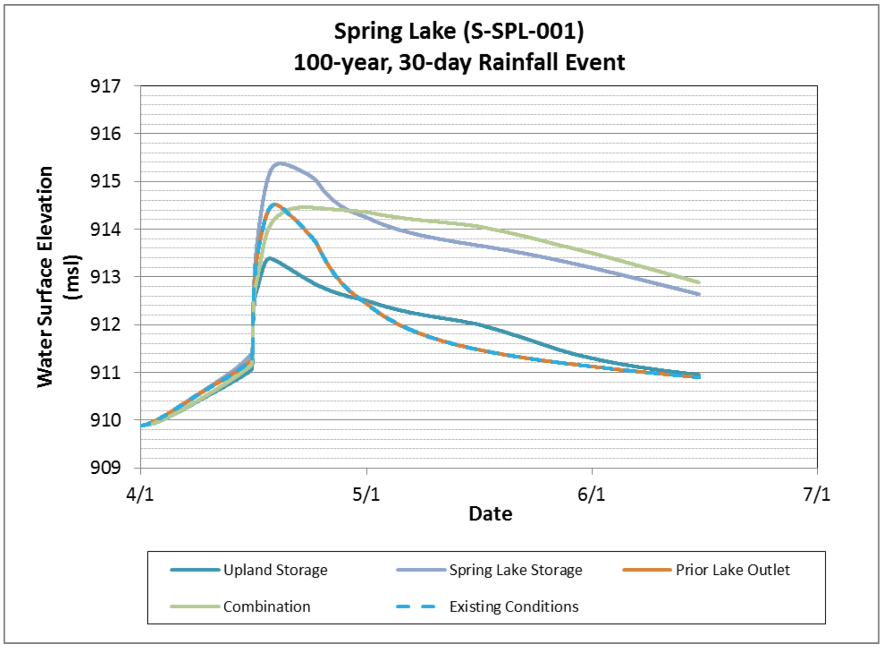


Figure 4-12 Comparison of 100-year, 30-day Spring Lake water elevations resulting from flood damage reduction scenario simulations

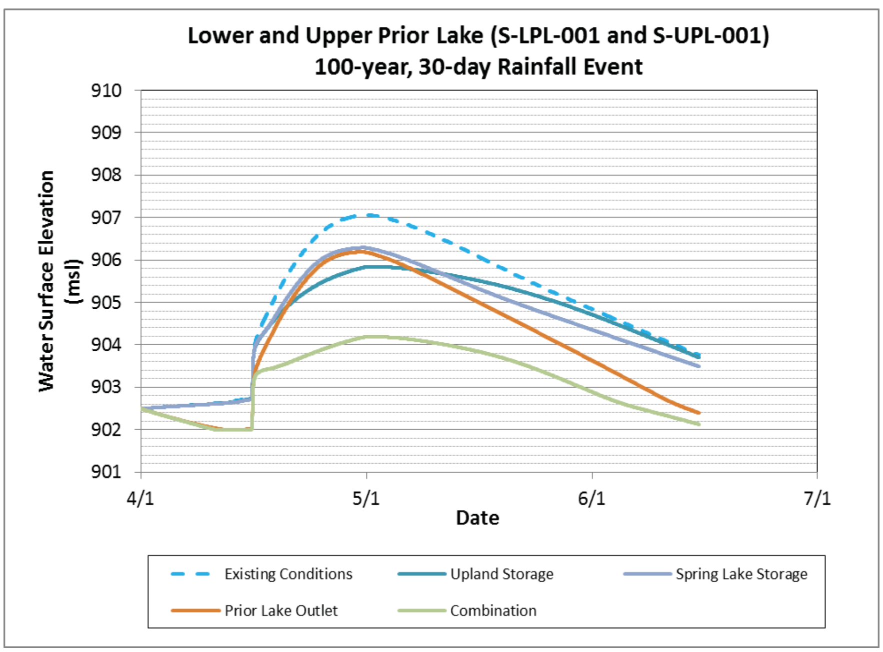


Figure 4-13 Comparison of 100-year, 30-day Prior Lake water elevations resulting from flood damage reduction scenario simulations

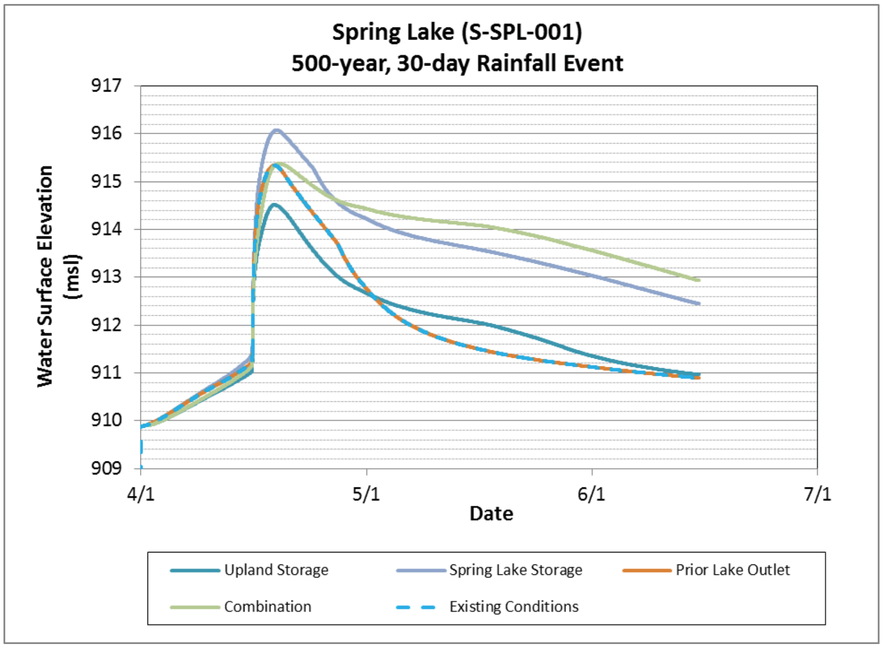


Figure 4-14 Comparison of 500-year, 30-day Spring Lake water elevations resulting from flood damage reduction scenario simulations

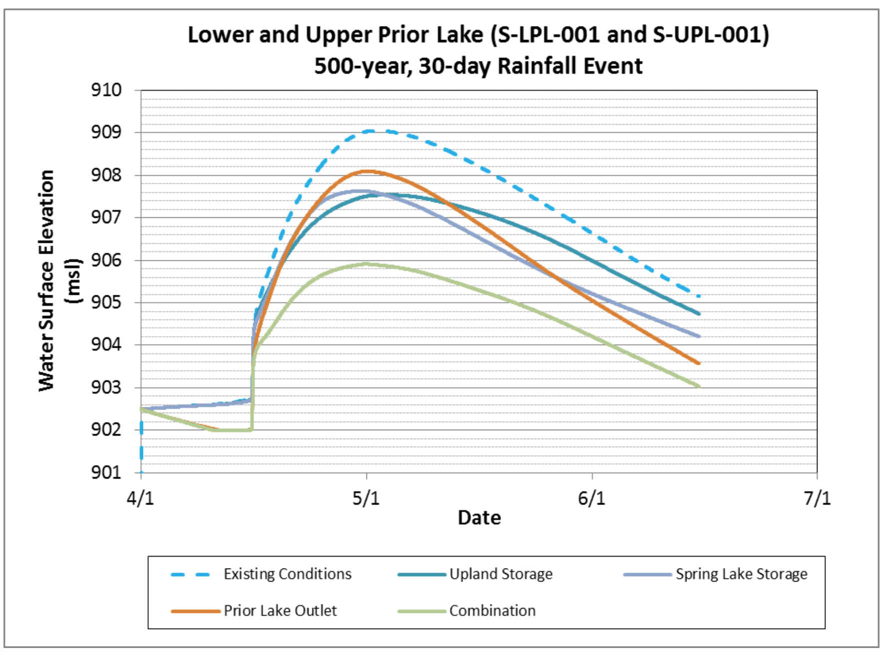


Figure 4-15 Comparison of 500-year, 30-day Prior Lake water elevations resulting from flood damage reduction scenario simulations

Appendix A

Detention Storage Area Maps

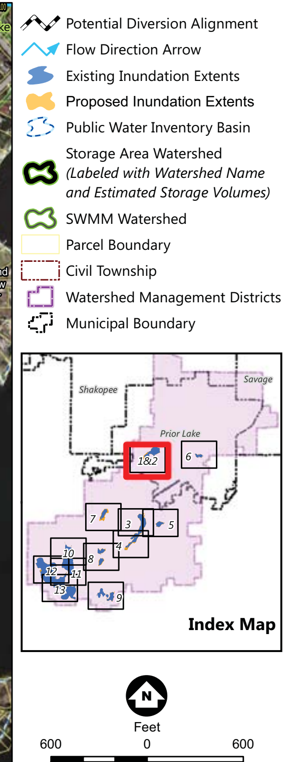
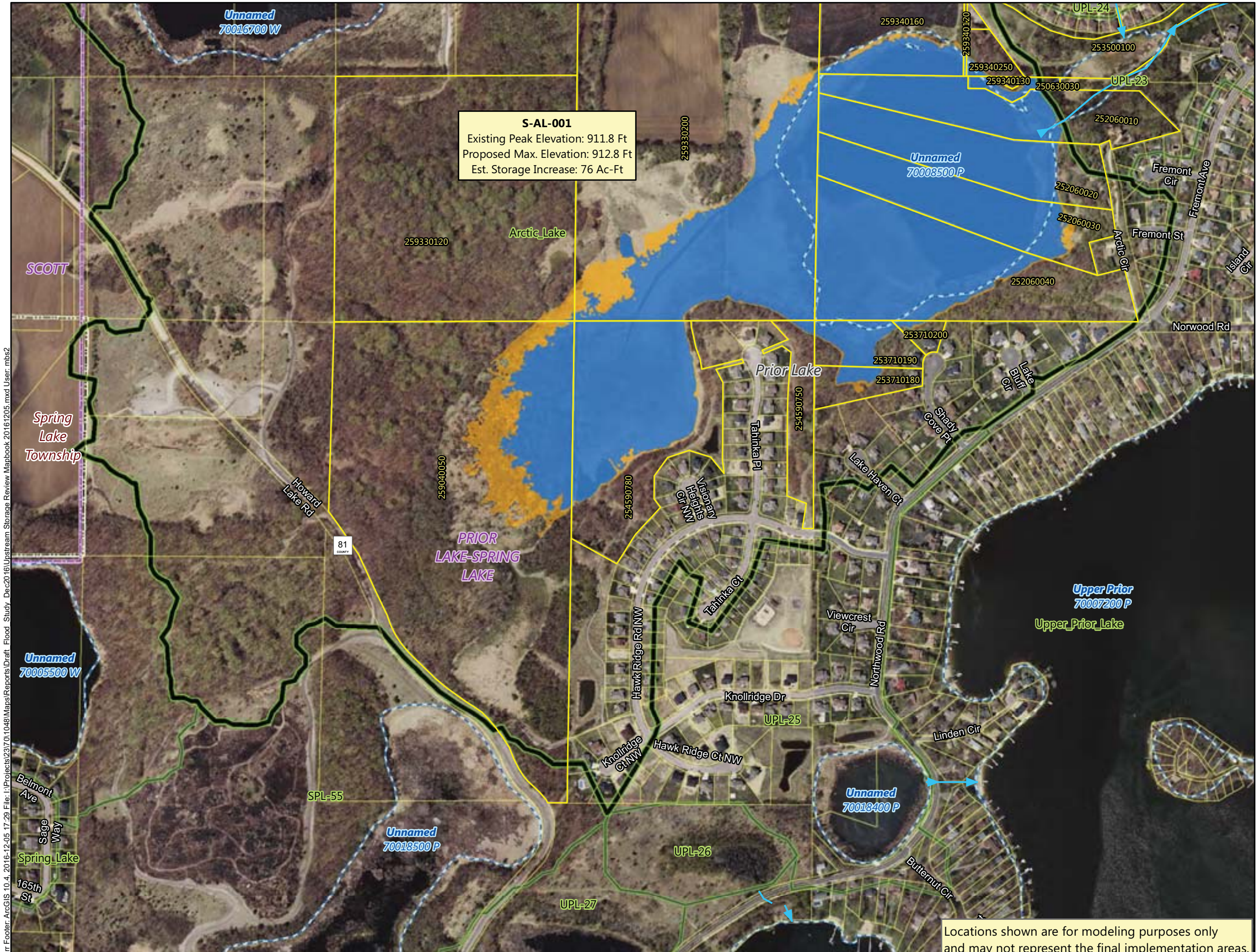


Figure A-1
S-AL-001 (Arctic Lake Diversion)

UPSTREAM STORAGE REVIEW
Prior Lake Stormwater Management & Flood Mitigation Study
Scott County, Minnesota



Flow Direction Arrow
Existing Inundation Extents
Proposed Inundation Extents
Public Water Inventory Basin
Storage Area Watershed *(Labeled with Watershed Name and Estimated Storage Volumes)*
SWMM Watershed
Parcel Boundary
Civil Township
Watershed Management Districts
Municipal Boundary

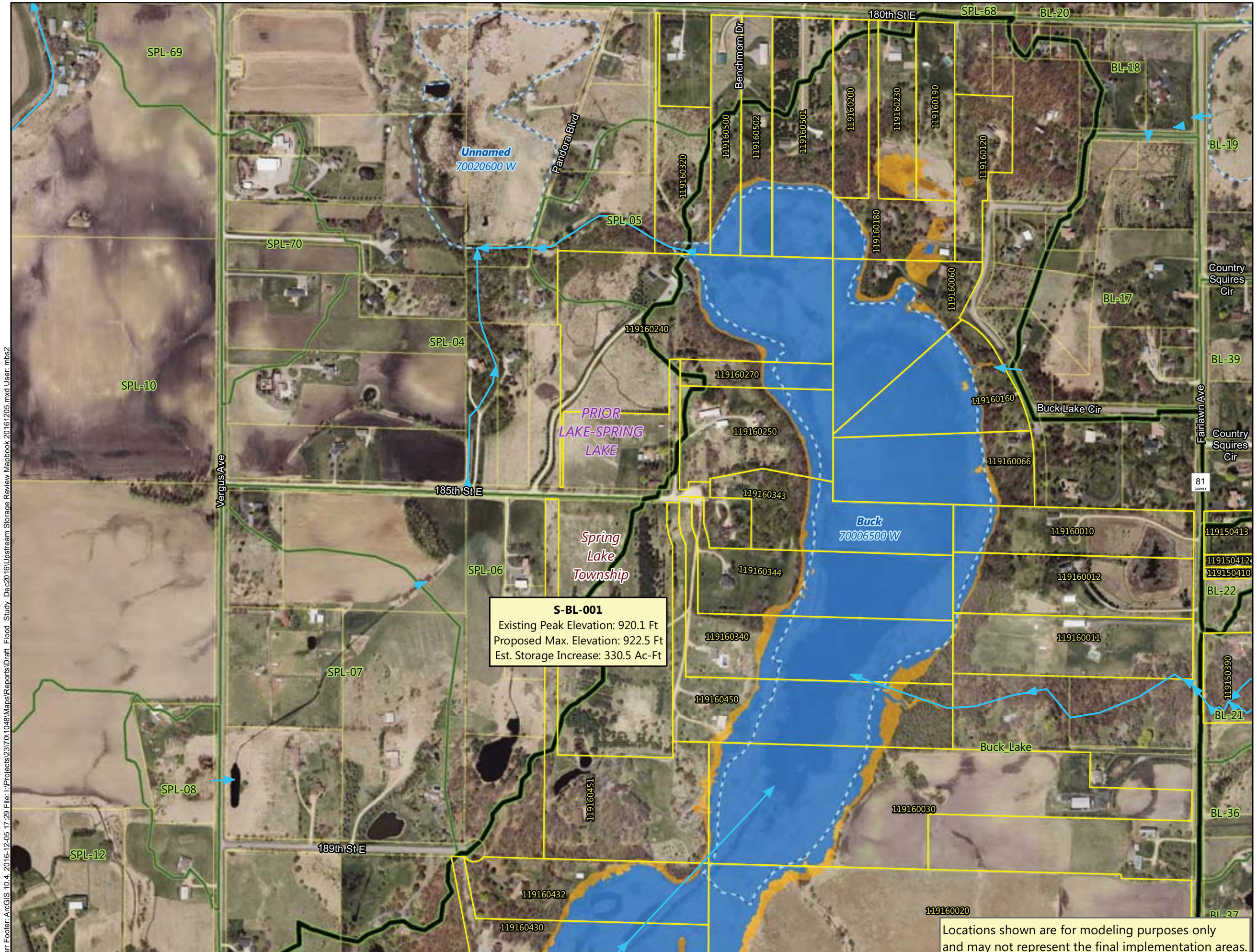
Index Map

Feet
500 0 500

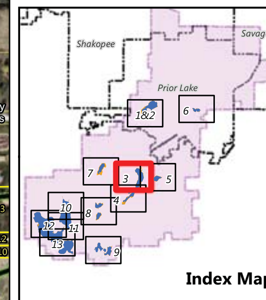
BARR

Figure A-2
S-AL-001 (Arctic Lake)

UPSTREAM STORAGE REVIEW
Prior Lake Stormwater Management & Flood Mitigation Study
Scott County, Minnesota



Flow Direction Arrow
Existing Inundation Extents
Proposed Inundation Extents
Public Water Inventory Basin
Storage Area Watershed *(Labeled with Watershed Name and Estimated Storage Volumes)*
SWMM Watershed
Parcel Boundary
Civil Township
Watershed Management Districts
Municipal Boundary



Index Map

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Feet
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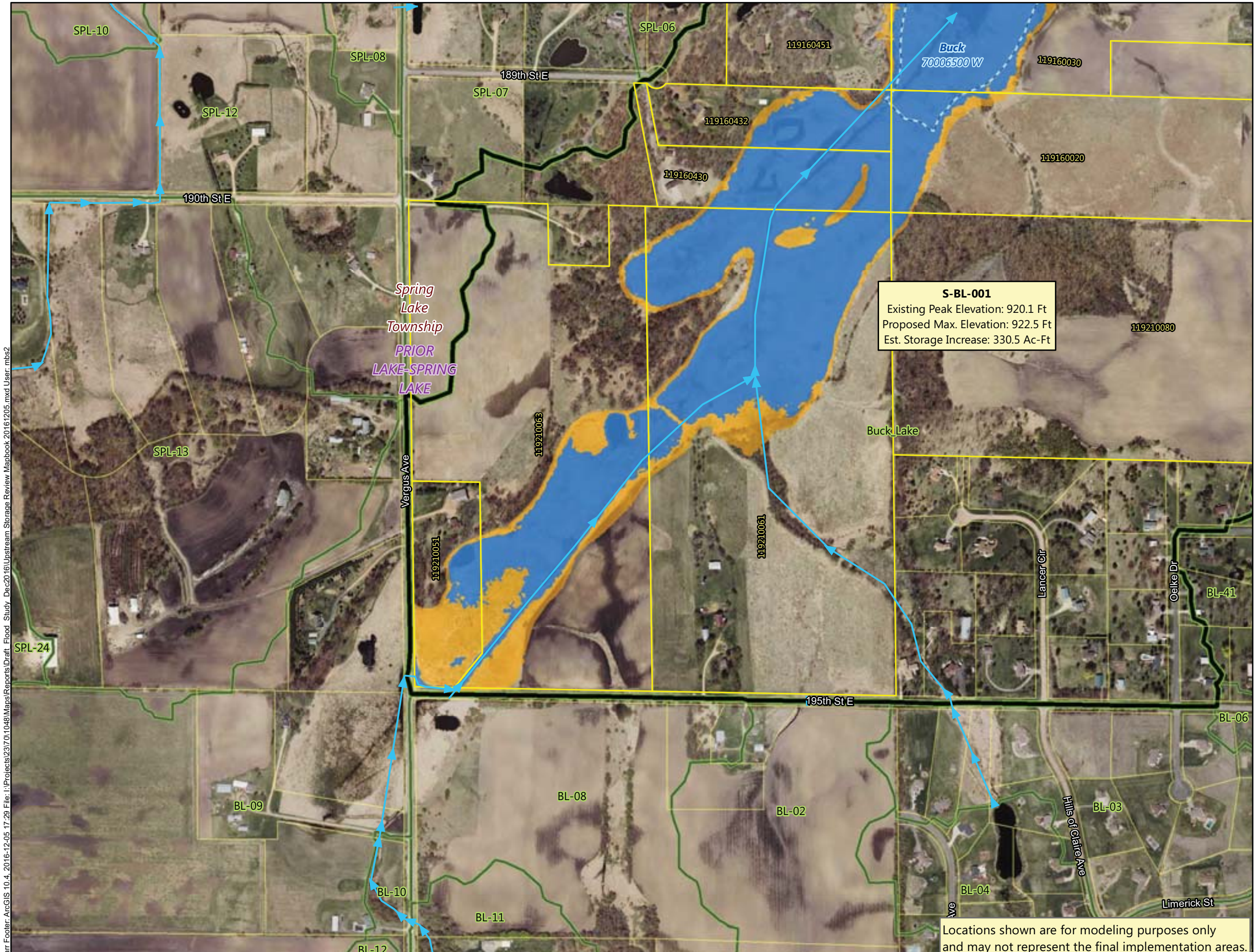
BARR

Figure A-3
S-BL-001 (Buck Lake)

UPSTREAM STORAGE REVIEW
Prior Lake Stormwater Management & Flood Mitigation Study
Scott County, Minnesota

Barr Footer: ArcGIS 10.4, 2016-12-05 17:29 File: I:\Projects\23\70\1048\Maps\Reports\Draft_Flood_Study_Dec2016\Upstream Storage Review Mapbook 20161205.mxd User: mbs2



Flow Direction Arrow

Existing Inundation Extents

Proposed Inundation Extents

Public Water Inventory Basin

Storage Area Watershed *(Labeled with Watershed Name and Estimated Storage Volumes)*

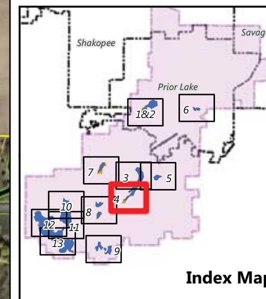
SWMM Watershed

Parcel Boundary

Civil Township

Watershed Management Districts

Municipal Boundary



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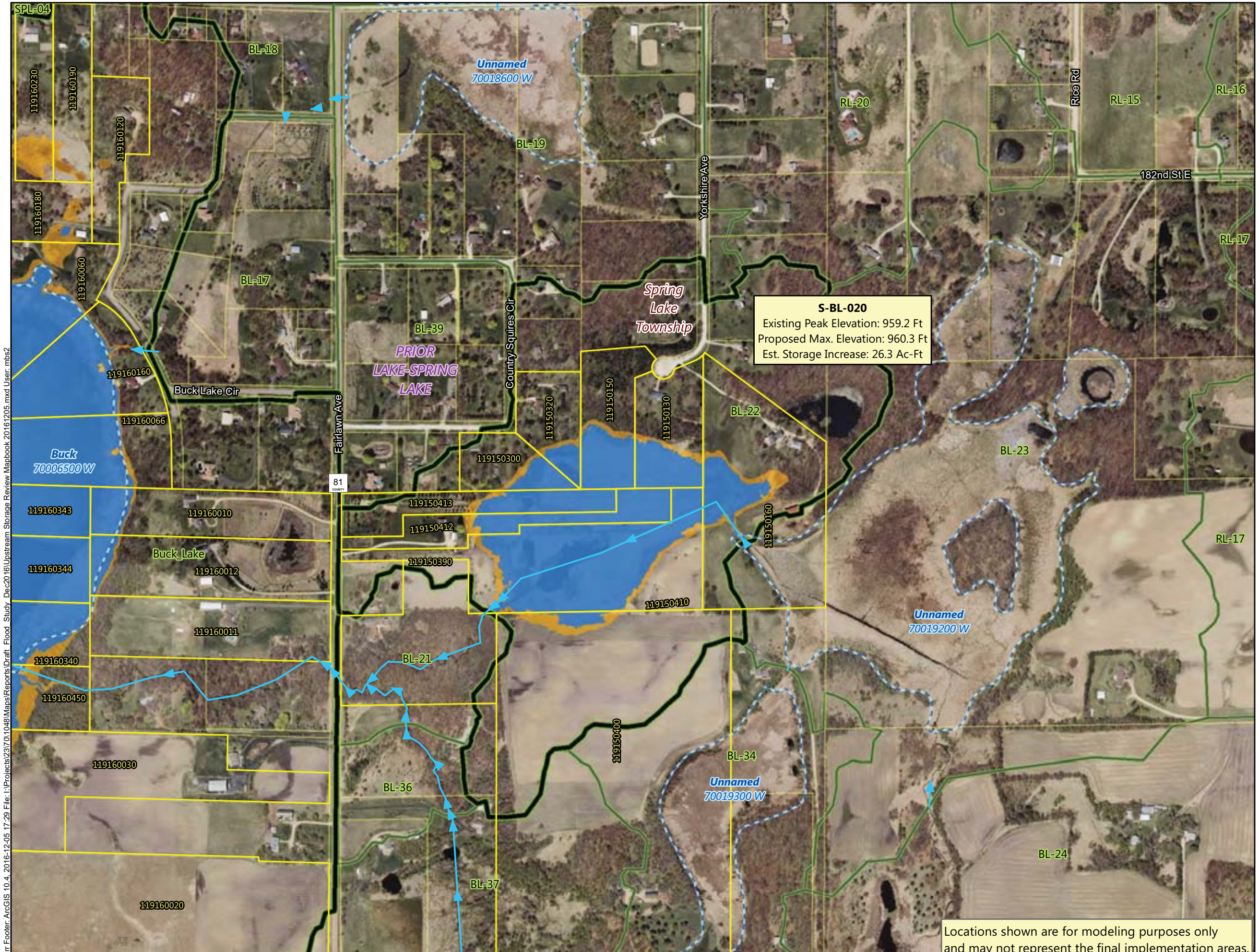
Feet

500 0 500

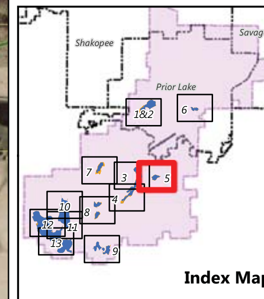
BARR

Figure A-4
S-BL-001 (Buck Lake)

UPSTREAM STORAGE REVIEW
Prior Lake Stormwater Management & Flood Mitigation Study
Scott County, Minnesota



Flow Direction Arrow
Existing Inundation Extents
Proposed Inundation Extents
Public Water Inventory Basin
Storage Area Watershed *(Labeled with Watershed Name and Estimated Storage Volumes)*
SWMM Watershed
Parcel Boundary
Civil Township
Watershed Management Districts
Municipal Boundary



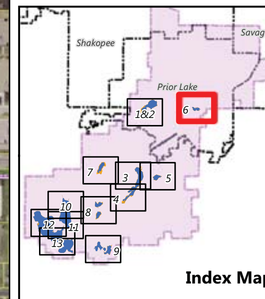
N
Feet
500 0 500

BARR

Figure A-5
S-BL-020

UPSTREAM STORAGE REVIEW
Prior Lake Stormwater Management & Flood Mitigation Study
Scott County, Minnesota

Flow Direction Arrow
Existing Inundation Extents
Proposed Inundation Extents
Public Water Inventory Basin
Storage Area Watershed *(Labeled with Watershed Name and Estimated Storage Volumes)*
SWMM Watershed
Parcel Boundary
Civil Township
Watershed Management Districts
Municipal Boundary

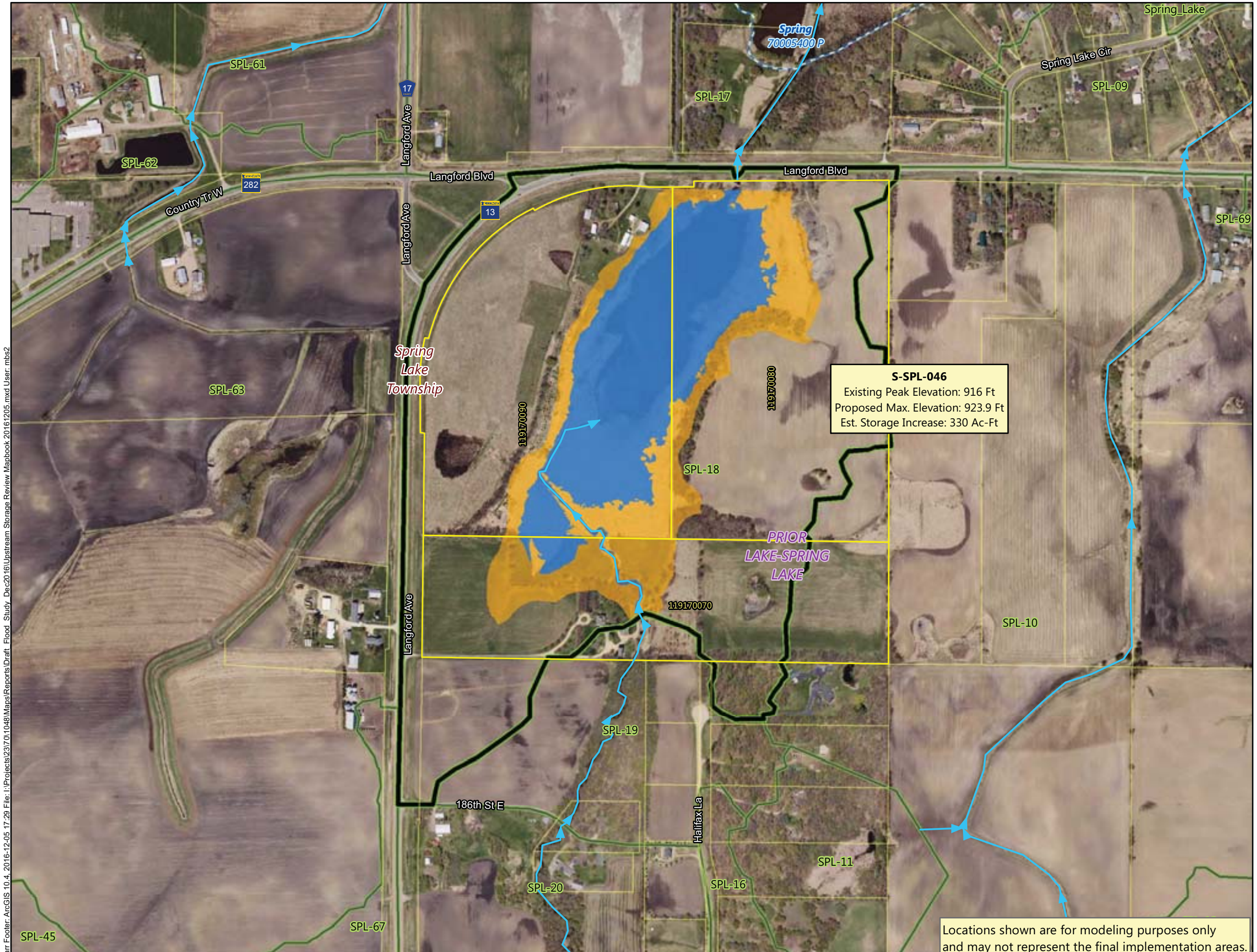


N
Feet
500 0 500

BARR

Figure A-6
S-LPL-048 (Little Prior Lake)

UPSTREAM STORAGE REVIEW
Prior Lake Stormwater Management & Flood Mitigation Study
Scott County, Minnesota



Flow Direction Arrow
Existing Inundation Extents
Proposed Inundation Extents
Public Water Inventory Basin
Storage Area Watershed *(Labeled with Watershed Name and Estimated Storage Volumes)*
SWMM Watershed
Parcel Boundary
Civil Township
Watershed Management Districts
Municipal Boundary

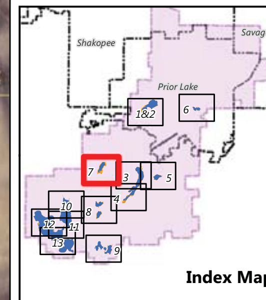


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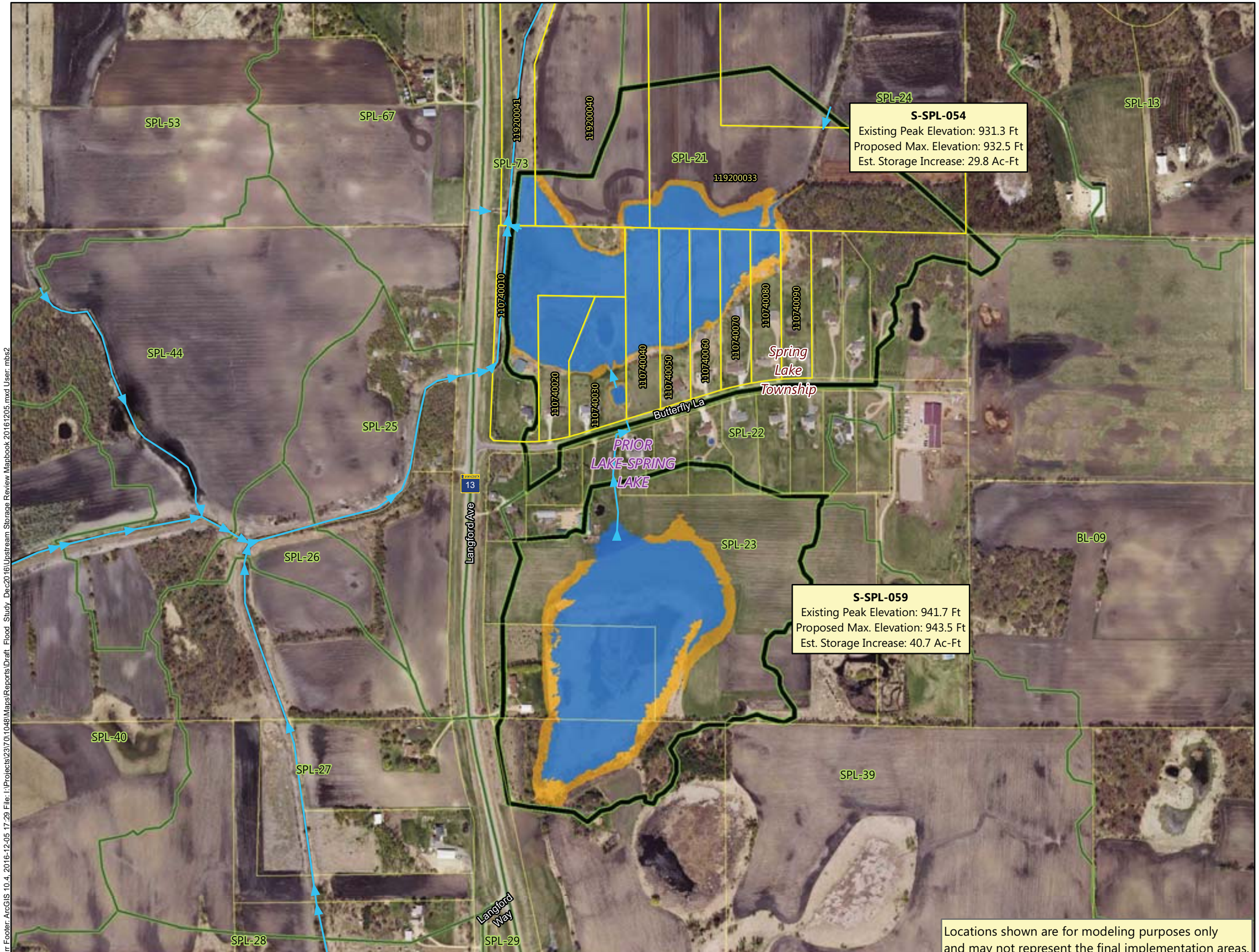
Figure A-7
S-SPL-046

UPSTREAM STORAGE REVIEW
Prior Lake Stormwater Management & Flood Mitigation Study
Scott County, Minnesota



Flow Direction Arrow
Existing Inundation Extents
Proposed Inundation Extents
Public Water Inventory Basin
Storage Area Watershed *(Labeled with Watershed Name and Estimated Storage Volumes)*
SWMM Watershed
Parcel Boundary
Civil Township
Watershed Management Districts
Municipal Boundary

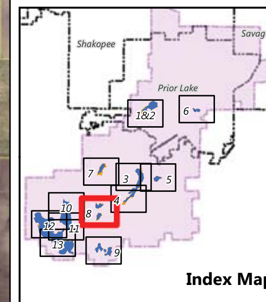


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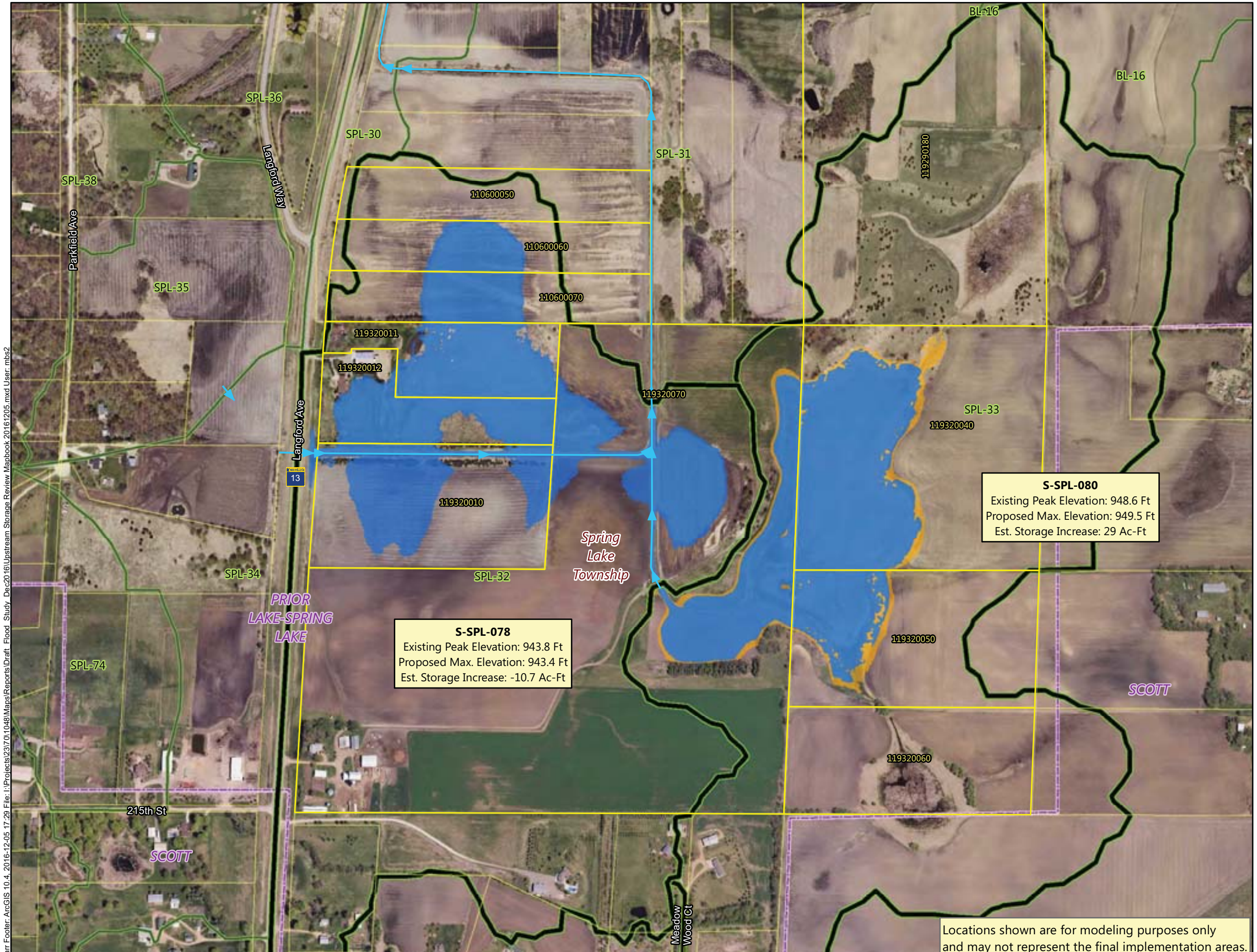
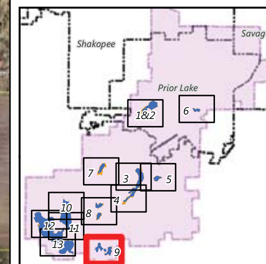
Figure A-8
S-SPL-054 & S-SPL-059

UPSTREAM STORAGE REVIEW
Prior Lake Stormwater Management & Flood Mitigation Study
Scott County, Minnesota



Flow Direction Arrow
Existing Inundation Extents
Proposed Inundation Extents
Public Water Inventory Basin
Storage Area Watershed *(Labeled with Watershed Name and Estimated Storage Volumes)*
SWMM Watershed
Parcel Boundary
Civil Township
Watershed Management Districts
Municipal Boundary



Index Map

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BARR

Figure A-9
S-SPL-078 & S-SPL-080

UPSTREAM STORAGE REVIEW
Prior Lake Stormwater Management & Flood Mitigation Study
Scott County, Minnesota

Flow Direction Arrow
Existing Inundation Extents
Proposed Inundation Extents
Public Water Inventory Basin
Storage Area Watershed *(Labeled with Watershed Name and Estimated Storage Volumes)*
SWMM Watershed
Parcel Boundary
Civil Township
Watershed Management Districts
Municipal Boundary

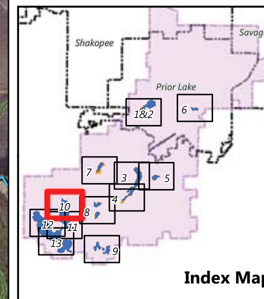

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Figure A-10
S-SPL-094

UPSTREAM STORAGE REVIEW
Prior Lake Stormwater Management & Flood Mitigation Study
Scott County, Minnesota

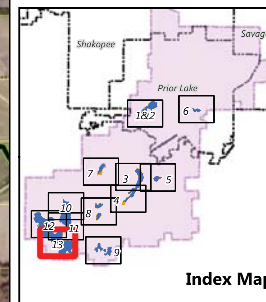
Figure A-11
S-SPL-094

UPSTREAM STORAGE REVIEW
Prior Lake Stormwater Management & Flood Mitigation Study
Scott County, Minnesota

Figure A-12
S-SUL-001 (Sutton Lake)

UPSTREAM STORAGE REVIEW
Prior Lake Stormwater Management & Flood Mitigation Study
Scott County, Minnesota

Flow Direction Arrow
Existing Inundation Extents
Proposed Inundation Extents
Public Water Inventory Basin
Storage Area Watershed
(Labeled with Watershed Name and Estimated Storage Volumes)
SWMM Watershed
Parcel Boundary
Civil Township
Watershed Management Districts
Municipal Boundary



Feet
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Figure A-13
S-SUL-001 (Sutton Lake)

UPSTREAM STORAGE REVIEW
Prior Lake Stormwater Management
& Flood Mitigation Study
Scott County, Minnesota

Appendix B—TP40/Atlas 14 Precipitation Comparison

MINNESOTA DEPARTMENT OF TRANSPORTATION
Engineering Services Division
Technical Memorandum No. 13-08-B-04
May 28, 2013

To: Electronic Distribution Recipients

From: Jon M. Chiglo, P.E. AS
Division Director, Engineering Services

Subject: Use of Atlas 14 Volume 8 Precipitation Frequency Estimates

Expiration

This is a new Technical Memorandum and shall remain in effect until May 28, 2018 unless superseded or included in the MnDOT Drainage Manual prior to that date.

Implementation

The guidelines contained in this Memorandum are effective immediately for trunk highway projects where feasible. Use the Atlas 14 precipitation data for hydraulic design on all trunk highway projects let after June 30, 2014.

Local road authorities are encouraged to adopt these or similar guidelines.

Introduction

The National Oceanic and Atmospheric Administration (NOAA) published new precipitation frequency estimates for the Midwestern States in Atlas 14 Volume 8. This information supersedes Technical Paper (TP)-40 published in1961 and NOAA Technical Memorandum NWS Hydro 35 published in 1977 that are the sources of precipitation frequency data and Intensity-Duration-Frequency (IDF) curves recommended in the Drainage Manual.

Purpose

This Technical Memorandum updates MnDOT design precipitation criteria to use the precipitation frequency data from NOAA Atlas 14. This replaces the design rainfall data in the Drainage Manual (2000).

Guidelines

Use Atlas 14 Precipitation Frequency Estimates when using rainfall-runoff models to compute hydrology for the design of hydraulic infrastructure. The data is obtained from NOAA's Precipitation Frequency Data Server (PFDS) at http://hdsc.nws.noaa.gov/hdsc/pfds/ based on the project location.

For rainfall-runoff models that use the Natural Resources Conservation Service (NRCS) rainfall distributions, if feasible, use a rainfall distribution based on the Atlas 14 data. Use the NRCS Type II rainfall distribution for NRCS peak flow methodology or for other projects where developing a rainfall distribution is not feasible.

Atlas 14 precipitation data should be used immediately for trunk highway projects using rainfall-runoff models provided its application does not jeopardize letting dates of projects already in the design phase. Use the Atlas 14 precipitation data for the hydraulic design of all trunk highway projects let after June 30, 2014. Where use of Atlas 14 is not feasible, evaluate the impacts of using Atlas 14 and document the justification for using the criteria from the Drainage Manual (2000). Notify the State Hydraulics Engineer about projects designed with rainfall-runoff models let after June 30, 2014 that are not designed with Atlas 14 precipitation data.

Questions
Any questions regarding the technical provisions of this memorandum can be addressed to the following:

- **Andrea Hendrickson, State Hydraulics Engineer, at (651) 366-4466**

Any questions regarding publication of this Technical Memorandum should be referred to the Design Standards Unit, DesignStandards.DOT@state.mn.us. A link to all active and historical Technical Memoranda can be found at http://techmemos.dot.state.mn.us/techmemo.aspx.

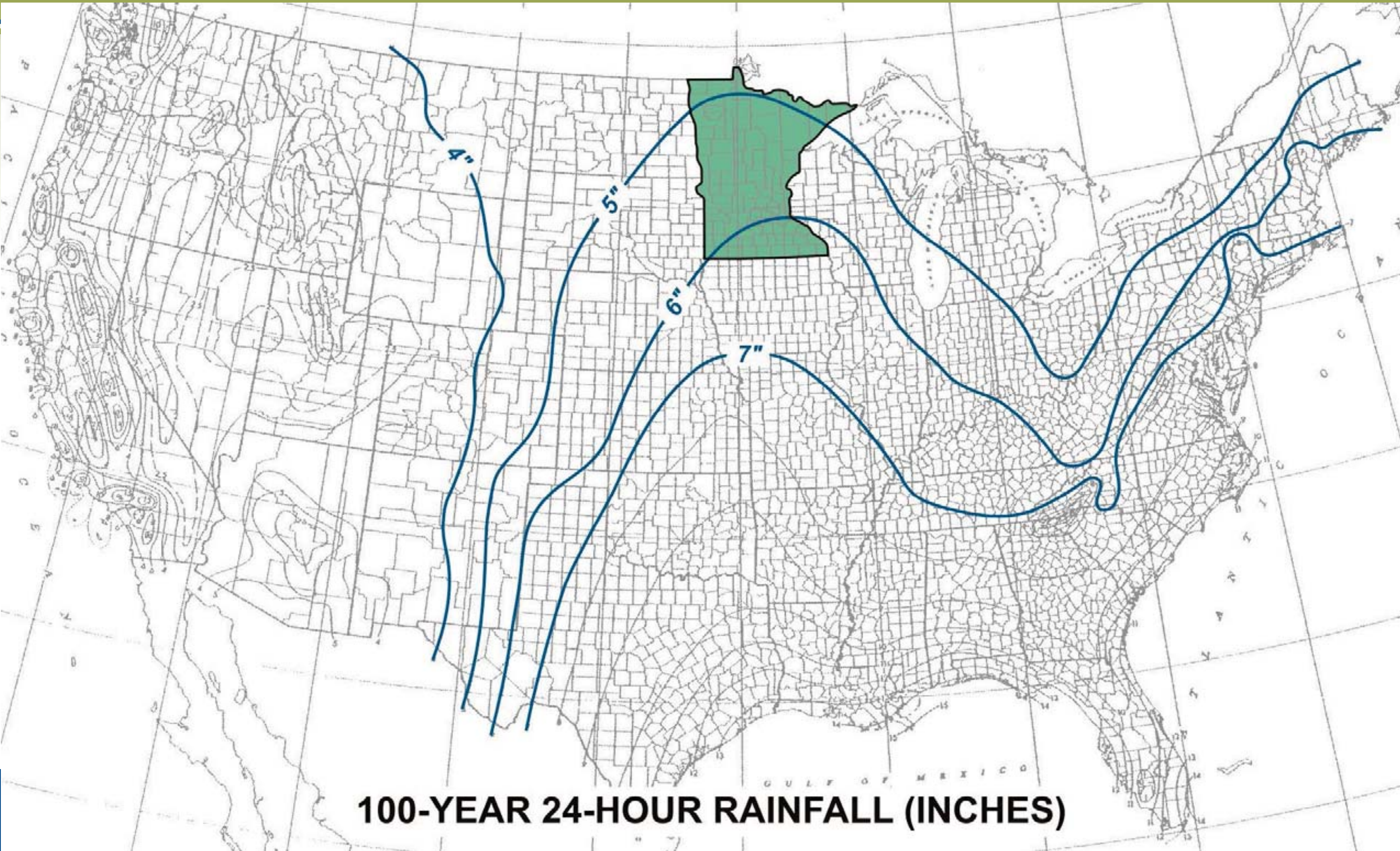
To add, remove, or change your name on the Technical Memoranda mailing list, please visit the web page http://techmemos.dot.state.mn.us/subscribe.aspx

-END-

1. Technical Paper 40 (TP-40)

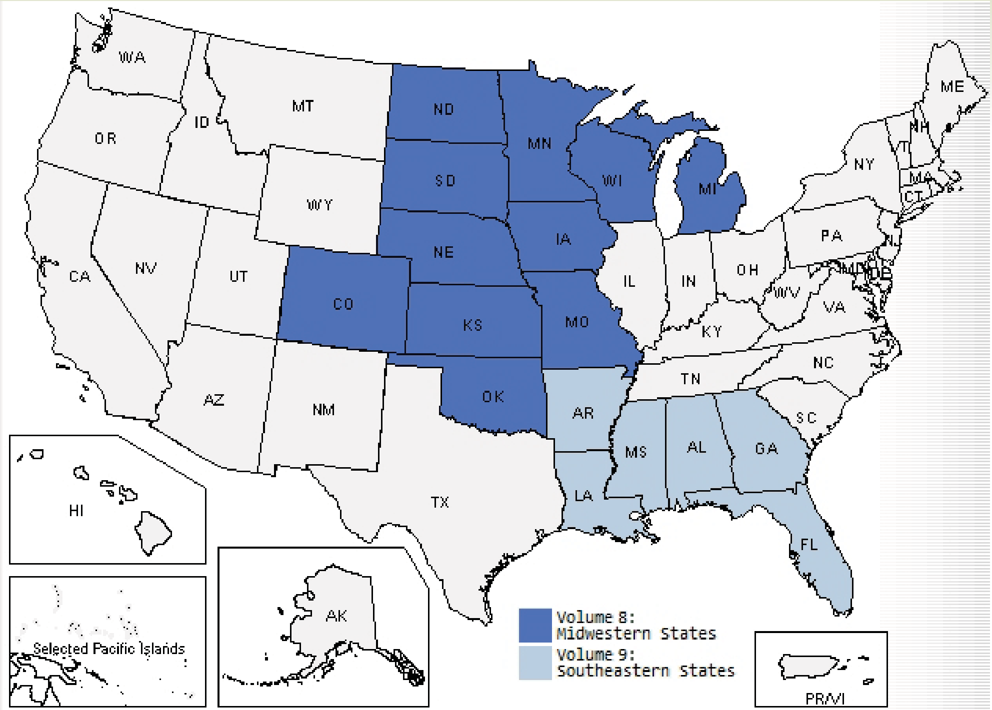
- key document for hydrologists and water planners, created by NOAA in 1961
- developed using available rainfall information from far fewer stations than exist today
- included the "dust-bowl" years of the 1930's
- gives rainfall data for entire country
  - **rainfall frequency or recurrence intervals:** 1-, 2-, 5-, 10-, 25-, 50-year, and 100-year events
  - **rainfall durations:** 30-m, 1-h, 2-h, 3-h, 6-h, 12-h, 24-h, 2-d, and 4-d events

1. Technical Paper 40 (TP-40)



2. Atlas 14 (the new TP-40)

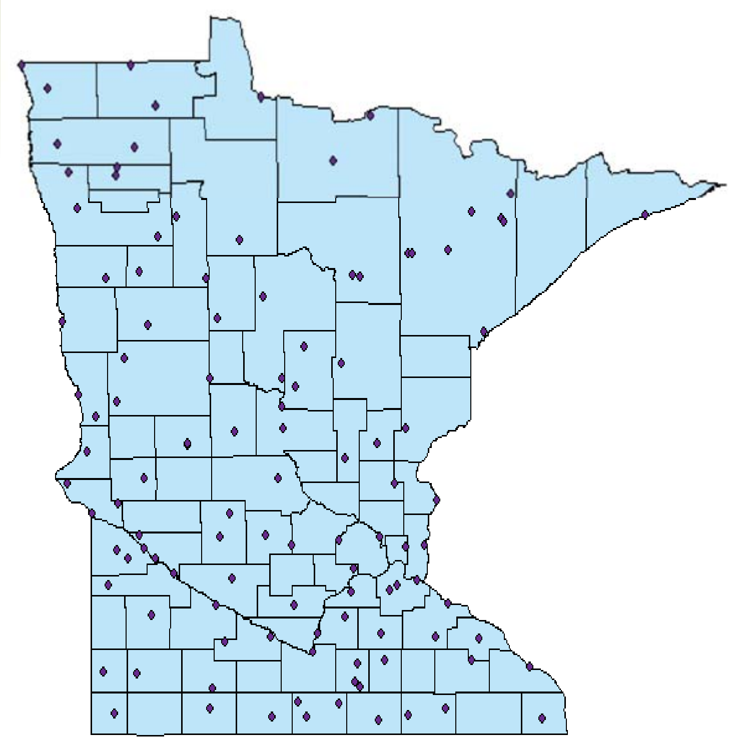
11 states (dark blue) pooled funds to update



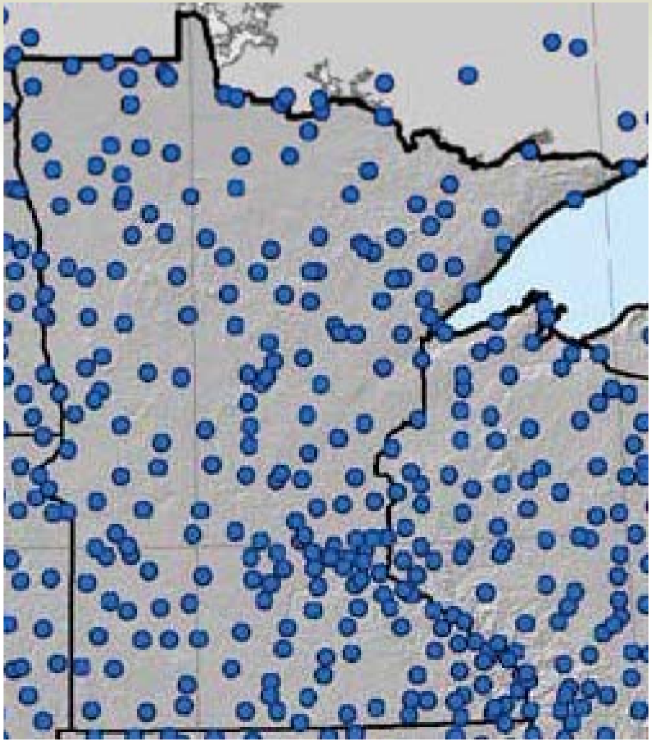
Source: NOAA, peer technical review document

2. Atlas 14 (the new TP-40)

TP-40 Minnesota daily stations

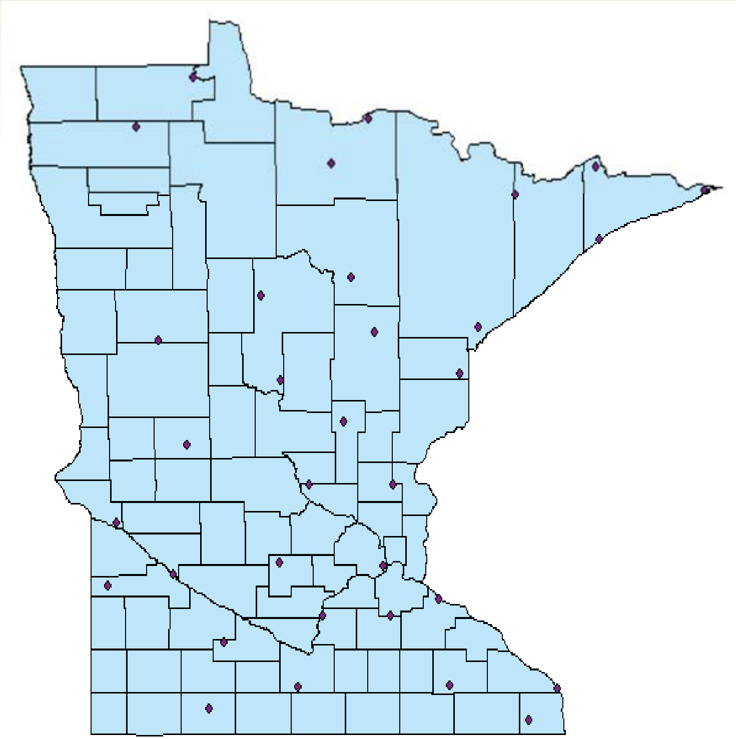


Atlas 14 Minnesota daily stations

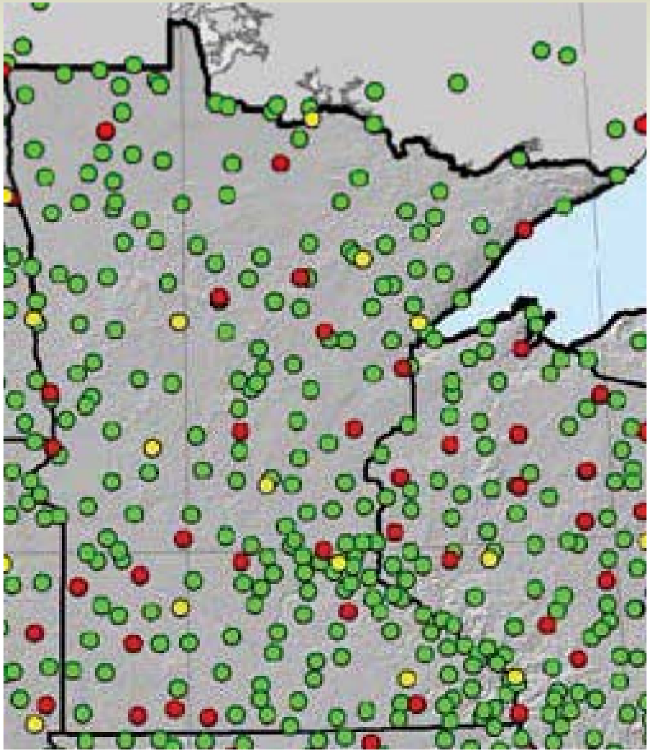


2. Atlas 14 (the new TP-40)

TP-40 Minnesota sub-daily stations



Atlas 14 Minnesota sub-daily stations



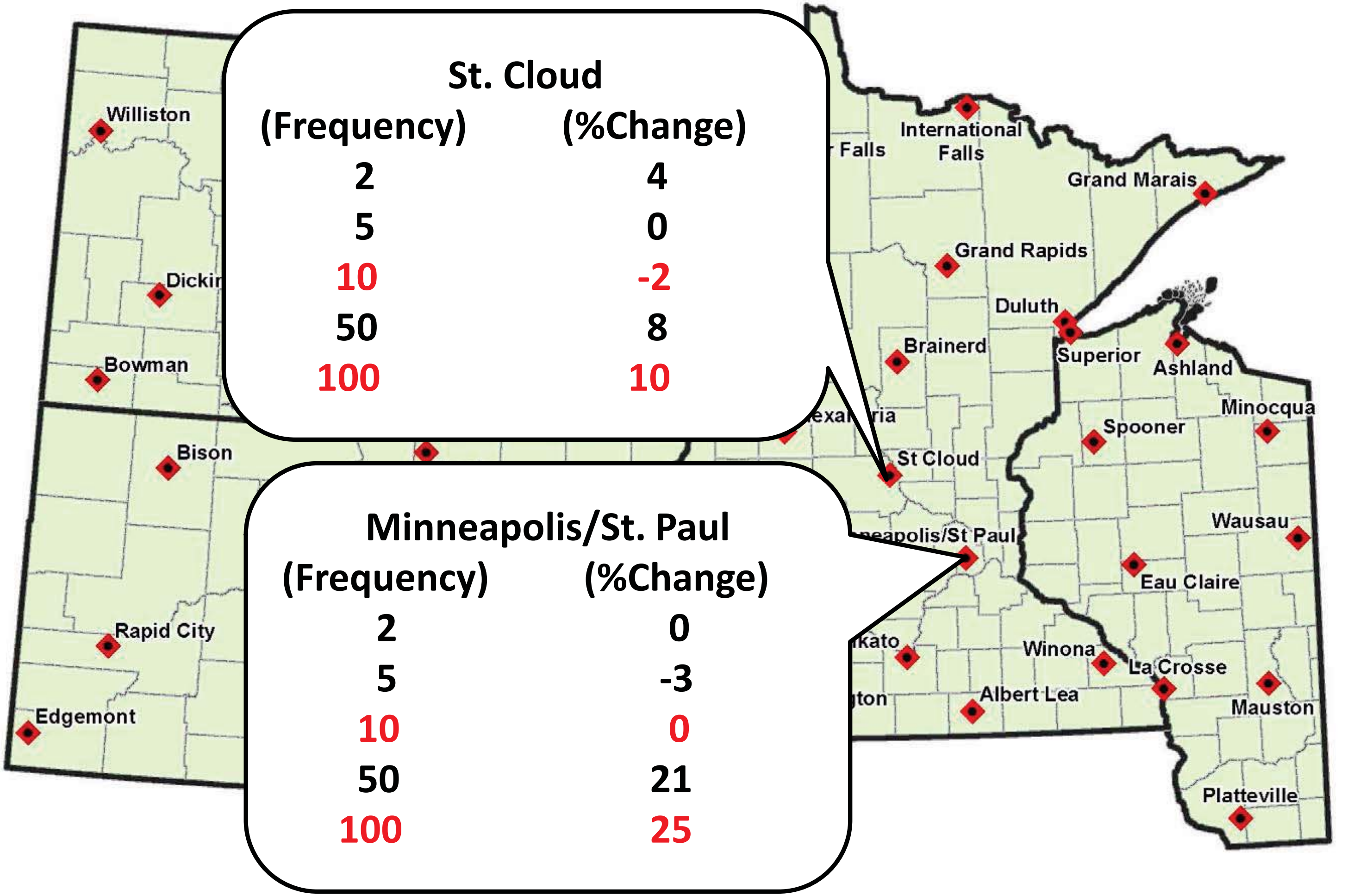
2. Atlas 14 (the new TP-40)

- average record length now over 50 years
  - more than double the record used in original studies
  - oldest Minnesota data set from 1836 (Ft. Snelling / Minneapolis St. Paul Airport)

3. TP-40/Atlas 14 comparisons

- many significant increases: e.g., Minneapolis, MN - 6.0 to 7.5 inches (+25%)
- some decreases for certain storms central Minnesota
- degree of change tends to increase as storm frequency decreases

MSP International AP	
Frequency	% Change
2	0
5	-3
10	0
50	21
100	25



St. Cloud

(Frequency)	(%Change)
2	4
5	0
10	-2
50	8
100	10

Minneapolis/St. Paul

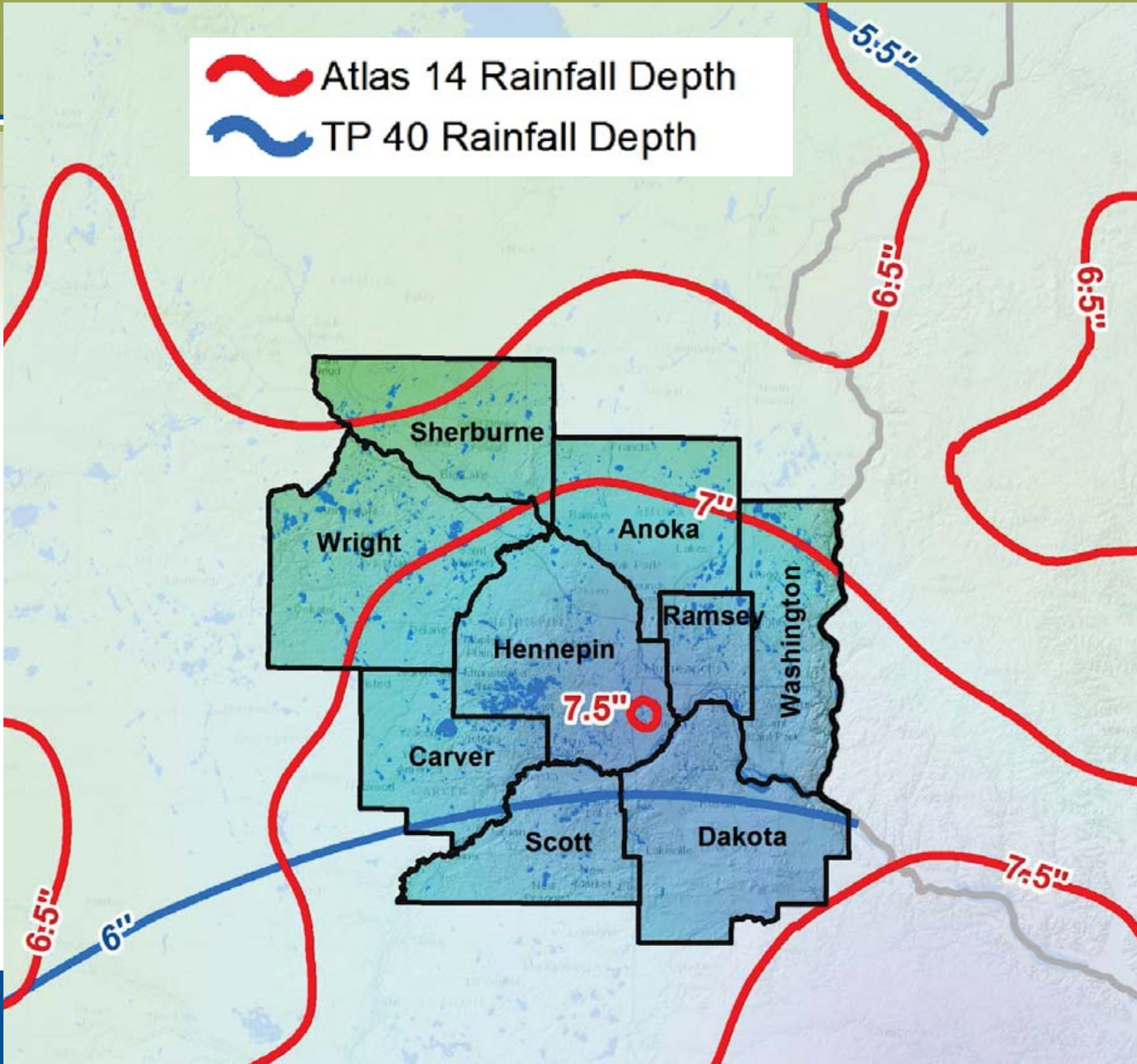
(Frequency)	(%Change)
2	0
5	-3
10	0
50	21
100	25

Location of Atlas 14/TP- 40 data comparisons by Barr Engineering
Source: NOAA Atlas 14, Vol. 8, Ver. 2 Midwestern States

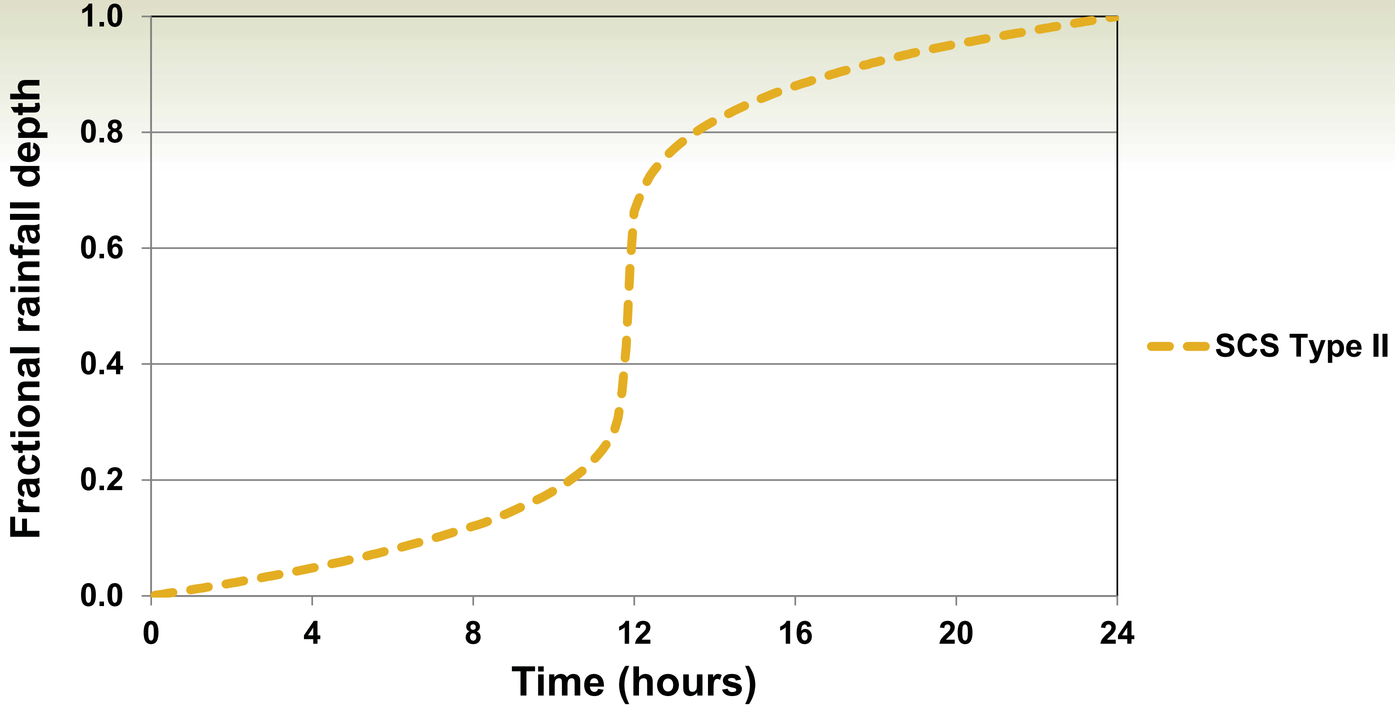
Final: April, 2013

3. Atlas 14/TP 40 comparison

- Twin Cities Metro area
  - 100-year, 24-hour event

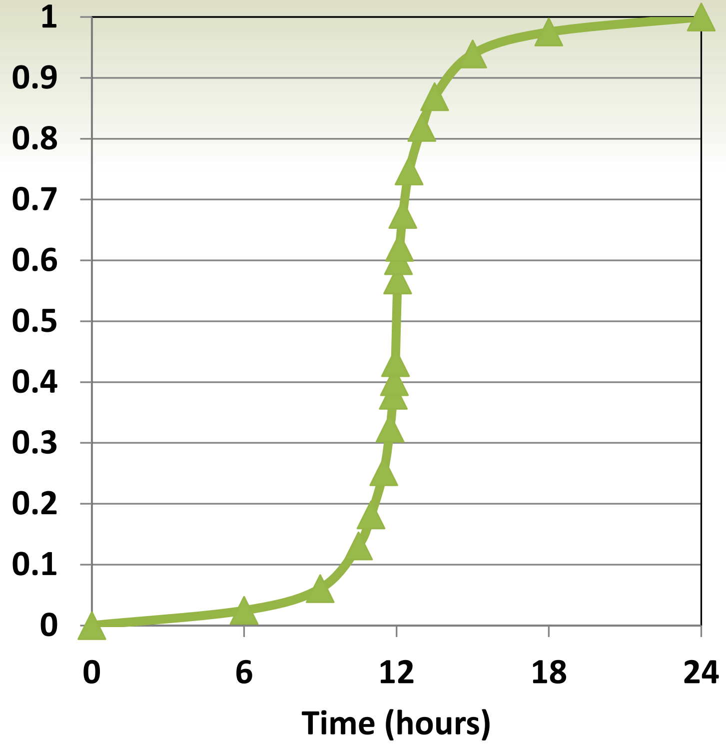


4. Review /compare rainfall distributions

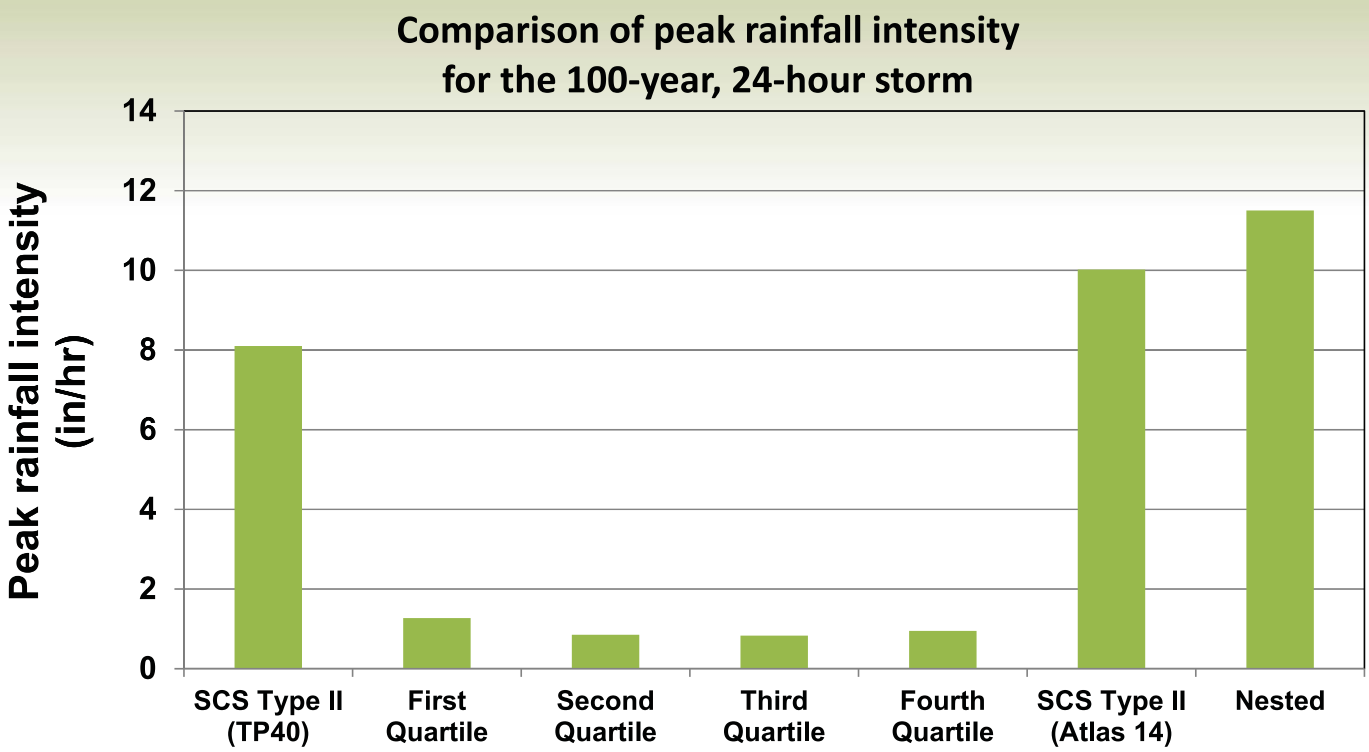


4. “nested” distribution

- hypothetical precipitation distribution
- point-specific
- embeds precip depths for multiple durations (e.g., 5-min, 1-hour, 24-hour, etc.)
- each return frequency has a different distribution (e.g., 10-year or 100-year)
- multiple storms “nested” within single distribution

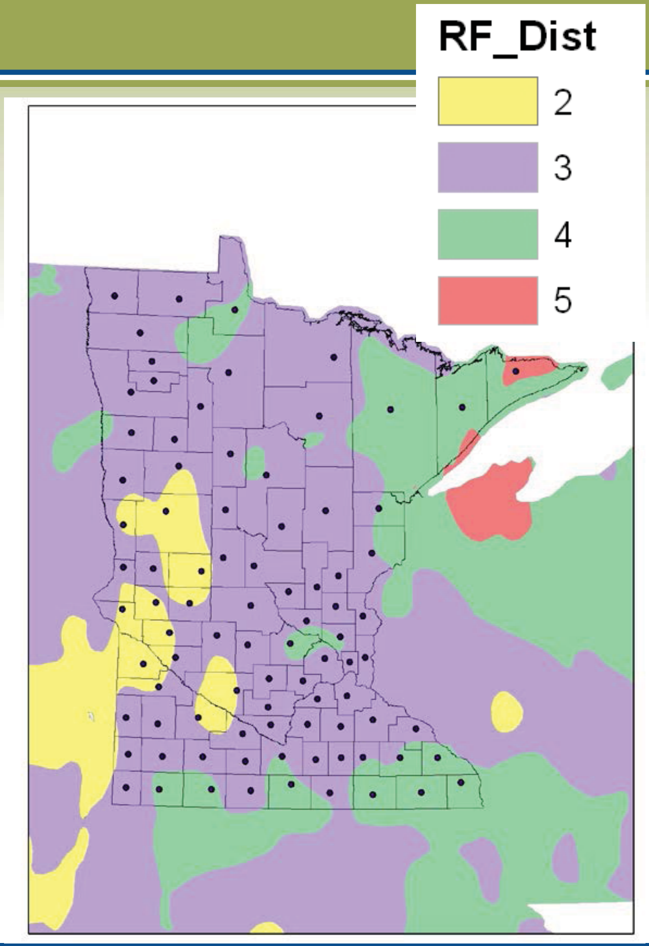


4. peak rainfall intensity of storms

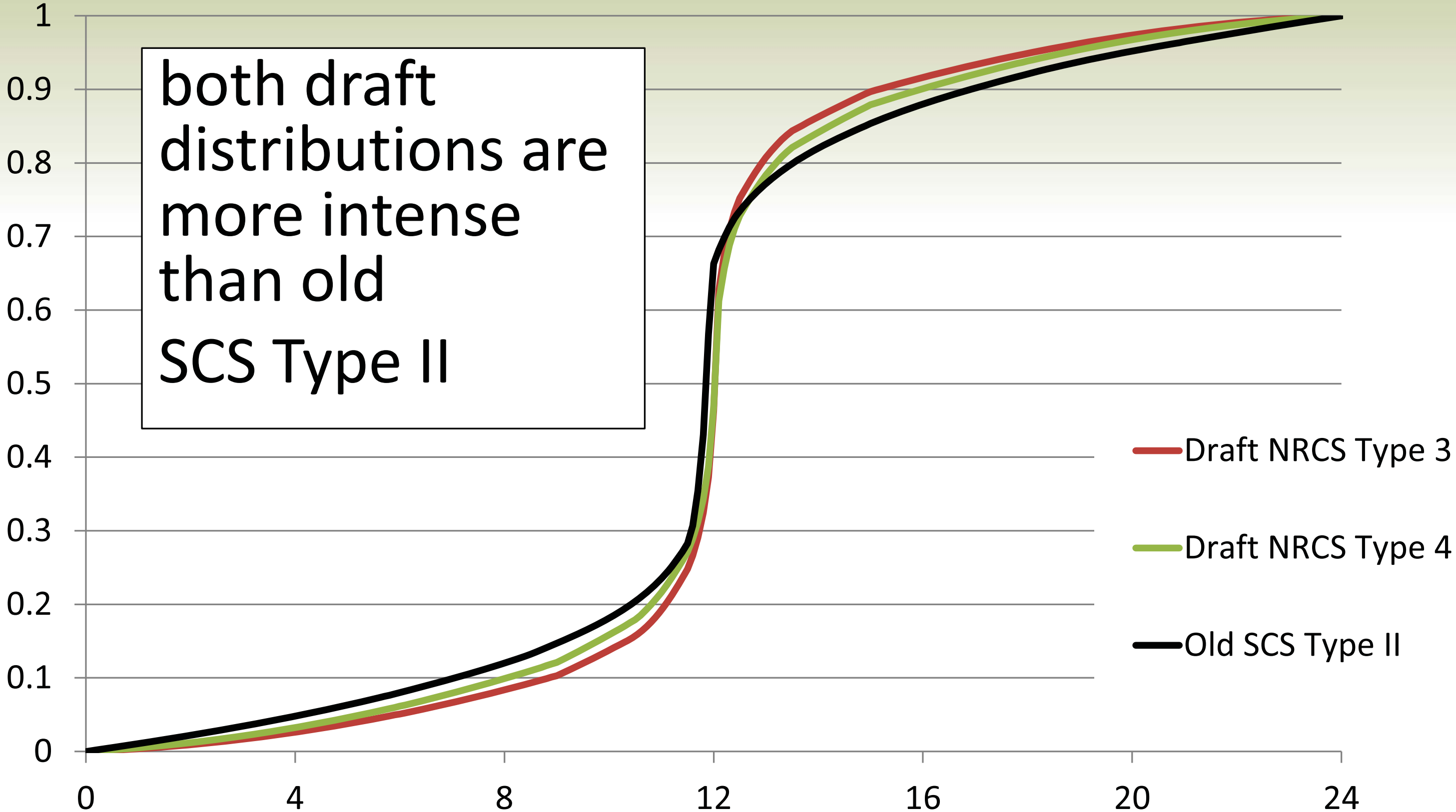


4. draft NRCS regional Atlas 14 distributions

- NRCS considering regionalized distributions for Minnesota
- likely 2 distributions for entire state:
  - #3: most of MN
  - #4: arrowhead



4. draft NRCS regional Atlas 14 distributions



Appendix C—Community Meeting Information

1) Survey Responses: Public Kick-Off Meeting—2/19/15

2) Meeting Summary: First Advisory Group Meeting—5/7/15

3) Survey Responses: Second Public Meeting—5/28/15

4) Meeting Summary: Farmer Listening Session—2/3/16

5) Meeting Summary: Second Advisory Group Meeting—2/4/16

6) Meeting Summary: Joint Policy Group Meeting—2/8/16

7) Meeting Summary: Second Joint Policy Group Meeting—9/26/16

8) Meeting Summary: Final Public Meeting—11/16/16

Stormwater Management and Flood Mitigation Study

Survey responses (18 Respondents)

How were you impacted by the 2014 flood?	
Themes: Flood damage to property structures, shoreline, lawn/yard noted by 9 respondents. Other flood-related impacts included road closures, and loss of recreational use of the lake. Mitigation measures included sandbags, a dirt berm, pumps, and a dam.	
3	County 21 closed, blocked roads, long detours
3	Used over 5,000 sandbag, dirt berm, and two pumps 24/hours (14247 Shady Beach Trail NE); used 600 sand bags; sand bagged lakeshore
4	Shoreline flooding/erosion
2	Damage to dock/property
5	Wet lawn/flooding in yard
2	Loss of recreational use of the lake
What issues, concerns, possible remedies would you like considered in this study?	
Themes: Wide variety of concerns and remedies; the most frequently suggested remedy was greater upstream storage, including wetlands.	
Modifications to outlets/outlet operation	
	Studies that would support opening the outlet at 901 feet; opening at 902.5 feet is too late.
	Get DNR pre-approval for damming the Spring Lake Outlet
	Upgrades to existing stormwater outlets to lakes and tributaries
	Prior Lake Outlet is undersized
	More flow from the outlet
	Controlled outlet from Spring Lake to Prior Lake
	Close off weir from Spring Lake
	Block Spring Lake access sooner
Storage	
	Look at opportunities to store runoff from streets and private property around the lakes
	Reservoir at the south end of town
3	More upstream storage (for flood prevention and increased water quality)
2	Store more water in Buck Lake; rebuild dam at Buck Lake inlet to Spring Lake
4	Restore wetlands in the upper portion of the watershed and throughout/possibly add control structures to existing wetlands (e.g., Sutton Lake) for storage.
2	Talk to landowners about allowing rise of water—much is wetland owned by PLSL WSD; pay landowners upstream to hold water during emergencies
Managing flow	
	Need to account for the volume of flow that is discharged to the lake from resident sump pumps
	Slow down the flow of water that runs off the land feeding into Spring/Prior Lake, and beyond
	Manage the water that farmers are sending downstream
	Replace Beaver Dam
	Use lake and tributary buffers
	Use/extend storm sewer to mitigate high water
Water quality concerns	
	Improve lake water quality (more duck ponds)
	Use rain gardens
	Concerned about the impacts of solutions on downstream resources (e.g., Dean Lake) and downstream erosion in areas already impaired for turbidity

Miscellaneous suggestions/concerns	
	Make improvements to older, developed areas
	Flood-proof homes
	Floodplain maps need to be redrawn
	Institute no wake zones
	Ideas from DNR (drain lakes) and Met Council (Dr. Alasan)
	Employ Candy Cove
	More citizens pumping from lake
	Concerned about the "massive amounts of water we have allowed to leave this basin"
For you, the most important outcome of this study would be…	
Themes: Variety of comments. Desire for better management of lake levels and more proactive flood response were most frequently mentioned.	
Managing flows/water levels	
	Find a way to increase the volume of water leaving Prior Lake
3	Maintain lake levels; never allow water to get to 904.5 feet
	Figure out a way to get the DNR to continue to impose roadblocks to water flow regulation
	De-emphasizing the lake outlet and focusing on managing incoming flows and improving/protecting long-term water quality
	Slow down water upstream; stop chemicals from running into lake
Storage	
	To see how existing and restored wetlands will not only hold water back (flood prevention) but "filter" out and settle nutrients—creating much needed wildlife benefits. Best bang for the buck!
	Improve water storage
Flood response	
	Getting a clearer idea of what I should do when facing flood
2	Understand how to estimate each spring if Prior Lake is going to flood and what measures need to be taken to prevent it; become proactive/take action before it is too late—we continue to be reactive and take way too much time to implement procedures.
Other comments	
	Better lake stewardship
	Ag buffer enforcement
	Frustrated by lack of action in dealing with flooding issues
	Please use surface water, in addition to aquifer, to provide city water to Prior Lake citizens; spare the aquifer for dry years by using surface water during normal seasons

Comments

Options

- Add storage to outlet channel between Blue Lake and Lower Prior Lake
- Enlarge Prior Lake Outlet
- Control Spring Lake Outlet
- Upstream storage (Buck Lake and CDB)
- Permanently or temporarily lower the control elevation of Prior Lake
- Permanent dam between Spring Lake and Upper Prior Lake
- Permanent dam on Spring Lake
- Flood-proof homes
- Offer buyouts
- Pump water to Campbell Lake (emergency)
- Re-establish overflow under TH 13
- Larger pipe for outlet channel to bypass Seq. 4—go north in straight line
- Let water out of the outlet at 901 feet (sooner)

Other Comments

- 100 feet of shoreline lost (100 feet by 3 feet high) at 2892 Center Road (south shoreline of Upper Prior Lake, directly west of inlet to Spring Lake
- Bob Busacker may be interested in upstream storage on family farm (near intersection of 196th Street and Vergus Avenue)

PRIOR LAKE - SPRING LAKE
WATERSHED DISTRICT

Stormwater Management & Flood Mitigation Study

Advisory Group Meeting
Thursday, May 7, 2015
6:30 - 8:00 p.m.
Prior Lake City Hall

MEMBERS:
ANNETTE THOMPSON, *PRIOR LAKE CITY COUNCIL*
BILL KALLBERG, *LAKES ADVISORY COMMITTEE*
CHARLIE HOWLEY, *PLSLWD*
DAN KELLY, *SPRING LAKE ASSOCIATION*
DONNA MANKOWSKI, *PRIOR LAKE ASSOCIATION*
GLENN KELLEY, *SPRING LAKE ASSOCIATION*
GREG WILSON, *BARR ENGINEERING*
JIM FITZSIMMONS, *SCOTT SWCD*
KATHY NIELSEN, *SPRING LAKE TOWNSHIP*
KIM SILVERNAGEL, *CITIZEN ADVISORY COMMITTEE*
MARK VIERLING, *SCOTT WMO*

OTHERS PRESENT:
KATY GEHLER, CIT*Y OF PRIOR LAKE*
PETE YOUNG, *CITY OF PRIOR LAKE*
TROY KUPHAL, *SCOTT SWCD*
CURT HENNES, *PLSLWD*
WOODY SPITZMUELLER, *PLSLWD*
MAGGIE KARSCHNIA, *PLSLWD*
DIANE LYNCH, *PLSLWD*
ANDREA SLOTKE, *PLSLWD*

1. First Community Meeting Debrief (Greg Wilson)

- Greg provided a re-cap of the first community meeting on February 19th.
- When compiling the feedback from the community meeting, Barr Engineering was looking for themes/common answers to such questions as:
    - How were residents most impacted by the 2014 flood?
    - What were the main issues/concerns/remedies residents would like considered?
    - What are the most important outcomes?

- Bill Kallberg noted that the themes mentioned in Greg's presentation were consistent with the ones he has heard on the Lakes Advisory Council and in his time on the watershed district board.
- Jim Fitzsimmons recalled a comment from a different meeting in regards to a designated area upstream for storage near the intersection of 196 & Vergas Avenue. Greg noted that upstream storage is one of the flood damage reduction tools that we will be exploring, but that no single upstream storage area will solve the problem entirely.
- Curt Hennes asked if the historic second outlet at Spring Lake will be considered as a possible solution. Curt had heard Mayor Hedberg talk about this historic and no longer present outlet on the east side of the lake. Pete Young from the City noted that the elevations in this part of the watershed don't support an outlet.
- Charlie Howley asked if other strategies will be considered other than the three mentioned, such as buyouts, infrastructure improvements, and better engineering solutions for shoreline properties and along the outlet channel (preparing for flooding vs. preventing flooding).

2. Overview and Current Status of Watershed Modeling (Greg Wilson)

- The larger watershed was broken down into four smaller sub-watersheds with known flow information from documented monitoring data.
- Barr calibrated the watershed model that was created using the 2014 flood event data, then used the calibrated model to adjust for different flood mitigation scenarios.
- Kim Silvernagel asked if the buyouts scenario was only for Prior Lake residents or for both Spring and Prior Lakes? Given that only secondary structures, were affected on Spring Lake, the buyouts would probably not include Spring Lake.
- Is there data on how often flooding on Prior Lake has occurred? Understanding the urgency of the situation, we should also be thoughtful that this was a 250-year event and balance the solution with other end of the spectrum (drought) conditions when considering lowering the lake level.
- Preventing flooding vs. preparing for flooding. Should we consider adopting regulations that limit where you can build/landscape to prevent future damage? Require or fund raingardens and/or shoreline restoration?

3. Potential Modeling Scenarios for Improvement Strategies (Greg Wilson)

- Greg summarized the three "What-if" modeling scenarios:
    - <u>Increase Outlet Structure Conveyance:</u> max. 1 foot difference at peak lake level with highest cubic feet per second (cfs) increase (highest scenario modeled)
    - <u>Increase Storage in Spring Lake Basin:</u> max. ½ foot difference at peak lake level with 2-foot outlet raise (highest scenario modeled)
    - <u>Increase Storage in Spring Lake Watershed:</u> max. just under 1 foot difference at peak lake level with 20% storage volume increase (highest scenario modeled)
- Kim Silvernagel asked if combined strategies will be modeled. Once Barr has a good model going with the three base models, additional combined strategies will be tested. Greg stressed that a combination of strategies will likely be the solution.

- Charlie Howley asked if the model requires an identified storage area. Greg stated that it needs to be fairly detailed with its assumptions in order to be accurate with defined, actual solutions.
- At what lake level to people start sandbagging? Is there significant storage volume lost? Katy Gehler stated that sandbagging starts at a lake level of 904 for some homes, but the current building elevation regulations are at 910. The amount of storage lost behind the sandbag line is insignificant.
- Next step will be to determine how much the scenarios will cost. Some scenarios might have exponential growth as you increase the size (e.g. x acres of restoration might cost you, but as you run out of willing landowners, the price per acre will increase).

4. Discussion of Draft Selection Matrix (Greg Wilson)

- Greg presented a list of potential criteria that might be considered in the matrix such as:
    - Costs of projects: design/prep, construction, loss of property/use
    - Benefits/Impacts: ecological, water quality, etc.
    - Feasibility: regulations, available funding, etc.
- How/or should an inconvenience cost be factored into the matrix, such as loss of accessibility to property, loss in use of property, etc.?
- Has there been a total $ amount associated with the financial impact of the 2014 flood? Need to weigh the potential strategies against true necessity, realizing that this was a 500-year flood event and is not likely to occur again soon.
- Greg noted that the matrix will take into account things we can and cannot quantify. Factors are weighted so that we can hone in on what is most important.
- Timing will also be taken into account – how long will it take to implement?
- What will ultimately be our goals? What are we shooting for?
- Once we have determined the right solution, what agency will be in charge of finding the money and resources to implement it?
- FEMA is not a good source for preventative funding, unless the cost/benefit ratio is extremely high.
- Upstream storage has minimal consequential impact as opposed to other strategies like increasing the outlet which can affect downstream residents or installing a dam on Spring Lake which will impact Spring Lake shoreline owners.

Next Steps:

- The Advisory Group will be meeting again at the end of June. A draft matrix will be presented at that time.
- Updates to the study will be provided by email as the project moves forward.

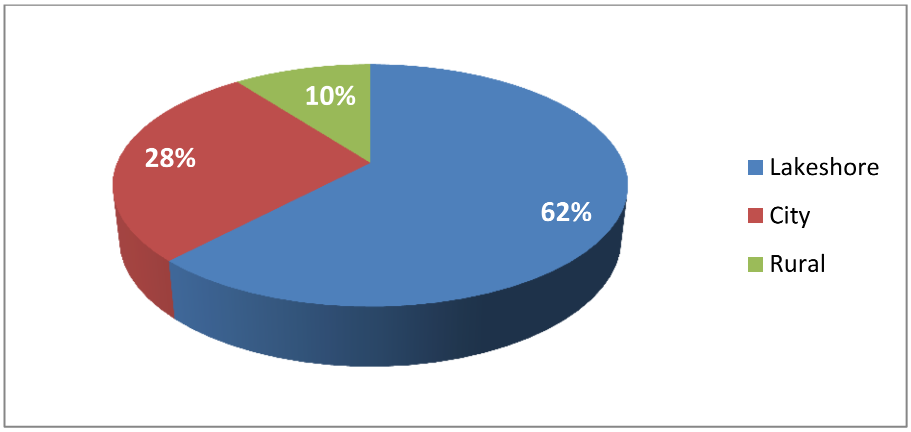
Surface Water Modeling and Flood Damage Reduction Study
May 28, 2015, public meeting

A total of 30 people responded to the survey distributed during the May 28, 2015, public meeting. The survey questioned participants about the location of their properties, what they viewed as important factors in selecting a potential flood-mitigation project, and their feelings about use of public funding for flood mitigation efforts. Survey results are documented on pages 2-7. A summary of participant comments on survey forms and as documented during facilitated discussions is provided on pages 8-9.

Property location

Within the watershed district I live on (please check one box): lakeshore/city lot/rural land

A total of 28 (out of 30) participants responded to this question: 18 indicated that they live on the lakeshore, eight in the city, and three in rural areas. One person indicated that property was owned on both the lakeshore and in the city.



Factors

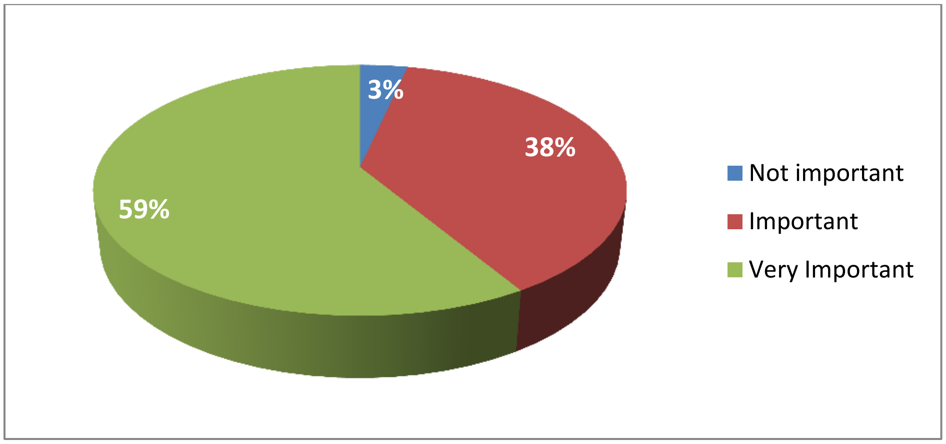
Participants were asked to rate the following factors that could be considered in the "universe of options" for flood mitigation.

- **Cost/benefit ratio:** Installation and maintenance costs of options should be weighed against the potential to reduce the volume or rate of stormwater
- **Water quality benefits:** Options should result in less sediment and pollutants
- **Protection below the 100-year FEMA flood level:** Options should protect properties and public roads below the 100-year FEMA flood level
- **Project readiness:** Options should be completed quickly

Respondents were asked to describe each of these options as either *not important/important/very important* and then to rank the factors from 1 to 4 in order of importance (1 being most important and 4 being least important).

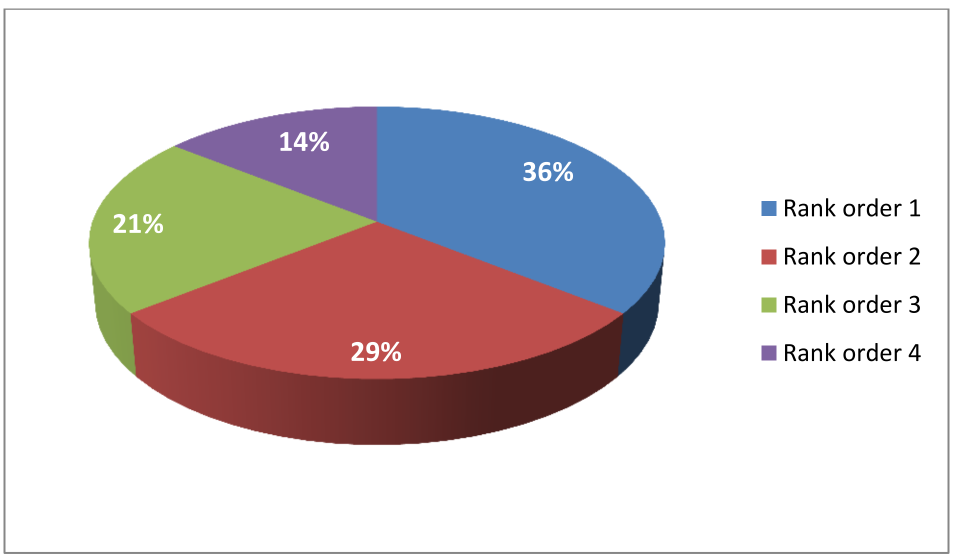
Cost/benefit ratio

Twenty-nine of the 30 participants responded to this question. Seventeen described cost/benefit ratio as a *very important* factor, 11 described it as *important,* and one as *not important.*



The rank order assigned to cost/benefit ratio benefit was as follows (two respondents did not provide a rank order of factors):

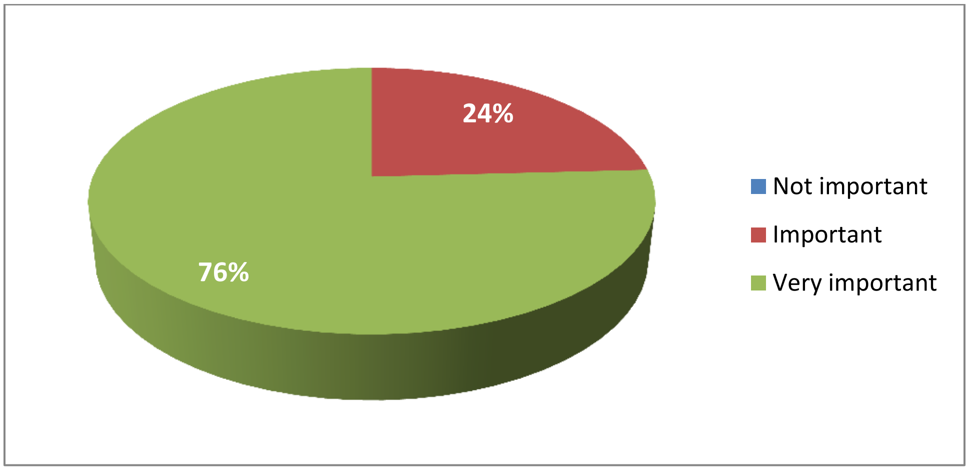
- **Rank order 1:** 10 participants
- **Rank order 2:** 8 participants
- **Rank order 3:** 6 participants
- **Rank order 4:** 4 participants



As shown above, 36% of participants ranked this factor as their first priority and a majority of participants (65%) ranked this factor as first or second in order of importance.

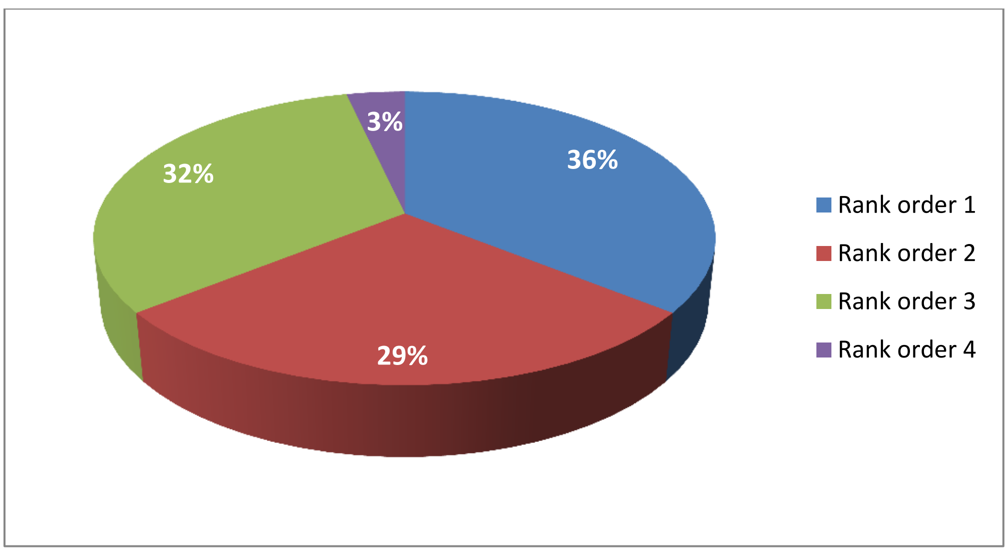
Water quality benefits

Twenty-nine of the 30 participants responded to this question. Twenty-two described water quality benefits as a *very important* factor and 7 described it as i*mportant*. No participant described this factor as *not important*.



The rank order assigned to water quality benefits was as follows (two participants did not provide a rank order of factors):

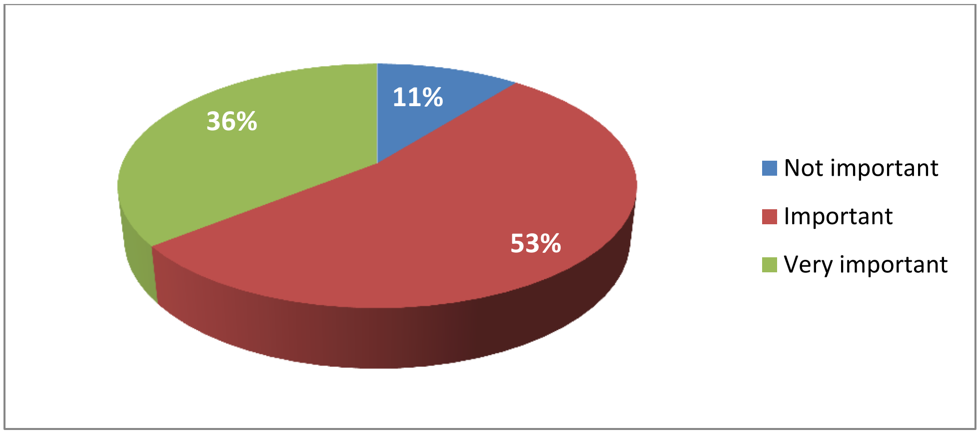
- **Rank order 1:** 10 participants
- **Rank order 2:** 8 participants
- **Rank order 3:** 9 participants
- **Rank order 4:** 1 participants



As with cost/benefit ratio, 65% of participants ranked water quality benefits as first or second in terms of importance; only one assigned it a rank of 4.

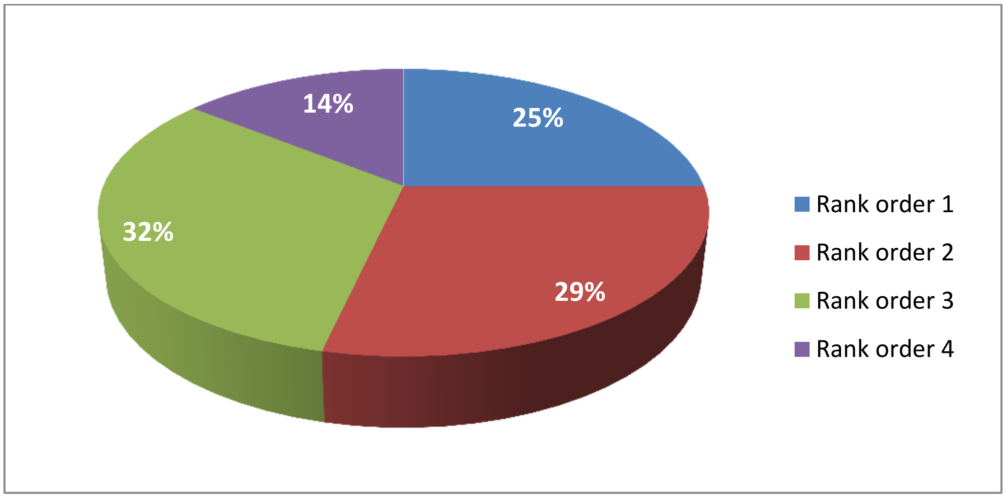
Protection below the FEMA 100-year flood level

Twenty-eight of the 30 participants responded to this question. Ten described protection below the 100-year FEMA flood level as a *very important* factor, 15 described it as i*mportant,* and 7 as *not important*.



The rank order assigned to protection below the FEMA 100-year flood level was as follows (two participants did not provide a rank order of factors):

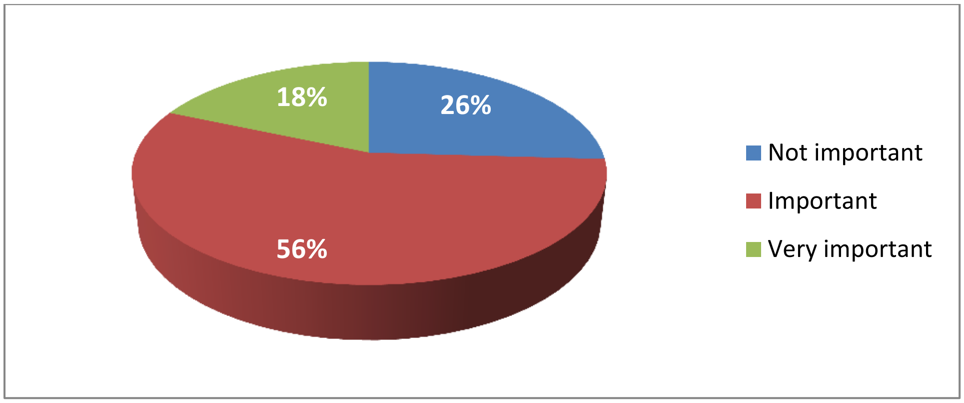
- **Rank order 1:** 7 participants
- **Rank order 2:** 8 participants
- **Rank order 3:** 9 participants
- **Rank order 4:** 4 participants



As shown above, ratings assigned to this factor were more evenly distributed than those for cost/benefit ratio and water quality. Though this factor was assigned a rank of 1 or 2 by the majority of participants (54%), cost/benefit and water quality factors ranked higher (65%).

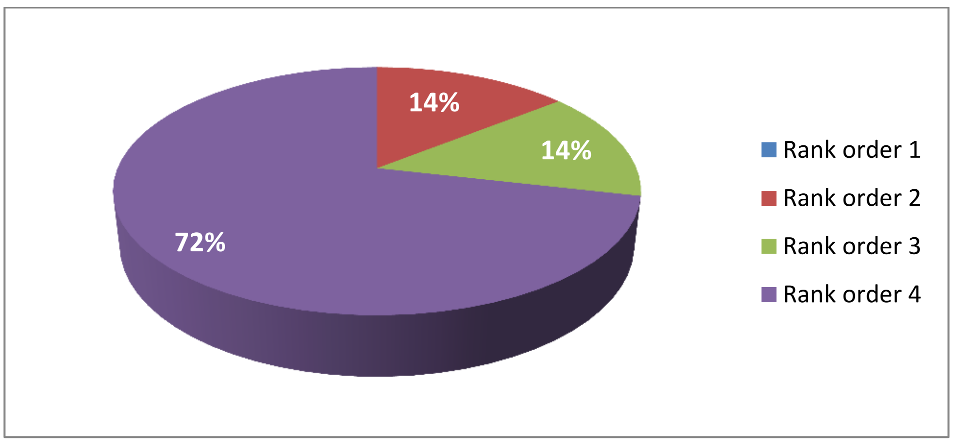
Project readiness

Twenty-seven of the 30 participants responded to this question. Five described expedited project completion as a *very important* factor, 15 described it as *important,* and five as *not important*.



The rank order assigned to project readiness was as follows (two participants did not provide a rank order of factors):

- **Rank order 1:** 0 participants
- **Rank order 2:** 4 participants
- **Rank order 3:** 4 participants
- **Rank order 4:** 20 participants



While 74% of respondents described project readiness as *important* or *very important*, this factor had the lowest rank order. No one considered this to be their number-one priority factor and 72% considered it to be their lowest priority.

Factor comparisons

The tables below provide a comparison of responses for the level of importance and rankings assigned to each factor.

Importance level

Factor	Value Assigned (% of Participants)		
	Not Important	Important	Very Important
Cost/benefit	3%	38%	59%
Water quality	0%	24%	76%
100-year FEMA flood level	11%	53%	36%
Project readiness	26%	56%	18%

As shown above, participants were reticent to define factors as *unimportant*. Cost/benefit ratio and water quality factors were considered most important and, by comparison, project readiness least (although 74% still considered it either *important* or *very important*).

Rankings

Factor	Rank Order Assigned (% of Participants)			
	Rank Order 1	Rank Order 2	Rank Order 3	Rank Order 4
Cost/benefit	36%	29%	21%	14%
Water quality	36%	29%	32%	3%
100-year FEMA flood level	25%	29%	32%	14%
Project readiness	0%	14%	14%	72%

Rankings for each factor were fairly well distributed—with the exception of project readiness (no participant gave it a rank order of 1 and 72% gave it a rank order of 4). Again, cost/benefit ratio and water quality were ranked as a first priority among the greatest number of participants (36% each); another 29% considered these factors as a second priority.

Funding support

In the last part of the survey, participants were asked to indicate if they would support two funding mechanisms as part of a flood mitigation project:

- Use of public money to protect individual homes/businesses
- Increasing property taxes to finance the options

Support for Public Funding		Support for Property Tax Increase	
Yes	No	Yes	No
69%	31%	60%	40%

Although a majority supported public funding/property tax increases, a number of respondents indicated that support depended on how much money was needed and/or how it was used. Specific considerations mentioned were:

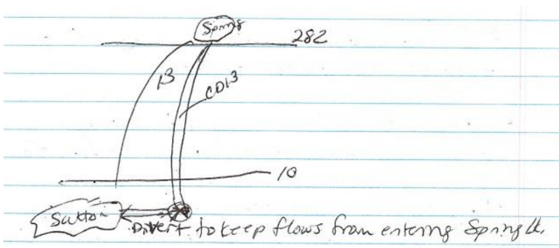
- Whether the project would be successful in removing homes from the floodplain.
- Whether the project would protect businesses.
- Whether the project improved water quality or provided other public benefits.

General sentiment was that public funds should be used to benefit the entire community, rather than select property owners.

Participant comments

Comments from survey forms and facilitated discussion are provided below, categorized by subject (s= survey form, d=discussion; numerals indicate number of similar responses).

Cost/benefit ratio factor	
S	Project cost should not be the only consideration—analysis needs to include value of homes, etc.
D	Duration of cost calculation—how do you calculate the personal loss?
2D	Need to consider the likelihood/frequency of dealing with these impacts every 100–500 years. Is doing flood protection (e.g., sandbagging and other routine emergency operations) sufficient, vs. spending significant funds to reduce risk frequency?
D	What is the cost/benefit of buyout vs. other options?
100-year FEMA flood level factor	
S	Flood level should not be lowered to the new FEMA standard (use 909 ft).
S	Is 100-year FEMA flood level the “right standard” given that these are not “river flooding” events?
D	City has the responsibility to protect to the level that was previously permitted
Project readiness factor	
D	Five years or less
Public funding	
S	Tax increase—YES only if the entire watershed is taxed
D	City has the obligation to protect
D	Everyone needs to help fund the projects as they will benefit
D	Public funds should be spent for protecting against business impacts—economic
S	Supports use of some public money ("how much is the question … in the greater good"); should probably not increase property taxes given this is a "long-duration solve in a changing environment"
2S	Supports use of public money and increased property taxes "depending on how much for both"
S	Use public money only if removing homes from floodplain; include USACE (federal) and state money in funding options
D	Increase taxes only for water quality and other public benefits; tax dollars should not be spent to protect landscaping
S	Have you looked at lakefront taxes lately? You are driving owners out. Why?
D	Tax dollars should not be spent to benefit 27 affected homes
Mitigation options	
S3	Would support upper-watershed storage as first option
D2	Creating upper-watershed storage is 2-for-1. You can get rid of the phosphorus and create less flooding. This is also an option that will not cause more damage to the outlet.
D2	Lease upstream land for storage (or drainage easement with compensation for property damage during flood events; no flooding, no payments); get help from township and Scott SWCD to work with landowners
D	Other ponding/storage below outlet—Pike Lake, Wilds, SIMSC lands, etc.
D	Can we dam up Artic Lake?
D	Are Sutton and Arctic Lake options feasible and cost effective?
D2	Storage in Artic Lake—between Spring and Prior Lakes (no private property)
S2	Dam the Pheasants Forever wetland south of Spring Lake; it was once blocked by a beaver dam
S	Spread out 2,000 acre feet among different basins (4)

S	OK with a temporary blockage of the outlet from Spring Lake to Prior Lake, but it needs to be fair. You can't let Spring Lake rise 6-8 feet while Prior Lake only goes up 3 to 4 feet. There has to be set rules so that Prior Lake doesn't open up the outlet during drought times but restrict it during floods; it needs to be fair.
S	Recommend combined effort of quick, easy upstream catch; set outlet control for Spring Lake to slow flow to Prior Lake; avoid Prior Lake outlet above 65, given multiple issues
D	Similar to what SMSC has been doing, Prior Lake could pump treated water back into the aquifer to manage water levels; could also use treated lake water for municipal use
D	The old outlet on the east end of Prior Lake is too high to get the right flow; that's why they made the outlet in the first place. Let's not consider that a viable option.
D	Although Spring Lake did not have the extent of flooding that Prior Lake did, it still did extensive damage to shorelines and property. The option to dam up Spring Lake will just switch the damage from Prior Lake to Spring Lake. Lakeshore owners who had damages on Spring weren't able to claim flood insurance, so it may have cost them more individually.
D	Work with Scott County to create a new lake in Spring Lake Regional Park for more storage.
D	What about everyone doing a rain garden (i.e., many small projects vs. a few large ones)?
D	Unplug Candy Cove
D	Build a small seawall in areas prone to flooding
D2	Like the Sutton Lake idea, but there are many farms and ditches downstream of the wetland that don't contribute to Sutton Lake
D	Put a restriction on ditch (CO 13) to divert water to Sutton Lake during flooding and keep flows from entering Spring Lake; get SWCD to work with adjacent farmer/landowners 

Miscellaneous comments/questions	
S	Cost-effective options should be considered to protect public streets and the seven neighborhoods that were affected by the flood
D	Buyouts "don't feel right"
D	Need a "Plan B" for a failure of the outlet channel
D	Continuing to maintain the outlet channel is very costly; the outlet channel project was assessed to benefitting properties
D	40 mi? that go to outlet structure—how much drainage area does the ditch serve?
D	Need to balance high- and low-water impacts
D	Moral equivalency: high water = homes destroyed; low water affects recreational use
D	Low water affects property values—shallow bays can end up with no lakeshore if water levels are low enough
D	Model for different events (how often do flows go above 905 feet?), 20-year frequency?
D	Can we run a drought scenario with the flood scenario when considering different options?
D	What is the impact on wetlands if you store a lot of water on a high-quality wetland—what is the impact of added "bounce?"
D	Discharge into Spring Lake is very sediment-laden; Spring Lake is the filter for Prior Lake.
D	There is no silver bullet.

Meeting Summary

Farmer Listening Session

Wednesday, February 3, 2016

Spring Lake Town Hall

PUBLIC ATTENDANCE: 24 residents present

Farmer-Led Council Members: Paul Krueger, Jim Dubbe, Rob Casey & Joe Hentges

STAFF PRESENT:

Watershed District: Maggie Karschnia, Diane Lynch, Andrea Slotke

Spring Lake Township: Kathy Nielsen

Scott Soil & Water Conservation District: Troy Kupahl and Scott Schneider

Prior to the meeting, flyers were mailed to all the known farming producers located within the watershed district. The Prior Lake-Spring Lake Watershed District's Farmer-Led Council helped contact neighbors and local farmers directly to encourage attendance at this meeting. Of the roughly 50 known farmers in the watershed district, 24 attended the Farmer Listening Session.

Paul Kruger, a Farmer-Led Council member, helped to facilitate the meeting which included a Watershed District staff presentation of the potential flood mitigation options and next steps for the flood study. The goal of the meeting was to better understand the flood impacts that farmers faced in 2014 and to hear concerns about the upstream storage option. A summary of what was discussed at the meeting is below.

Sharing Flood Damage Experiences:

Comments:

- Crop insurance does not cover all loses. There is a loss of property, time, soil, etc.
- There are many different types of crop insurance, and farmers usually take at least a small hit from flooding whether they have insurance or not.
- Not all farmers have crop insurance.

- Many farmers tried to re-plant after the heavy rains, only to get hit again and lose the 2nd crop. Crop insurance only covers the first.
- If fields are flooded for a certain period of time, the microbes in the soil die off. Farmers need time to re-build the soil before they can plant crops again. Some flood damaged fields will take two or more years to recover.
- For dairy farmers, crop insurance does not cover the purchase of replacement silage for their cows. Buying silage is much more expensive than growing your own, and many farmers took a hard hit in 2014.
- Loss of access to some fields during the 2014 flood.
- Farmers experienced a loss of valuable soil that washed away during flood events.
- Erosion and flood damage to crop fields that needs to be corrected.
- For some, the rain washed away a 2-year application of fertilizer. Not only is that year's fertilizer lost, but the following as well.
- Not just fields that were flooded out, it was farm buildings and houses that were damaged as well.
- Farmers don't complain much about flood damage - it's just part of running a farm. "Just because the lakeshore owners cry louder than the farmers, it doesn't mean that farmers didn't suffer damage from the flood too."

What obstacles/challenges do you see there being for Upstream Storage as a flood mitigation option?

Comments:

- Concern that the creation of upper watershed storage areas will plug up tile lines upstream.
- Farm acreage in the Twin Cities area is extremely valuable as the amount of tillable land decreases every year with the expansion of the urban areas. Available cropland becomes more and more expensive to replace. This should be considered when identifying upper watershed storage areas.
- It's saving expensive lake homes in the City of Prior Lake at the sacrifice of prime farmland in the upper watershed.
- If a farmer gives up land, there are very few properties in the area to buy to make up the loss. Being so close to the Twin Cities, it is also hard to afford to buy those properties up.
- It's not just the farm producer you need to negotiate with, it's the owner of the land. Many properties in production in the area are rented out.

- Temporary storage won't work. If there is a water control structure on a field, crop insurance won't cover it.
- Worried about condemnation and the taking of land.
- Most farmers won't want to even start the conversation with staff about potential upstream storage or wet areas, as it will put a target on their farm fields.
- There has been a lot of finger pointing upstream. If rural residents don't also see an effort to fix the problem by urban landowners, they are less likely to want to help out the situation.
- Farming is a business. If upstream storage is going to happen, it has to make sense from a business standpoint and help the farm be profitable, not hinder production.

Surface Water Modeling and Flood Damage Reduction Study

Advisory Group Meeting
February 4, 2016
6:30 - 8:00 p.m.
Prior Lake City Hall

MEMBERS:

ANNETTE THOMPSON, *PRIOR LAKE CITY COUNCIL*
BILL KALLBERG, *LAKES ADVISORY COMMITTEE*
CHARLIE HOWLEY, *PLSLWD*
DAN KELLY, *SPRING LAKE ASSOCIATION*
DONNA MANKOWSKI, *PRIOR LAKE ASSOCIATION*
GLENN KELLEY, *SPRING LAKE ASSOCIATION*
GREG WILSON, *BARR ENGINEERING*
JIM FITZSIMMONS, *SCOTT SWCD*
KATHY NIELSEN, *SPRING LAKE TOWNSHIP*
KIM SILVERNAGEL, *CITIZEN ADVISORY COMMITTEE*
LIZ WENINGER, LAKES ADVISORY COMMITTEE
MARK VIERLING, *SCOTT WMO*

OTHERS PRESENT:

KATY GEHLER, CIT*Y OF PRIOR LAKE*
PETE YOUNG, *CITY OF PRIOR LAKE*
TROY KUPHAL, *SCOTT SWCD*
CURT HENNES, *PLSLWD*
WOODY SPITZMUELLER, *PLSLWD*
MAGGIE KARSCHNIA, *PLSLWD*
DIANE LYNCH, *PLSLWD*
ANDREA SLOTKE, *PLSLWD*
GREG WILSON, *BARR* ENGINEERING

Kathy Nielsen welcomed the Advisory Group members and described the purpose of the meeting. Katy Gehler reviewed the Study process and Diane Lynch reviewed the Study Options.

The Advisory Group was asked to respond to 4 question which started with, "What should the priorities be for."

1. Protection of private property?

Comments:

- Set expectations of what the city will do for property owners if there is a flood
- Safety of citizens, schools etc. should take precedence
- We've had 2, 100 year storms in recent memory—1985 and 2014. What can we do in 10 or 20 years?
- There have been 5 flooding events in recent memory

2. Access to private property?

Comments:

- Taxpayers pay for access with their tax dollars
- Three areas sandbagged their roads
- Public infrastructure should take priority, including septic and sewer
- Important to maintain public roads
- Watersedge—In order to raise the road, the City would have to buy lots of properties

3. Assistance with protection of private property?

Comments:

- What would happen to properties that are bought out?
- What is the number of properties below 908.9?

4. Addressing transportation connectivity issues (CR21)?

Comments:

- County Road 21 should take precedence over local access because of its impact on homes and businesses
- 8 street segments were underwater, along with sanitary sewers
- Lunds, Village Liquor and other businesses were impacted. No one from the west side of Prior Lake could get there
- County Road 21 access should take precedence over local access

Options

- Best would be to hold water south of Spring Lake
- Is it okay to do sandbagging if the flood is only once every 100 years?
- Does not support Option #1 Spring Lake Storage
- Option #1 is best, but homeowners need to be compensated
- #3 Upstream Storage, #6 Actively Manage Outlet and #0 Existing Managed Protection are the best
- #3 Upstream Storage is best, but it will take a lot to convince farmers in the upper watershed
- #2 Increase Prior Lake Outlet is reasonable
- #3 is best, but will require lots of support
- There aren't any short-term options
- Option #1 Spring Lake Storage may compromise the Ferric Chloride plant so that plan is not favorable

Meeting Summary

Policymakers Workshop

Monday, February 8, 2016

Policymakers Attending:

City: Councilmembers Hedberg (Mayor), Keeney, McGuire and Morton

Township: Supervisors Kelley, Kowalski and Berens

Watershed District: Managers Breitbach, Corrigan, Hennes, Howley and Spitzmueller

Staff Presenters: Katy Gehler (City), Kathy Nielsen (Township) and Diane Lynch (Watershed District). Q & A Assistance: Greg Wilson, Barr Engineering, Study Consultant; Pete Young, City; Carl Almer, District Engineer

Facilitator: Karen Chandler, Barr Engineering

1. Should public dollars be used to protect public infrastructure?

Comments:

- If a home is within the 100 year flood level, it should be protected
- Lift station, sewers, manholes etc. should be protected
- Spring and Prior Lakes are regional recreational lakes. Should we protect their recreational attributes?
- The City should put an emergency plan together based upon "lessons learned"
- The City should develop a flood response plan/protocol and clearly communicate this to the public
- Are we understating or overstating flood problems? It is a greater risk if we are understating
- Should try to minimize peak flood elevations on Spring Lake

2. To what degree should access be provided?

Comments:

- Worried that Atlas 14 is already out-of-date, since TP-40 was the latest model and it was developed in the 1960s. It took about 55 years to get a new model

- How has development in the subwatershed impacted flood levels?
- Priority should be on public safety, transportation and local access
- Streets cannot be retrofitted/elevated without causing a lot of other problems
- Provide incentives for access, when needed. Expect local communities to assist by providing them a "road map" What does "incentives for access" mean?
- Emergency vehicles can traverse water that is 18" deep, but the first responders cannot see if there are road failures under that water. This creates a potential safety hazard. Standing water 18" deep or more for long periods of time can affect road integrity
- Neighbors living on low-lying roads should take responsibility with the City to raise the road

3. To what degree should public dollars be used to protect or assist in the protection of private property?

Comments:

- Some people need help, but don't hold their hands
- Low-lying homes eventually take care of themselves with tear down/rebuilds
- How much of the problem is caused by policies which allowed people to build in the floodplain?
- Residents should take their own initiatives
- Loans could be provided to help residents get out of the floodplain
- Flooded out homes create public problems and homeowners could be given 5 years to flood proof. In a way, this may be seen as a temporary "taking" of land
- Homes lower than the lowest flood level (907.1) should not be bought out
- Flooding happens infrequently and doesn't justify the cost
- How many homes on Spring Lake have flood insurance?

Options

- Option #3 Upstream Storage provides a lot of water quality benefits (3)
- Give serious consideration to Option #3
- Since it is probable major rain events will occur every 25 years, we need to plan for that
- Optimize storage that is already out there
- Was there an intermediate option such as rate control with active management on Spring Lake?
- What happened to Arctic Lake storage as an option?

Funding

- If using an ad valorem tax, the entire watershed would pay

- If money from the state bonding bill was approved, how will the local match get paid for?
- Where are the funds coming from for upper watershed storage?
- This is a lot of money we're considering and we already struggle to stay within our means with current projects
- How much will landowners need to spend? How do I explain this to landowners?

Other Comments

- 1988-89, water levels were under 900 feet on Prior Lake. In 1981-82, they were even lower. In the 1930s, there was a drought and the lakes were dry
- During the 2014 flood, the City could not respond fast enough
- Should public money be used for economic productivity and property values?
- Why is this conversation limited to two hours? I suggest we meet again
- Big money/big problem

Facilitator's Wrap-up

- Protect public access
- Buying out homes below 907.1 is generally not supported
- Some support for upstream storage
- Homeowners should take responsibility for their properties

Meeting Summary

Policymakers Workshop

Monday, September 26, 2016

Policymakers Attending:

City: Councilors Hedberg, Keeney, McGuire, Morton and Thompson

Township: Supervisors Kelley, Kowalski and Berens

Watershed District: Managers Breitbach, Corrigan, Hennes, Howley and Spitzmueller

Staff Presenters: Katy Gehler and Pete Young (City), Kathy Nielsen (Township) and Diane Lynch and Maggie Karshnia (Watershed District). Q & A Assistance: Greg Wilson, Barr Engineering, Study Consultant

Facilitator: Steve Woods, The Freshwater Society

Public: There were several members of the public present

Welcome and History

Kathy Nielsen welcomed the participants to the meeting and provided a short summary of the first Policymakers Meeting on February 8. She indicated that the *goal of the meeting was to have the 13 policymakers weigh in on the recommendations of their staff on how to proceed in the short and long term.* She introduced Steve Woods, Executive Director of the Freshwater Society, who facilitated the meeting. Steve indicated that the first half of the meeting would be a presentation about the Stormwater Management and Flood Mitigation Study and the second half of the meeting would be to develop priorities.

Study Results

Maggie Karschnia and Pete Young described the Study results: updated flood model and stormwater management. They reviewed the “universe of options,” an analysis matrix and seven options: Actively Manage the Prior Lake Outlet; Upper Watershed Storage; Prior Lake Outlet Modification; Flood Storage Combination; Enhanced Protection; Spring Lake Storage and Floodproofing/Buyouts.

Reaffirm Goals

Steve Woods reaffirmed the goals from the February 8, 2016 Policymakers' Meeting:

1. Protect public safety and maintain emergency access
2. Protect public utility infrastructure
3. Maintain traffic flow through the County Road 21 corridor
4. Maintain access to private properties

Staff Recommendation

Katy Gehler reviewed the Short and Long-Term goals recommended by staff. The first tier protection level was to reduce the flood level of Prior Lake to 905.5 for the 25-year return period, which will protect six out of eight public right-of-way areas that would otherwise become inundated with flood water under existing conditions. The Short-term Goal supported Option A-Enhanced Protection, which is a City-led interim strategy to address any flood event while other permanent options are being developed and Option G-Actively Managed Prior Lake Outlet, which is a strategy that will involve PLSLWD managing more deliberate operation of the existing low-flow gate. Details of both short-term strategies will be developed in 2017. The second tier flood protection level would be determined by future assessments as part of an adaptive management strategy. The staffs' Long-Term goal was: upper watershed storage which can incrementally achieve lake level reductions and provides the most secondary benefits. Some flood storage was needed to meet the 905.5 flood level target.

Adaptive Management

Diane Lynch described the adaptive management strategy, which is a systematic approach for improving overall results by learning from incremental outcomes. For the Study, adaptive management will include: regular assessment every 5 years; exploration of alternative ways to meet the objectives and adjusting management actions, as necessary. In addition, Ms. Lynch described funding strategies. Besides a District levy, private grants, legislative funding and special assessments, grant opportunities from agencies, such as: Natural Resources Conservation Service (4 grant programs); Board of Soil and Water Resources (2 grant programs); MN Department of Natural Resources (2 grant programs); MN Pollution Control Agency (2 grant programs) and the US Army Corps of Engineers (4 grant programs).

Policymaker Discussion

Steve Woods facilitated the discussion between the policymakers. Topics discussed included:

Costs of land purchase for easements: Policymakers had questions about land costs. Staff clarified that potential projects would involve easements or other incentives and not full land purchases. The study cost assumptions were conservatively high and based on assessed land value.

Water quality impacts: Staff responded to a policymaker question about future development, noting that modern stormwater management rules require developments to incorporate both rate and volume control. No increase in rate or volume is allowed over existing conditions. Managing stormwater in this way mitigates the impacts of adding new impervious surfaces. Staff also noted the Upper Watershed Storage option included the most secondary benefits of the options considered, including water quality benefits.

Adequacy of the 25-year protection level: One policymaker question centered around whether the current rainfall models were accurate and whether using a 25-year return period as a goal will be adequate. Staff discussed the Atlas 14 rainfall model and pointed out that it is the standard being used statewide. Different return periods were carefully evaluated during the study process and the staff recommendation reflects those evaluations.

Role of the City in meeting citizens' flood protection needs: The policymakers reaffirmed the four goals from the February 8 meeting; these goals are listed in order of City priority. Policymakers agreed that private property protection is not a role of the City, but it will happen indirectly as a result of the City's Enhanced Protection efforts during flooding events.

How much of the cost for protection should go to those immediately benefitting versus others: Policymakers discussed options that could ensure that costs for flood protection are not shifted to taxpayers who do not benefit from these efforts. They also raised the point that Prior Lake is an important resource for more than just lakeshore property owners. Staff responded that there are mechanisms available to proportionally assess. Sources and levels of funding for flood protection efforts are future policymaker decisions.

Ways to fund the options and the role of Spring Lake Township to help: Staff responded to policymaker questions about funding options, stating that there are many options and that they will be based on project type and feasibility studies or other pre-project studies/analyses. Options include PLSLWD/City levies, special assessments, legislative funding, grants and other outside funding. There was policymaker support for Spring Lake Township lending their support to potential solutions as the upstream Local Governmental Unit, although there were also concerns raised about shifting flooding problems to property owners located upstream or downstream. These concerns will be addressed during the feasibility phase of any potential project.

Impacts on the farm community: Staff described a meeting with members of the farming community where they voiced their concerns about flooding and how it impacted them during 2014 and into 2015. Impacts included multiple seeding attempts, loss of soil quality, loss of silage, having to pay for silage and need for additional fertilizer due to the timing of flooding. There is acknowledgement that the impacts of flooding will make potential negotiations with agricultural property owners more complicated. Policymakers generally agreed that the impact on the local farm economy needs to be a major factor when considering how to address flooding impacts in the watershed.

Likelihood of long-term success: A policymaker concern regarding the likelihood of long-term program success was raised; there are potential problems with changing administrations and policymakers along with shifting resident priorities. There were also concerns about the overall costs during a 30-year timeframe. Discussion included the example of the Prior Lake Outlet Channel, which has been successfully operating for over 30 years. There was general support for the adaptive management approach outlined in the staff presentation, but policymakers cautioned that for the plan to be realistic and that an incremental approach is best.

Policymaker Discussion Summary: Policymakers supported the staffs' recommendations for the short-term and long-term approach to meeting the prioritized policymakers' goals. However, there is only support for working with willing landowners when studying and implementing potential projects. There is support for an approach that considers investing in the most cost-effective projects instead of funding projects that may be easier to achieve, but are high-cost and low-benefit. Policymakers reiterated their support for an adaptive management approach, noting that this is a multi-generational fix and that long-term relationships between all the study partners will be a key to successful implementation.

Wrap-up and Next Steps

Diane Lynch stated that it was expected that Barr would finish the draft report in October and it would be ready for public input. Mayor Hedberg thanked everyone who participated and indicated the City appreciated the opportunity to meet with Spring Lake Township and the Prior Lake-Spring Lake Watershed District.

Meeting Summary

Stormwater Management & Flood Mitigation Study

Final Community Meeting

Wednesday, November 16, 2016

Staff: Katy Gehler and Pete Young (City), Kathy Nielsen (Township) and Diane Lynch and Maggie Karshnia (Watershed District). Q & A Assistance: Greg Wilson, Barr Engineering, Study Consultant

Policymakers: There were representatives of the City Council, Spring Lake Township and Prior Lake Spring Lake Watershed District attending

Public: There were approximately 25 attendees

Welcome and History

Kathy Nielsen welcomed the participants to the meeting and indicated the two goals for the meeting were to provide an overview of the Study and the Recommendations and to receive public comments.

Project Update and Recommendations

Diane Lynch reviewed the upper watershed, lower watershed and Prior Lake Outlet Channel impacts of the 2014 flood. She indicated that the four study goals were:

- Update the Flood Model
- Identify Flood Mitigation Options
- Evaluate Flood Mitigation Options
- Develop an Implementation Plan

She described the beginning of the project in February 2015 and the extensive outreach process that was undertaken with a: Technical Advisory Committee; Advisory Group; Farmer Listening Session; Policymakers Group and Community Meetings.

A Universe of 20 Options recommended by participants in the meetings, staff and policymakers were identified and ranked by: water quality and natural resources; stormwater management; legal authority; project readiness; human impacts and incremental costs. Seven options resulted from the ranking: Actively Manage Prior Lake Outlet; Upper Watershed Storage; Prior

Lake Outlet Modification; Combination of Storage Options; Enhanced Protection; Spring Lake Storage and Floodproofing/Buyouts.

Diane reaffirmed the goals from the last policymakers' meeting on September 26:

- Protect public safety and maintain emergency access
- Protect public utility infrastructure
- Maintain traffic flow through the County Road 21 corridor
- Maintain access to private properties

The policymakers supported the staff recommendation regarding the level of protection:

- High priority to reduce the flood level on Prior Lake to 905.5 at the 25-year return period
- Secondary priority to cost effectively provide additional flood damage reduction based upon future assessments as part of an adaptive management strategy

To achieve that level of protection, the policymakers supported the staff recommendation for a short-term goal of the Enhanced Protection and Actively Manage the Prior Lake Outlet options. For a long-term goal, staff recommended the Upper Watershed Storage Option, which could be done in a gradual fashion.

Diane described the adaptive management strategy, which is a systematic approach for improving overall results by learning from incremental outcomes. For the Study, adaptive management will include: regular assessment every 5 years; exploration of alternative ways to meet the objectives and adjusting management actions, as necessary.

The next steps are that the City Council and the PLSLWD Boards will review the Study at their December meetings. A complete draft of the Study will be available by December 5, 2016 at www.plslwd.org/flood-study.

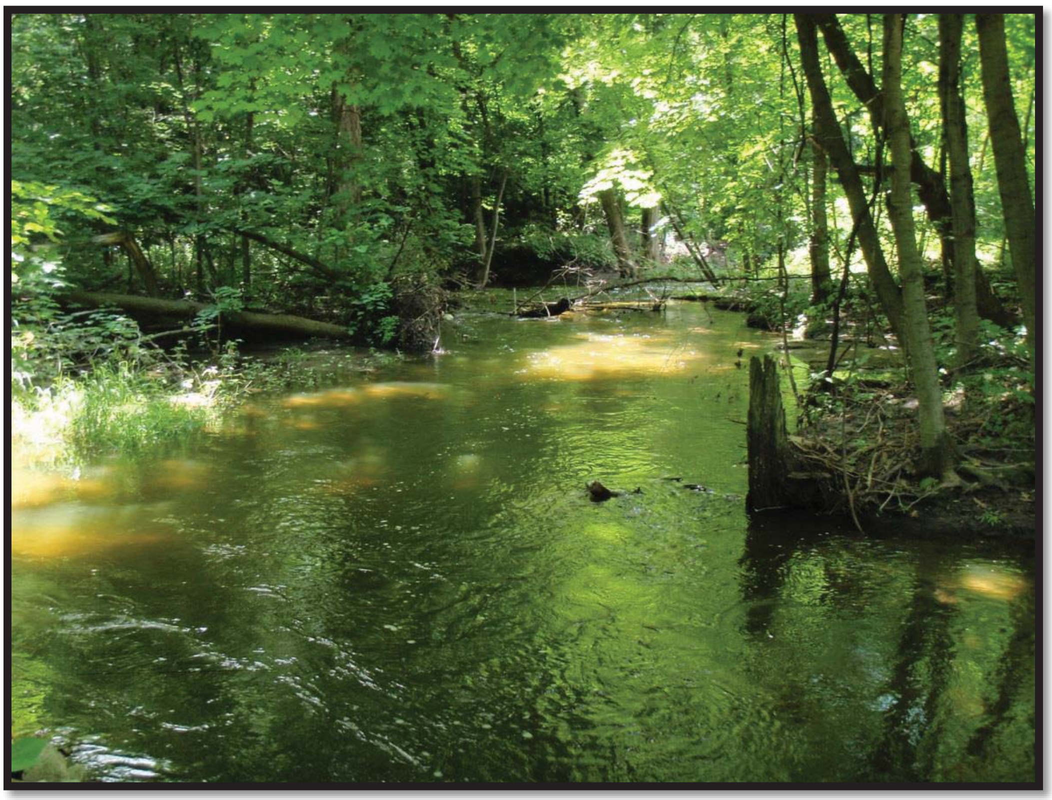
Questions and Answers

Attendees asked questions about the options, street intersection priorities, details about Enhanced Protection and next steps.

The meeting adjourned at 7:30 p.m.

Appendix D—2014 Prior Lake Outlet System Annual Operations Report

2014 Prior Lake Outlet System Annual Operations Report



February 2015

PRIOR LAKE - SPRING LAKE
WATERSHED DISTRICT

CONTENTS

ATTACHMENTS

A. Prior Lake Outlet Structure Diagram

B. Outlet Operations Summary

C. Stage-Discharge Relationship

D. Volumes Discharged from Prior Lake

E. Prior Lake Elevations and Precipitation

F. Prior Lake Elevations Graph

G. Summary of Precipitation within PLSLWD

H. Culvert Inspections and Monitoring Sites

I. Inspection Frequency Guidelines

J. Bank Erosion Inventory

K. Vegetation Survey Results

INTRODUCTION

The Prior Lake Outlet Structure and Outlet Channel were constructed in 1983 under DNR permit 79-6016 to address high lake level issues on Prior Lake, which does not have a natural outlet. The Prior Lake Outlet Channel (PLOC) is utilized by the Prior Lake- Spring Lake Watershed District (District or PLSLWD) in managing lake levels on Prior Lake, as well as a trunk stormwater system for the Cities of Prior Lake and Shakopee, and the Shakopee Mdewakanton Sioux Community. The 7 mile long PLOC has been divided into 8 management Segments. Segment 1 is on the southern end beginning at the Prior Lake Outlet Structure, while Segment 8 is on the northern end and flows into the Minnesota River in Shakopee.

To address current needs and plan for future development in the watershed, in 2007 the District finalized a Joint Powers Agreement/Memorandum of Agreement (JPA/MOA) with the Cities of Prior Lake and Shakopee, and the Shakopee Mdewakanton Sioux Community for the operation, maintenance and use of the Prior Lake Outlet Channel. This group of cooperators oversees the operation of the PLOC, while the District administers the day to day operations. In the early 2000's, it was determined by these JPA/MOA Cooperators that while the channel and outlet had worked well since their inception, if modified in several places, they could operate more efficiently, reduce long term maintenance and enhance the environment. With this in mind, the cooperators formed the JPA/MOA and undertook a 5-7 year project to restore and enhance the PLOC. Acknowledging that the PLOC is used as a stormwater conveyance system and is not just a natural conveyance, the JPA/MOA cooperators focus is to manage the easements of the channel and the channel itself to maintain hydrologic capacity, reduce maintenance needs, provide long-term stability and improve water quality. Secondary benefits include increased aesthetics, providing improved habitat and providing consistency with city and county plans for parks and greenways.

Operation of the Prior Lake Outlet Structure is governed by the DNR-approved Prior Lake Outlet Control Structure Management Policy and Operating Procedures dated October 2004, approved February 2005. This plan specifies a review procedure that is to be repeated every 3 years. A review and revision of this document is anticipated to occur in 2015 now that a calibrated rating curve has been established for the new design of the Prior Lake Outlet Structure. Additionally, an Operation, Inspection and Maintenance Manual was drafted and adopted in September 2011 for the Prior Lake Outlet Structure. The purpose of this secondary manual is to establish guidelines and practices to provide existing and future District Staff with the knowledge of how to properly operate, inspect and maintain the structural and operational components of the outlet to maximize the life and effectiveness of the structure. The manual includes a table of recommended inspection items along with the recommend frequency of inspection. These recommendations will be reviewed periodically by District Staff to determine if the frequency is appropriate based on findings in the field and the manual will be updated accordingly.

According to the National Oceanic and Atmospheric Administration records, the 30-year county wide average annual precipitation for Scott County is 30.95 inches. The rainfall in 2014 at the PLSLWD office totaled 36.44 inches. (Note the PLSLWD office moved to Prior Lake City Hall in July and precipitation was recorded at the City Hall after September 17th) Record rainfalls in June totaled 13.01 inches, creating massive floods on Prior Lake. Figure 1 and Attachment G summarize the precipitation recorded within the District in more detail.

In 2014, the extreme rainfalls (see Figure 1) created record flood conditions and caused the outlet structure and outlet channel to be engulfed with water for long periods of time. Prior Lake reached a record 906.16', which was the highest recorded lake level since 1915, when 907 feet was recorded.

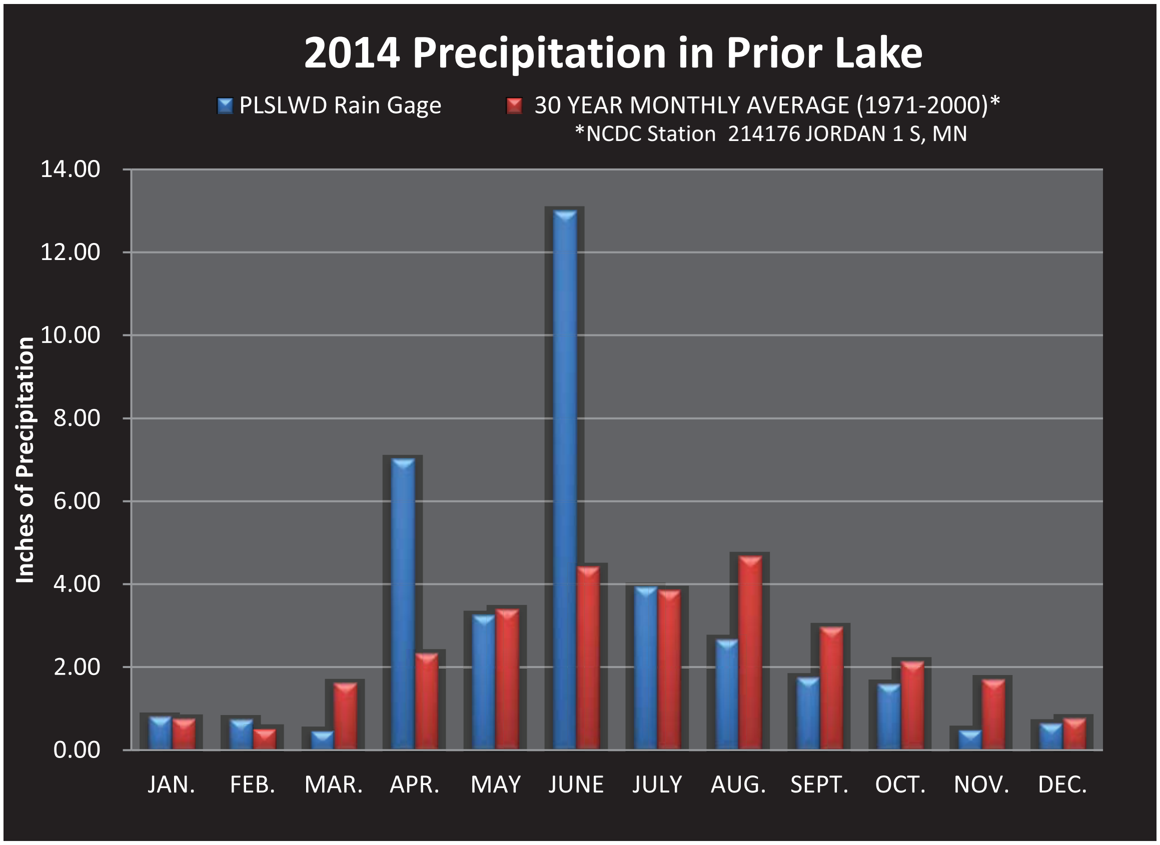


FIGURE 1 PRECIPITATION GRAPH

OUTLET STRUCTURE

HISTORY

The Prior Lake Outlet Structure (Figure 2) was originally constructed in, and has been operated since1983. The original design of the structure required manual operation to open and close gates to regulate the flow. This design posed safety concerns to staff while operating the structure during high water levels. Additionally, there were inefficiencies in the structure's design because the 36 inch pipe connected to the structure did not reach its maximum flow of 65 cfs until lake levels well surpassed the outlet elevation. Over the years the structure had also developed wear and required minor maintenance.

Given these conditions, a replacement structure was pursued by the District and installed in 2010. The new design has increased the efficiency of discharging water by allowing the outlet pipe to reach capacity sooner. It has also proven to provide safer conditions for staff during inspections and maintenance, and is self-operating, which will reduce overall operations and maintenance costs. A schematic of the outlet structure is provided in Attachment A.

FIGURE 2 – OUTLET STRUCTURE

MAINTENANCE AND OPERATION

The new structure needs minimal maintenance in order to operate. Once Prior Lake reaches 902.5’, water starts spilling over the accordion shaped weir located inside the trash rack seen in Figure 2. Maintenance includes visual inspections, greasing gates, and removing debris from the trash rack. Removing vegetation and other debris from the trash rack is the most time-consuming and labor-intensive task. When the structure is operating (Prior Lake is greater than 902.5’), the structure will be inspected no less than once a week, and as much as twice per day (depending on the lake level and amount of vegetation getting stuck on the trash rack). Inspections and debris removal is typically conducted by PLSLWD staff. During the 2014 flood, however, the City of Prior Lake staff helped remove vegetation once per day and on the weekends in addition to District staff also removing the vegetation daily in order to ensure Outlet Structure was not blocked.

Excluding 2009, the Prior Lake Outlet Structure had flow, at least partially, every year since 1999. The year 2011 held the greatest volume of water flowing through the system since the structure’s establishment in 1983. This was partially due to the more efficient design of the new Outlet Structure; however, the primary factor was the duration of continuous discharge being significantly greater than in previous years.

During 2014 operations, the Prior Lake Outlet Structure performed well throughout the duration that water discharged from the lake. The Prior Lake elevation receded below the outlet elevation on September 11 and remained so for the rest of the year. In its 136 days of discharge during 2014, an estimated 6.10 feet of vertical volume was eliminated from the lake through the Prior Lake Outlet Structure. This is the second largest volume of water discharged through the outlet structure since 1983 (See Attachment D). It is estimated that the lake level of Prior Lake could have reached approximately 912.26 feet without the outlet structure (See Figure 3 and Figure 4). Attachment D is provided for comparison between years on the overall usage of the Prior Lake Outlet Structure. The numbers shown are calculated based on the most accurate information available. They are not exact and are intended for yearly comparisons only. Attachments E and F show daily Prior Lake elevations throughout 2014.

FIGURE 3 – OUTLET STRUCTURE DURING FLOOD IN 2014

FIGURE 4 – OUTLET STRUCTURE DURING NORMAL CONDITIONS

OUTLET CHANNEL

CULVERT INSPECTIONS AND MAINTENANCE

As stated above, the Prior Lake Outlet Structure was in full operation and discharging water from April 29th to September 11th. Before and during operations, the District is required to perform regular inspections of the Outlet Structure and the PLOC in accordance with the Outlet Operations Manual. However, the inspection guideline in the Outlet Operations Manual was found to be too vague, so a more detailed Inspection Frequency Guideline was created and adopted by the JPA/MOA group in 2014 (see Attachment I and Figure 5). On the basis of these inspections, the District was able to determine that the Outlet Structure and PLOC were structurally sound and able to handle the lake discharges and surface flows downstream of the Outlet Structure. However, due to the severity and intensity of the flood in June, unavoidable damage occurred in several locations along the channel.

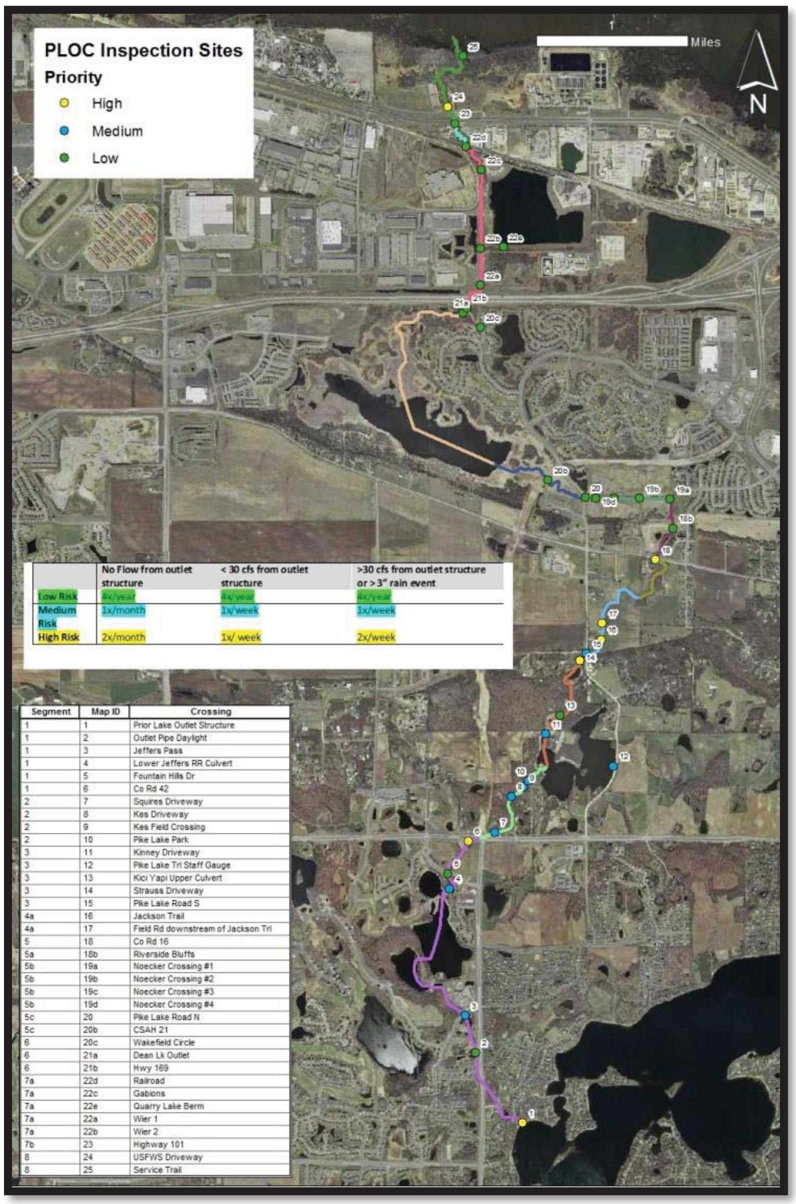


FIGURE 5 MAP OF CULVERT INSPECTIONS

Extreme velocity and duration of flow during the flood caused bank erosion to worsen along the entire length of the channel (see Figure 6). According to a Bank Erosion Survey conducted by EOR in fall of 2014, over 20,000 feet of bank erosion was observed. Many trees fell into the channel due to the erosion as well. Details of this survey can be found in Attachment J.

FIGURE 6 BANK EROSION AND FALLEN TREES

In early January, segment 2 experienced what appeared to be groundwater seepage during some below-zero temperatures. The water continued to rise and then freeze, causing a concern that the culvert under Kes Driveway would become completely frozen which could cause the culvert to become plugged. Fortunately, the water stopped rising and flowing after about a week and never plugged completely (see Figure 7).

FIGURE 7 GROUNDWATER SEEPS IN JANUARY

Due to the 2014 flood, the Kes field road crossing has eroded on the downstream side of the crossing and also experienced some piping (water flowing along the outside of culvert). The PLSLWD is working with FEMA to repair this crossing (See Figure 8).

FIGURE 8 KES FIELD ROAD CROSSING EROSION

Also in segment 2, the Pike Lake Park crossing experienced erosion along the bank due to the water overtopping the road and creating a gouge in the bank where the water eroded the bank as it flowed back into the channel (Figure 9). PLSLWD is working with FEMA to repair this erosion.

FIGURE 9 PIKE LAKE PARK BANK EROSION

Segment 3 had two areas of damage – the KiciYapi culvert and the Strauss Driveway crossing. The KiciYapi culvert was damaged during the flood because the culvert was rusted and the increased velocities eroded the soil around the culvert

(See Figure 10). In addition, when the road overtopped, more erosion occurred and was impassible. A permit was issued and the SMSC repaired the culvert over the 2014-2015 winter.

Figure 10 KiciYapi Culvert Crossing During Emergency Repair

In Segment 3, the Strauss driveway overtopped with water, dropping debris and eroding the driveway (See Figure 11). The City of Prior Lake removed the debris from the driveway.

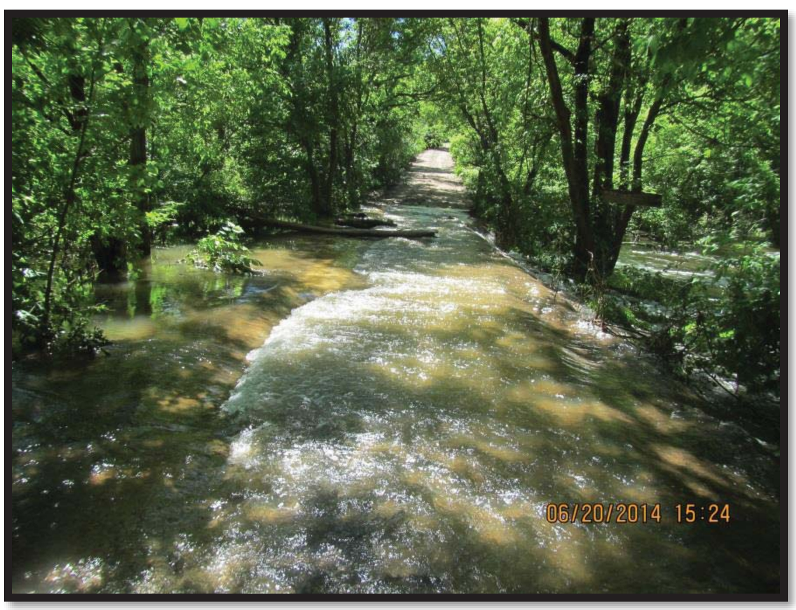


Figure 11 Strauss Driveway During Flood

Bank erosion in segment 4a was temporarily repaired to prevent a homeowner's pole building from falling into the channel. A more permanent fix will move the entire channel away from the driveway and realign the channel in its original location. The realignment will be completed in 2015 (see Figure 12 for progress as of January 2015).

FIGURE 12 SEGMENT 4A REALIGNMENT

In segment 4a, two crossings were damaged during the flood. The Jackson culvert was overtopped by water (Figure 13), but no significant damage resulted. More gravel was added to the crossing to replace the gravel that was washed away in the flood.

FIGURE 13 JACKSON TRAIL DURING FLOOD

Another culvert in Segment 4a (Gonyea, aka Field Road downstream of Jackson Trail) was washed out and in need of replacement (See Figure 14). This culvert was installed by Minnesota Dirt Works in October 2013. The PLSLWD is working with FEMA to get funding for repair of this culvert.

FIGURE 14 GONYEA CULVERT AFTER FLOOD

At the end of Segment 4, the culvert under County Road 16 was clogged and caused the water to overtop the road and erode the walking path and road (See Figure 15). Scott County repaired this crossing.

FIGURE 15 COUNTY ROAD 16 AFTER FLOOD DAMAGE

Segment 5 collected more sediment deposition during the flood due to upstream erosion (See Figure 16). PLSLWD is seeking funds from the State for removal of this sediment delta.

FIGURE 16 SEDIMENT DELTA IN SEGMENT 5

Segment 8 had two culverts with damage. The USFWS driveway got completely washed out (See Figure 17). The USFWS may be replacing this crossing, or possibly removing it for good.

FIGURE 17 USFWS DRIVEWAY DURING FLOOD

The Service Trail crossing experienced some erosion on the downstream side as well (See Figure 18). At the time this report was written, it is unclear who will be repairing this erosion.

FIGURE 18 EROSION AT SERVICE TRAIL CROSSING AFTER FLOOD

Removal of vegetation and debris from several culverts or grates throughout the year to ensure free flows was the primary extent of the additional maintenance that occurred (See Figure 19).

FIGURE 19 REMOVING VEGETATION FROM CULVERT GRATE AT CR42

Monitoring

Monitoring along the outlet channel in 2014 consisted of water quantity and quality, and vegetation and erosion monitoring. Some of this monitoring is funded by the JPA/MOA, and some is done for other programs or entities. A map is provided below, and in Attachment H, that displays the monitoring sites.

Water Quantity and Quality

Water quantity monitoring consisted of obtaining continuous stage and flow measurements at the Outlet Structure (Map ID #1), Pike Lake Road South (Map ID #10), and the Service Trail (Map ID #25), and Deans Lake Inlet (Map ID #20b). At each site, a level logger recorded stage in 15 minute increments. Flow measurements were taken at various stages in order to create a stage-discharge relationship (rating curve). The primary goal for monitoring flow at the outlet structure was to provide an accurate field verified rating curve for the new Outlet Structure. Additionally, the flow data was used to help estimate pollutant loads at the outlet structure site. The Pike Lake Road and Service Trail water quantity monitoring was used to update and calibrate the XP-SWMM model. The Deans Lake Inlet site was monitored by Scott Soil and Water Conservation District for purposes of quantifying water volume going into Deans Lake.

By recording water levels and taking flow measurements, a stage-discharge relationship (rating curve) can be developed. Stage (level) is recorded every 15 minutes by an automated level logger. Flow measurements (discharge) are taken at various lake levels and a stage-discharge relationship is developed. This data allows us to calculate the total annual volume of water discharged through the structure.

A new field-verified rating curve for the outlet structure was developed in 2014. A graph showing the Prior Lake rating curve can be seen in Attachment C. Flow measurements were taken by EOR, Scott SWCD, and PLSLWD at the outlet of the pipe coming from the outlet structure (outlet daylight). All meters used for measuring flow were calibrated no earlier than June of 2012. When comparing flow meters at high velocities at the outlet daylight, they proved to be very precise with a relative percent difference of no greater than 5%. More detail on these comparisons can be found in the 2013 PLSLWD Stream Flow Monitoring Equipment Analysis Memo. The maximum measured flow in 2014 was 63.85 cfs when the lake was 906.13' on July 7th (see Attachment C for all flow measurements). For stage or discharge data for Pike Lake Road South, the Service Trail, or Deans Lake Inlet, please contact the PLSLWD office.

Water quality (and quantity) was monitored at multiple sites along the outlet channel (see Figure 20). Refer to map in Appendix H or Figure 20 for locations. Sonde monitoring is conducted by using a multi-parameter Hydrolab MS5 to measure pH, temperature, conductivity, turbidity, and dissolved oxygen. Samples were taken on three separate occasions.

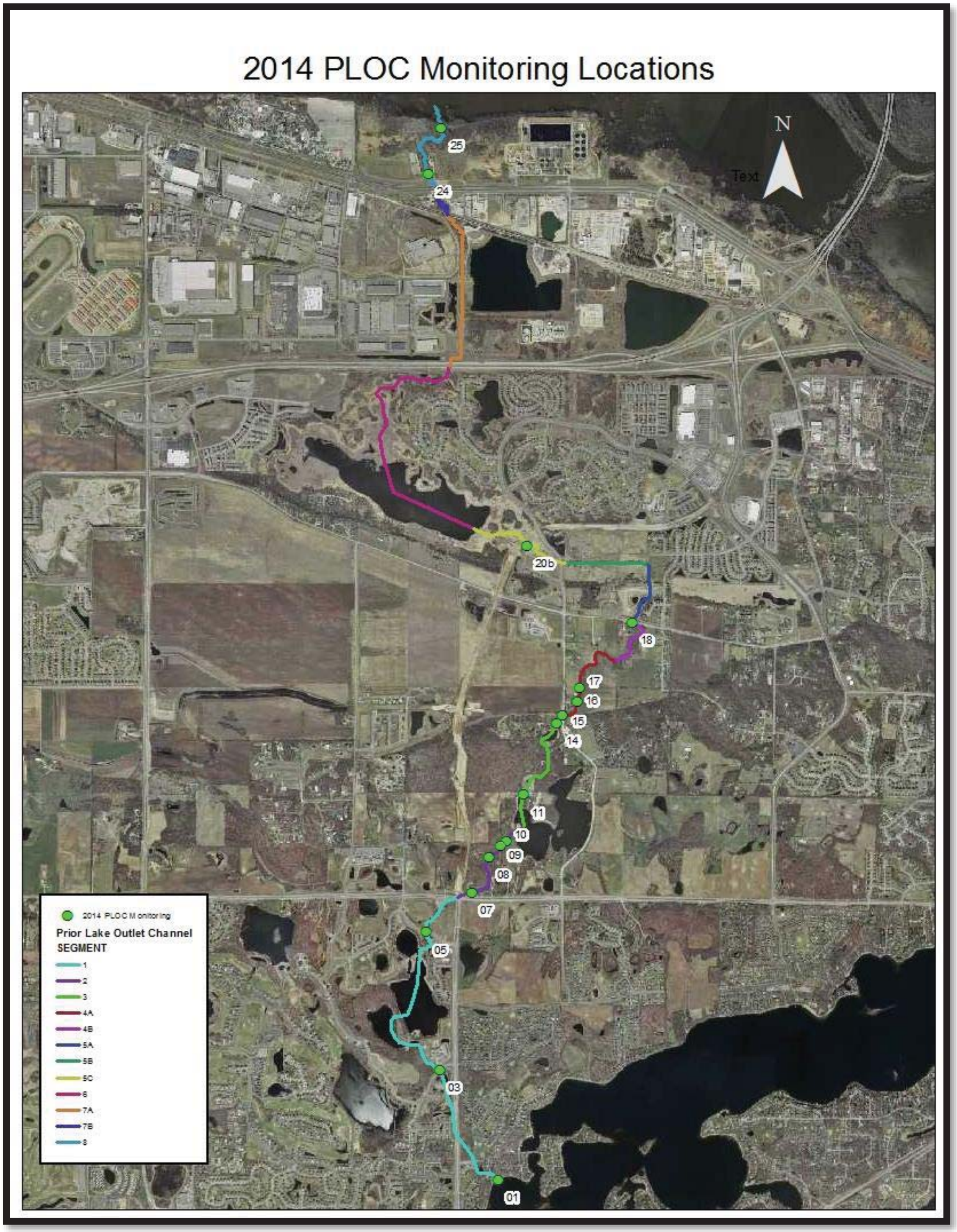


FIGURE 20 MONITORING SITES ALONG THE OUTLET CHANNEL

TABLE 1 MONITORING TYPES AND LOCATIONS

Map ID	Monitoring Type	Location	Monitoring Organization
01	Level and Flow	Prior lake Outlet Structure	PLSLWD
03	Sonde	Jeffers Pass	PLSLWD
05	Sonde	Fountain Hills	PLSLWD
07	Sonde	Squires/Campbell Driveway	PLSLWD
08	Sonde	Kes Driveway	PLSLWD
09	Sonde	Kes Field Crossing	PLSLWD
10	Sonde	Pike Lake Park	PLSLWD
11	Sonde	Kinney Driveway	PLSLWD
14	Sonde	Strauss Driveway	PLSLWD
15	Level and Flow	Pike Lake Road S	PLSLWD
16	Sonde	Jackson Trail	PLSLWD
17	Sonde	Gonyea	PLSLWD
18	Sonde	County Road 16	PLSLWD
20b	Chemistry and Flow	Deans Lake Inlet	Scott SWCD
24	Chemistry	USFWS Driveway	Scott SWCD
25	Level and Flow	Service Trail	PLSLWD

TABLE 2 SONDE MONITORING RESULTS

Map ID and Date	DO (mg/L)	Turbidity (FNU)	Conductivity (µm/cm)	pH	Water Temp °C
5/13/2014					
1	11.02	2.2	432.5	8.62	11.89
3	11.36	1.3	436.9	8.59	12.73
5	11.3	0.8	436.9	8.55	13.16
7	11.14	0.4	438.2	8.61	13.52
10	10.69	2.7	427.3	8.54	13.49
11	11.46	1.7	440.9	8.59	13.55
15	10.4	0	443.7	8.55	14.07
18	10.39	16.7	443.6	8.4	14.24
24	10.18	3	464.6	8.24	14.79
25	10.32	2.8	465.8	8.26	14.82
8/5/2014					
1	10.37	0.4	393.6	8.92	25.72
3	7.02	0	399.1	8.68	25.33
5	4.93	0	404.1	8.27	25.5
6	5.34	0	406.5	8.12	25.71
7	6.51	15.3		8.24	25.65
8	7.45	2	405.1	8.21	25.51
9	7.72	53.4	380.3	8.17	25.54
10	7.76	56.7	271.6	8.21	25.56
11	7.28	0	396.2	8.25	26.03
14	5.69	0	398	8.13	25.86
15	5.84	0.6	396.8	7.99	25.78
16	6.57	0	398	8.02	25.77
17	7.07	0	397.9	8.02	25.78
24	7.65	0.2	931.4	7.9	25.41
8/18/2014					
1	5.97	1.3	403.4	8.12	25.08
3	6.81	0	401.2	8.11	25.71
5	6.42	0.4	397.5	8.1	26.08
6	6.58	0	398.2	8.16	26.22
7	7.87	25.2		8.21	26.5
8	7.67	6.3	400	8.16	26.18
9	7.74	5.4	398.9	8.17	26.21
10	7.8	27.8		8.17	26.17
11	7.39	4.1	389	8.11	26.25
14	6.76	3.4	390.2	8.18	27.12
15	6.56	7.4	390.5	7.93	26.57
16	7.01	9.1	246.3	7.91	26.57
17	7.31	2.5	390.3	7.96	26.58
24	7.37	0.9	463.7	7.82	25.5

Water quality samples were also collected in the outlet channel at the Deans Lake Inlet (Map ID# 20b) and USFWS Driveway (Map ID #24) by the Scott SWCD. The results of this monitoring can be found by contacting the Scott SWCD or LMRWD.

Lake Monitoring

The Three Rivers Park District conducted monitoring on Pike Lake. The PLOC flows through Pike Lake. Samples are collected bimonthly in the east and west bay.

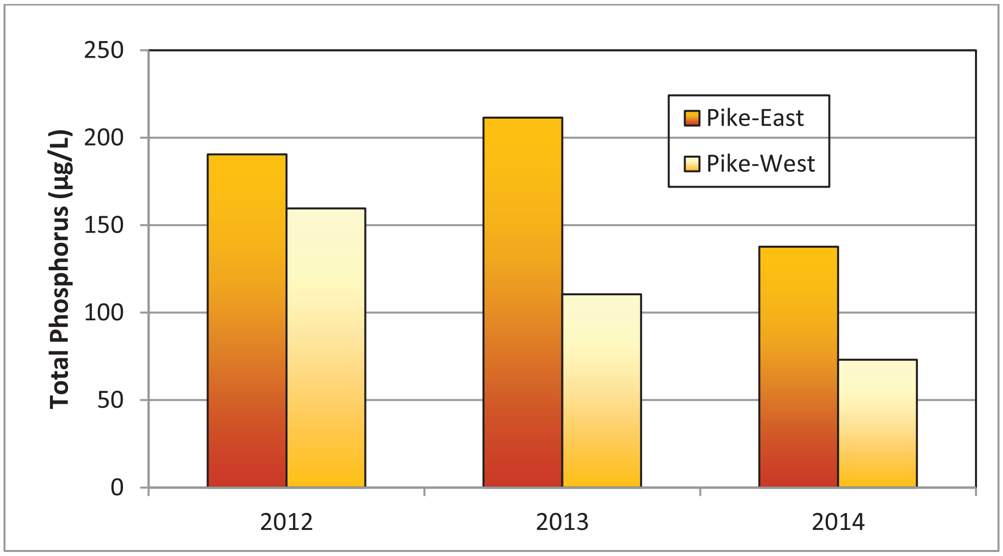


Figure 21 Total Phosphorous Season Average

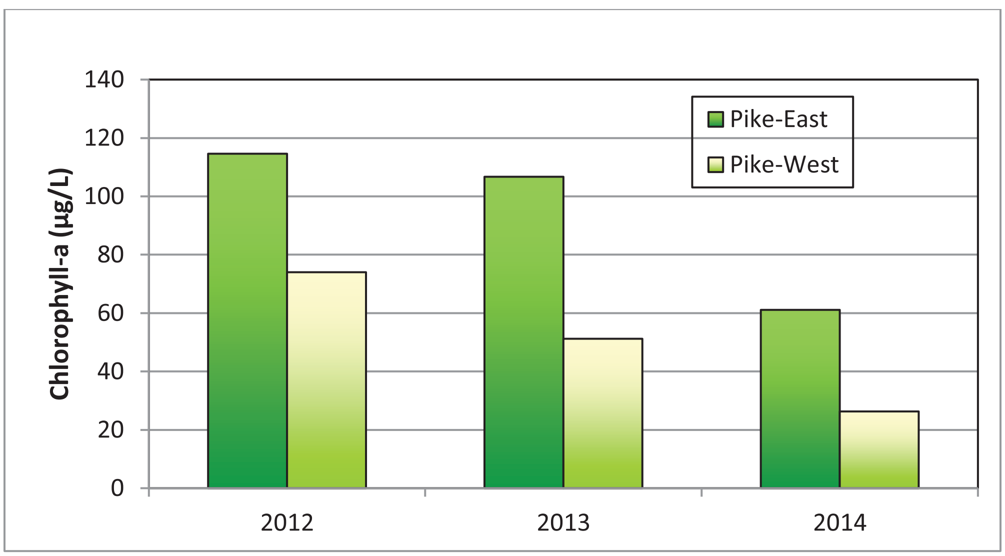


Figure 22 Chlorophyll-a Season Average

Figure 23 Secchi Depth Summer Average

The Lower Minnesota River Watershed District (LMRWD) conducted a Paleolimnology study on Dean's Lake in 2014. This study provides information on historic water quality conditions based off of sediment core samples. This information can be obtained by calling the LMRWD for a copy of the report.

Vegetation and Erosion Monitoring

Vegetation and erosion surveys were completed along the easements of the PLOC in the spring and fall by EOR. These assessments collected data on species composition and distribution of noxious plants, noted erosion sites along the PLOC, and identified land cover and plant community types.

The JPA/MOA has extended the contract with EOR to continue the surveys through June of 2016. After each survey is completed, a memo is provided detailing the results of the surveys, as well as management recommendations. These reports are included in Attachment J and K. There is also a summary regarding the vegetation management found in the Outlet Channel Restoration and Enhancement Project section of this report. The bank erosion survey conducted in fall was much more detailed than previous erosion surveys in order to get a good understanding of the additional bank erosion caused by the flood.

Permits

Seven permits were active in 2014. Jeffers Waterfront (permit 2010.02), Jeffers Pointe (permit 2011.03), Pike Lake Road Culvert Replacement (permit 2012.05), Jeffers Pass Outlet (2013.01), Valley Park Business Center (2013.04), East Village 3rd Addition (permit 2013.05), and KiciYapi Culvert (2014.01) remain active and will likely be closed out in 2015.

- Jeffers Waterfront, Pike Lake Road Culvert Replacement, and Jeffers Pass Outlet permits require a signed Certificate of Completion before the permit can be closed out.
- Valley Park Business Center needs a final site visit before a Certificate of Completion is approved.
- The Jeffers Pointe permit needs staff to work with developer to address the degraded raingarden onsite before assigning a Certificate of Completion.

- East Village 3rd was completed late in 2014, but conditions were unable to be assessed due to snowfall, so the permit will be reviewed in spring before closing out.
- KiciYapi was opened in 2014 and the work will be completed in early 2015. An as-built survey will be required before the permit is closed.

Outlet Channel Restoration and Enhancement Project

Over the last few years, the JPA/MOA cooperators have undertaken a project to restore and enhance the PLOC. The purpose of the project has been to maintain hydrologic capacity, reduce maintenance needs, provide long-term stability, improve water quality, increase aesthetics, provide improved habitat and provide consistency with city and county plans for parks and greenways. Several portions of this project have been completed.

- Work completed on Segment 1 in 2006 consisted of bank stabilizations, increased native plantings and a creation of a spillway between Upper and Lower Jeffers Ponds.
- A basin was excavated and sinuosity was added to the channel in Segment 5c prior to entering Dean Lake during the early portion of 2007.
- Work in 2009 included the replacement of an undersized culvert on the northern end of Segment 8.
- The year 2010 held the finalization of work in several Segments including: banks being reshaped, in addition to toe stabilization and weir reinforcements put in place on Segment 7a; toe stabilization, bank protections and flow realignment in Segment 3; and work to build up the channel bed and reconnect it to the floodplain in Segment 2.
- Additional site checks were made throughout 2012 to ensure stability against erosion and vegetation survival within the areas of previous work in Segments 2, 3, and 7a.
- In 2013, three failing culverts were replaced between Segments 3 and 4B (Pike Lake Road, Jackson Trail, and the Field Road downstream of Jackson Trail). In addition, vegetation along the channel was managed for herbaceous invasives by EOR and woody invasives by Applied Ecological Services. Garlic mustard was hand cut in Segments 3-8. Small populations of Common burdock were cut in Segments 4A, 4B, and 8. Block locust, common buckthorn, and Tatarian honeysuckle suckers and seedlings were treated in segments 1, 3, 4A, 5C, 6, and 7A.

In 2014, activities include:

- Garlic mustard was hand cut with a weed cutter in segments 3-7 by EOR.
- Wild Parsnip was hand cut with a weed cutter in segment 1 by EOR (only location wild parsnip was found).
- A foliar spray was applied for woody invasives (black locust, common buckthorn, and honeysuckle) in segments 1, 3, 4a, 5c, 6, and 7a (by AES).

Additional areas with planned future reconstruction include Segments 4b and 7b. Segment 4b will include bank stabilizations, grade controls, cattle exclusion fencing and vegetation plantings within the bank and riparian area. Segment 7b is planned to have toe stabilizations and bank protection installed. These additional reconstruction items will be addressed with the JPA/MOA cooperators as they progress.

Appendix E—Fact Sheet: Prior Lake Outlet Channel

FACT SHEET: Prior Lake Outlet Channel

PRIOR LAKE SPRING LAKE WATERSHED DISTRICT

The Prior Lake Outlet Channel (PLOC) resulted from a citizen petition for an outlet to carry stormwater from the landlocked Prior and Spring Lakes. Flooding has historically been an issue in the area and was a main cause for establishment of the Prior Lake-Spring Lake Watershed District in 1969. The outlet channel, completed in 1983, works to address high lake level issues on Prior Lake and as a trunk stormwater system for the City of Prior Lake, the City of Shakopee, and the Shakopee Mdewakanton Sioux Community.

A look at the accordion-shaped fixed crest weir located inside the outlet structure on Prior Lake.

FAST FACTS

- ***Watershed Area:***

  42 square miles

- ***Ordinary High Water Elevation:***

  Prior Lake 903.9 feet

  Spring Lake 912.8 feet

- ***Peak Lake Elevations 2014:***

  Prior Lake 906.17 feet (June 30)

  Spring Lake 913.30 feet (June 21)

- ***Maximum Flow of Outlet Structure:***

  65 cubic feet per second

- ***Outlet Channel Length:***

  7 miles

Outlet Structure:

The outlet structure was updated in 2010 and includes an accordion-shaped fixed crest weir (see photo on left) with a low flow gate to allow manual discharge of water.

The current structure allows water to naturally fall over the weir when the lake surpasses 902.5 feet, providing a consistent flow of water through the channel.

Segment 1 of the PLOC near Jeffers Pond Elementary.

The Channel:

The Prior Lake Outlet Channel (PLOC) is approximately 7 miles long and is divided into 8 management segments. Segment 1 is on the southern end beginning at the Prior Lake Outlet Structure, while Segment 8 is on the northern end and flows into the Minnesota River in Shakopee. Channel placement was designed to follow natural flow of water north.

There are above and below-ground portions of the channel. In above-ground sections the PLOC appears as a stream and borders or traverses multiple properties. The watershed district holds easements for access and maintenance of the channel on many of these properties.

Local Partnership:

A Joint Powers Agreement/Memorandum of Agreement (JPA/MOA) exists between the Prior Lake-Spring Lake Watershed District, the Cities of Prior Lake and Shakopee, and the Shakopee Mdewakanton Sioux Community for the operation, maintenance, and use of the Prior Lake Outlet Channel. This group of operators oversees the operation of the PLOC, while the watershed district administers the day to day operations.

Map of the Prior Lake Outlet Channel (PLOC). The PLOC receives water from Lower Prior Lake and the surrounding watershed and discharges into the Minnesota River.

2014 Flood:

A major flood event occurred in 2014 leading to the highest recorded water elevation of 906 feet on Prior Lake since the outlet system was first installed. It is estimated that the lake level could have reached approximately 912 feet without the outlet structure.

Record high water levels created unavoidable damage in several sections along the channel. Extreme velocity and duration of flow during the flood caused bank erosion to the entire length of the channel, causing over 20,000 feet of bank erosion and trees to fall into the channel. Repair efforts to be taken in2015-2016 include:

- tree and woody debris removal
- sediment removal
- streambank stabilization
- culvert replacements.

Monitor the level of Prior Lake on the District's Website at

www.plslwd.org/waterbodies/

PRIOR LAKE - SPRING LAKE
WATERSHED DISTRICT

4646 Dakota Street SE, Prior Lake, MN 55372
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Mission: to manage and preserve the water resources of the Prior Lake-Spring Lake Watershed District to the best of our ability using input from our communities, sound engineering practices, and our ability to efficiently fund beneficial projects.