

Studies for Potential Infrastructure Solutions

Potential Infrastructure Solution	Estimated Increase to Surface Water Elevation in White Bear Lake at Ultimate Development (feet)	Estimated Capital Cost	Estimated Capital Cost Per Foot of Increase to Surface Water Elevation in White Bear Lake	Estimated Annual Operation & Maintenance Cost	Present Worth 20-Year Capital and Operation & Maintenance Cost	Water Quality Summary	Water Quantity, Reliability, and Risks Summary	Regulatory Requirements Summary
Study 1 - Redirect stormwater to augment White Bear Lake								
Evaluated redirecting water that is collected in nearby stormwater ponds, Centerville Lake, Ramsey-Washington Counties Judicial Ditch 1, Judicial Ditch 3 downstream of Bald Eagle Lake, and areas of Grant that are known to flood to augment White Bear Lake.								
1 Augment White Bear Lake from surface water pumped from Judicial Ditch 3 (outfall from Bald Eagle Lake) that is treated for phosphorus, nitrogen, and chlorophyll (Study 1)	2.1	\$53,887,000 - \$54,187,000	\$25,660,476 - \$25,803,333	\$1,363,000 - \$1,376,000	\$81,147,000 - \$81,707,000	Water quality should be maintained in White Bear Lake. Surface water pumped from Bald Eagle Lake would be treated for nitrogen, phosphorus, and chlorophyll before pumping to White Bear Lake.	Low water quantity - 275 million gallons per year (MGY) available from Bald Eagle Lake discharge while 780 MGY minimum needed for augmentation of White Bear Lake. Low reliability - Bald Eagle Lake has discharged surface water from its outlet structure 34 percent of the total time from April 30, 1923 through March 25, 2026. High risk - Would need to be done in conjunction with another potential solution since there is inadequate volume to recharge White Bear Lake and there would be periods when Bald Eagle Lake does not discharge to Judicial Ditch 3.	High regulatory challenge - Several approvals related to multiple rules required by Rice Creek Watershed District (RCWD) that may not be possible. Construction right-of-way permits required by counties and cities.
Study 2 - Convey treated surface water from Saint Paul Regional Water Services or a new regional surface water treatment plant								
Evaluated conveying treated surface water from either St. Paul Regional Water Services or a new regional surface water treatment plant to select White Bear Lake area communities in the north and east metro area.								
2A Distribute treated surface water from St. Paul Regional Water Services to Mahtomedi, Saputo Dairy Foods, Vadnais Heights, White Bear Lake, and White Bear Township for Hugo 1 or Hugo 2 development scenario – Alternative 1 (Study 2)	3.1 - 3.6	\$448,355,000 - \$735,605,000	\$124,543,055 - \$237,291,935	\$7,325,400 - \$13,265,300	\$594,863,000 - \$1,000,911,000	No effects on White Bear Lake surface water quality. Drinking water quality provided by SPRWS meets all EPA/MDH drinking water quality standards.	High water quantity - Improvements would meet all future drinking water demands. Average reliability - SPRWS' system can be expanded with redundancy. Mississippi River provides average reliable during most extreme drought conditions. Low risk - SPRWS is an established public drinking water system with full operation and maintenance services to help reduce risk.	Standard regulatory approvals required - MDH approval required for water system improvements. Construction right-of-way permits required by counties and cities.
2B Distribute treated surface water from St. Paul Regional Water Services to Mahtomedi, North St. Paul, Saputo Dairy Foods, Vadnais Heights, White Bear Lake, and White Bear Township for Hugo 1 or Hugo 2 development scenario – Alternative 2 (Study 2)	3.1 - 3.6	\$457,655,000 - \$746,705,000	\$127,126,389 - \$240,872,581	\$8,381,000 - \$13,265,000	\$625,275,000 - \$1,012,005,000	No effects on White Bear Lake surface water quality. Drinking water quality provided by SPRWS meets all EPA/MDH drinking water quality standards.	High water quantity - Improvements would meet all future drinking water demands. Average reliability - SPRWS' system can be expanded with redundancy. Mississippi River provides average reliable during most extreme drought conditions. Low risk - SPRWS is an established public drinking water system with full services to help reduce risk.	Standard regulatory approvals required - MDH approval required for water system improvements. Construction right-of-way permits required by counties and cities.
2C Distribute treated surface water from St. Paul Regional Water Services to Mahtomedi, North Oaks, Saputo Dairy Foods, Vadnais Heights, White Bear Lake, and White Bear Township for Hugo 1 or Hugo 2 development scenario - Alternative 3 (Study 2)	3.1 - 3.6	\$538,285,000 - \$809,605,000	\$149,523,611 - \$261,162,903	\$8,845,100 - \$14,227,200	\$625,275,000 - \$1,094,149,000	No effects on White Bear Lake surface water quality. Drinking water quality provided by SPRWS meets all EPA/MDH drinking water quality standards.	High water quantity - Improvements would meet all future drinking water demands. Average reliability - SPRWS' system can be expanded with redundancy. Mississippi River provides average reliable during most extreme drought conditions. Low risk - SPRWS is an established public drinking water system with full operation and maintenance services to help reduce risk.	Standard regulatory approvals required - MDH approval required for water system improvements. Construction right-of-water permits required by counties and cities.
2D Distribute treated surface water from St. Paul Regional Water Services to Mahtomedi, North Oaks, North St. Paul, Saputo Dairy Foods, Shoreview, Vadnais Heights, White Bear Lake, and White Bear Township - Alternative 4 (Study 2)	3.1 - 3.6	\$583,885,000	\$162,190,278 - \$188,350,000	\$12,655,700	\$836,999,000	No effects on White Bear Lake surface water quality. Drinking water quality provided by SPRWS meets all EPA/MDH drinking water quality standards.	High water quantity - Improvements would meet all future drinking water demands. Average reliability - SPRWS' system can be expanded with redundancy. Mississippi River provides average reliable during most extreme drought conditions. Low risk - SPRWS is an established public drinking water system with full operation and maintenance services to help reduce risk.	Standard regulatory approvals required - MDH approval required for water system improvements. Construction right-of-way permits required by counties and cities.
2E Distribute treated surface water from St. Paul Regional Water Services to Saputo Dairy Foods, White Bear Lake, and White Bear Township with up to 3.8 million gallons per day (MGD) of treated wastewater injected into Prairie du Chien-Jordan aquifer or discharged directly into White Bear Lake - Alternative 5 (Study 2)	3.1 - 3.6	\$695,055,000	\$193,070,833 - \$224,211,290	\$4,687,700	\$788,809,000	No effects on White Bear Lake surface water quality. Drinking water quality provided by SPRWS meets all EPA/MDH drinking water quality standards.	High water quantity - Improvements would meet all future drinking water demands. Average reliability - SPRWS' system can be expanded with redundancy. Mississippi River provides average reliability during most extreme drought conditions. Wastewater reuse volumes for aquifer injection or lake augmentation would be dependent on future development projections occurring. Low risk - SPRWS is an established public drinking water system with full operation and maintenance services to help reduce risk.	High regulatory challenge - Injection of treated wastewater into aquifers is currently not allowed in Minnesota. MDH approval required for water system improvements. Construction right-of-way permits required by counties and cities. MPCA permit required for wastewater treatment system improvements.
2F Construct a new regional surface water treatment plant near the chain of lakes to serve Mahtomedi, Saputo Dairy Foods, Vadnais Heights, White Bear Lake, and White Bear Township for Hugo 1 or Hugo 2 development scenario – Alternative 1 (Study 2)	3.1 - 3.6	\$578,935,000 - \$965,965,000	\$160,815,278 - \$311,601,613	\$12,447,000 - \$19,156,900	\$827,875,000 - \$1,349,103,000	No effects on White Bear Lake surface water quality. Drinking water quality provided by new regional surface water treatment plant would be designed to meet all EPA/MDH drinking water quality standards.	High water quantity - Improvements would be designed to meet all future drinking water demands. Average reliability - A new regional surface water treatment plant would be designed with redundancy. Mississippi River provides average reliability during most extreme drought conditions. Low risk - A new regional surface water treatment plant would be staffed by licensed water operators and potentially managed by a joint powers commission.	Standard regulatory approvals required - MDH approval required for water system improvements. Construction right-of-way permits required by counties and cities. MPCA and Met Council permits required for wastewater discharges.
2G Construct a new regional surface water treatment plant near the chain of lakes to serve Mahtomedi, North St. Paul, Saputo Dairy Foods, Vadnais Heights, White Bear Lake, and White Bear Township for Hugo 1 or Hugo 2 development scenario - Alternative 2 (Study 2)	3.1 - 3.6	\$603,185,000 - \$998,565,000	\$167,551,389 - \$322,117,742	\$13,061,000 - \$19,621,100	\$864,405,000 - \$1,390,987,000	No effects on White Bear Lake surface water quality. Drinking water quality provided by new regional surface water treatment plant would be designed to meet all EPA/MDH drinking water quality standards.	High water quantity - Improvements would be designed to meet all future drinking water demands. Average reliability - A new regional surface water treatment plant would be designed with redundancy. Mississippi River provides average reliability during most extreme drought conditions. Low risk - A new regional surface water treatment plant would be staffed by licensed water operators and potentially managed by a joint powers commission.	Standard regulatory approvals required - MDH approval required for water system improvements. Construction right-of-way permits required by counties and cities. MPCA and Met Council permits required for wastewater discharges.
2H Construct a new regional surface water treatment plant near the chain of lakes to serve Mahtomedi, North Oaks, Saputo Dairy Foods, Vadnais Heights, White Bear Lake, and White Bear Township for Hugo 1 or Hugo 2 development scenario - Alternative 3 (Study 2)	3.1 - 3.6	\$642,335,000 - \$1,036,565,000	\$178,426,389 - \$334,375,806	\$13,207,400 - \$19,692,600	\$906,483,000 - \$1,430,417,000	No effects on White Bear Lake surface water quality. Drinking water quality provided by new regional surface water treatment plant would be designed to meet all EPA/MDH drinking water quality standards.	High water quantity - Improvements would be designed to meet all future drinking water demands. Average reliability - A new regional surface water treatment plant would be designed with redundancy. Mississippi River provides average reliability during most extreme drought conditions. Low risk - A new regional surface water treatment plant would be staffed by licensed water operators and potentially managed by a joint powers commission.	Standard regulatory approvals required - MDH approval required for water system improvements. Construction right-of-way permits required by counties and cities. MPCA and Met Council permits required for wastewater discharges.

2I	Construct a new regional surface water treatment plant near the chain of lakes to serve Mahtomedi, North Oaks, North St. Paul, Saputo Dairy Foods, Shoreview, Vadnais Heights, White Bear Lake, and White Bear Township - Alternative 4 (Study 2)	3.1 - 3.6	\$769,135,000	\$213,648,611 - \$248,108,065	\$17,857,200	\$1,126,279,000	No effects on White Bear Lake surface water quality. Drinking water quality provided by new regional surface water treatment plant would be designed to meet all EPA/MDH drinking water quality standards.	High water quantity - Improvements would be designed to meet all future drinking water demands. Average reliability - A new regional surface water treatment plant would be designed with redundancy. Mississippi River provides average reliability during most extreme drought conditions. Low risk - A new regional surface water treatment plant would be staffed by licensed water operators and potentially managed by a joint powers commission.	Standard regulatory approvals required - MDH approval required for water system improvements. Construction right-of-way permits required by counties and cities. MPCA and Met Council permits required for wastewater discharges.
2J	Construct a new regional surface water treatment plant near the chain of lakes to serve Saputo Dairy Foods, White Bear Lake, and White Bear Township with up to 3.8 million gallons per day (MGD) of treated wastewater injected into Prairie du Chien-Jordan aquifer or discharged directly into White Bear Lake – Alternative 5 (Studies 2 and 6)	3.1 - 3.6	\$731,935,000	\$203,315,278 - \$236,108,065	\$7,719,300	\$886,321,000	Minimal to no effects on White Bear Lake surface water quality as the wastewater reuse system would be designed to remove drinking water contaminants including chloride prior to aquifer injection or lake augmentation. Drinking water quality provided by new regional surface water treatment plant would be designed to meet all EPA/MDH drinking water quality standards.	High water quantity - Improvements would be designed to meet all future drinking water demands. Average reliability - A new regional surface water treatment plant would be designed with redundancy. Mississippi River provides average reliability during most extreme drought conditions. Wastewater reuse volumes for aquifer injection or lake augmentation would be dependent on future development projections occurring. Low risk - A new regional surface water treatment plant would be staffed by licensed water operators and potentially managed by a joint powers commission.	High regulatory challenge - Injection of treated wastewater into aquifers is currently not allowed in Minnesota. MDH approval required for water system improvements. Construction right-of-way permits required by counties and cities. MPCA and Met Council permits required for wastewater treatment improvements.
2K	Serve City of Lake Elmo with treated surface water from Saint Paul Regional Water Services in addition to Alternatives 1, 2, 3, 4, or 5 (Study 2)	0.16	\$272,490,000	\$1,703,062,500	\$5,009,700	\$372,684,000	No effects on White Bear Lake surface water quality. Drinking water quality provided by SPRWS meets all EPA/MDH drinking water quality standards.	High water quantity - Improvements would meet all future drinking water demands. Average reliability - SPRWS' system can be expanded with redundancy. Mississippi River provides average reliable during most extreme drought conditions. Low risk - SPRWS is an established public drinking water system with full operation and maintenance services.	Standard regulatory approvals required - MDH approval required for water system improvements. Construction right-of-way permits required by counties and cities.
Study 3 - Reuse of treated wastewater from local Met Council interceptors for industrial and agricultural users Evaluated reusing treated wastewater from nearby Met Council wastewater interceptors for industrial and agricultural users in the White Bear Lake area.									
3	Reuse treated wastewater from local Met Council interceptors for industrial and agricultural users (Study 3)	0.1	\$296,000,000	\$2,960,000,000	\$1,350,000	\$323,000,000	Minimal to no effects on White Bear Lake surface water quality as the wastewater reuse system would be designed to remove drinking water contaminants including chloride prior to groundwater recharge for agricultural irrigation or for industrial processes.	Low water quantity - Improvements would raise White Bear Lake by only 0.1 feet and provide less recharge of the underlying aquifer. Average reliability - A wastewater reuse facility would be designed with redundancy. Wastewater reuse volumes for aquifer injection or lake augmentation would be dependent on future development projections occurring. Low risk - Wastewater treatment facility would be staffed by licensed wastewater operators.	High regulatory challenge - Reuse of treated wastewater for industrial use is currently not allowed in Minnesota. MDH approval required for water system improvements. Construction right-of-way permits required by counties and cities. MPCA and Met Council permits required for wastewater treatment improvements.
Study 4 - Stormwater reuse for irrigation Evaluated using stormwater reuse for irrigation to reduce groundwater pumping from the aquifer.									
4	Implement stormwater reuse for irrigation in existing and future development areas (Study 4)	0.1 - 0.14	\$31,800,000 - \$279,600,000	\$318,000,000 - \$1,997,142,857	\$209,000 - \$2,700,000	\$35,980,000 - \$333,600,000	No effects on White Bear Lake surface water quality. Impacts to drinking water quality from stormwater irrigation recharge to aquifer are unknown.	Average water quantity - Potential potable water savings of 4.35 million gallons per day (MGD) on average at 25% implementation rate at ultimate development with significantly less volumes available during low precipitation periods (less stormwater runoff). Average reliability - Stormwater will not be available or at lower than needed volumes during dry periods and droughts. Moderate risk - Less to no stormwater would be stored and available for reuse during low precipitation periods.	High regulatory challenge - Minnesota rules have not been established for stormwater reuse in Minnesota. The Minnesota Plumbing Board proposed changes to Chapter 15 of the plumbing code that would not allow stormwater to be used a source of water for stormwater reuse, but these proposed changes are currently being reconsidered by the board.
Study 5 - Reuse water discharged from contaminated wells – MPCA Project 1007 Evaluated constructing multiple extraction and injection remediation wells in Oakdale, Lake Elmo, and other areas located near PFAS plumes and treating this water for municipal water use in Oakdale and Lake Elmo. The purpose of this method is to prevent the migration of PFAS to neighboring communities and private wells if Oakdale and Lake Elmo pumped significantly less groundwater from its existing municipal wells to supply its drinking water systems.									
5	Reuse and treat water discharged from contaminated wells for the City Lake Elmo or both the cities of Lake Elmo and Oakdale – MPCA Project 1007 (Study 5)	0.1 - 0.2	\$181,000,000 - \$308,000,000	\$1,540,000,000 - \$1,810,000,000	\$10,000,000 - \$29,200,000	\$381,000,000 - \$892,000,000	No effects on White Bear Lake surface water quality. Drinking water quality provided by Project 1007 water treatment system would be designed to meet all EPA/MDH drinking water quality standards.	Moderate water quantity - Improvements would be designed to meet all future drinking water demands with groundwater but within limits that would not impact surface water elevations in White Bear Lake. High reliability - Project 1007 system would be designed with redundancy. Low risk - Project 1007 system would be staffed by licensed water operators and potentially managed by a joint powers commission.	Standard regulatory approvals required - DNR, MDH, and MPCA approvals required for water system improvements. Construction right-of-way permits required by counties and cities.
Study 6 - Treat wastewater from local Met Council interceptors and inject the treated wastewater into the aquifer to raise groundwater elevations Evaluated reusing treated wastewater from a Met Council interceptor and injecting it into the aquifer through injection wells or by direct lake augmentation into White Bear Lake.									
6	Treat wastewater from local Met Council interceptors and inject the treated wastewater into the aquifer to raise groundwater elevations (Study 6)	0.7 - 1.44	\$201,200,000 - \$329,300,000	\$228,680,556 - \$287,428,571	\$1,450,000 - \$2,360,000	\$230,200,000 - \$376,500,000	Minimal to no effects on White Bear Lake surface water quality as the wastewater reuse system would be designed to remove drinking water contaminants including chloride prior to groundwater recharge for agricultural irrigation or for industrial processes.	Low water quantity - Improvements would raise White Bear Lake by only 0.7-1.44 feet and provide less recharge of the underlying aquifer. Average reliability - A wastewater reuse facility would be designed with redundancy. Wastewater reuse volumes for aquifer injection or lake augmentation would be dependent on future development projections occurring. Low risk - Wastewater treatment facility would be staffed by licensed wastewater operators.	High regulatory challenge - Reuse of treated wastewater for industrial use is currently not allowed in Minnesota. MDH and Minnesota State Plumbing Board approvals required for water system improvements. Construction right-of-way permits required by counties and cities. MPCA and Met Council permits required for wastewater treatment improvements.
Study 7A - Water quality study for the chain of lakes as it relates to lake augmentation Evaluated potential water quality impacts to the chain of Lakes (Charley Lake, Pleasant Lake, Sucker Lake, and East Vadnais Lake) and White Bear Lake and the underlying aquifer that supplies drinking water for the 14 White Bear Lake area communities if White Bear Lake was augmented using treated water from the Mississippi River and chain of lakes, which is the primary source of drinking water for Saint Paul Regional Water Services.									
7A	Surface water quality study for the chain of lakes and White Bear Lake.	NA	NA	NA	NA	NA	NA	NA	NA
Study 7B - Lake augmentation infrastructure study Evaluated the infrastructure improvements and costs to pump and treat surface water from the chain of lakes (Sucker or East Vadnais Lake) or supply partially treated surface water from Saint Paul Regional Water Services to augment White Bear Lake. The study incorporated recommended mitigation methods from the water quality study for the chain of lakes (Study 7A) to evaluate and recommend surface water treatment methods for lake augmentation and their estimated costs.									
7B-1	Augment White Bear Lake from East Vadnais Lake with up to 2 billion gallons per year (BGY) of surface water treated for suspended solids, aquatic invasive species, phosphorus, nitrogen, total organic carbon, and manganese (Study 7B)	2.9 (*)	\$182,409,000	\$62,899,655	\$2,495,000	\$232,309,000	Water quality should be maintained in White Bear Lake. Surface water pumped from East Vadnais Lake would be treated for aquatic invasive species, suspended solids, nitrogen, phosphorus, chlorophyll, total organic carbon, and manganese before pumping to White Bear Lake.	High water quantity - Improvements should maintain surface water elevations in White Bear Lake at or above elevation 922.0 ft and supply all future drinking water demands for existing and future municipal groundwater wells in the White Bear Lake area through ultimate development. Average reliability - The Mississippi River, which provides pumped surface water for the chain of lakes, provides average reliability during most extreme drought conditions. Low risk - The lake augmentation system would be maintained by licensed operators and potentially managed by a joint powers commission.	Standard regulatory approvals required - DNR and RCWD approvals required. Construction right-of-way permits required by counties and cities. MPCA and Met Council permits required for wastewater discharges.

7B-2	Augment White Bear Lake from East Vadnais Lake with up to 1 billion gallons per year (BGY) of surface water treated for suspended solids, aquatic invasive species, phosphorus, nitrogen, total organic carbon, and manganese with a facility that is designed to be expanded up to a 2 billion gallons per year pumping and treatment capacity in the future if needed (Study 7B)	2.9 (*)	\$156,403,000	\$53,932,069	\$1,490,000	\$186,203,000	Water quality should be maintained in White Bear Lake. Surface water pumped from East Vadnais Lake would be treated for aquatic invasive species, suspended solids, nitrogen, phosphorus, chlorophyll, total organic carbon, and manganese before pumping to White Bear Lake.	Moderate water quantity - Improvements should maintain surface water elevations in White Bear Lake at or above elevation 922.0 ft and supply all future drinking water demands for existing and future municipal groundwater wells in the White Bear Lake for area through ultimate development although with lesser pumping and treatment capacity. Average reliability - The Mississippi River, which provides pumped surface water for the chain of lakes, provides average reliability during most extreme drought conditions. Moderate risk - There is moderate risk in which a 1 BGY pumping and treatment system may not be adequate to maintain the surface water elevations in White Bear Lake at or above elevation 922.0 ft at all times through ultimate development although the system could be expanded in pumping and treatment capacity in the future if needed. The lake augmentation system would be maintained by licensed operators and potentially managed by a joint powers commission to help reduce risk.	Standard regulatory approvals required - DNR and RCWD approvals required. Construction right-of-way permits required by counties and cities. MPCA and Met Council permits required for wastewater discharges.
7B-3	Augment White Bear Lake from East Vadnais Lake with up to 2 billion gallons per year (BGY) of surface water treated for suspended solids and aquatic invasive species only (Study 7B)	2.9 (*)	\$89,213,000	\$30,763,103	\$1,670,000	\$122,613,000	There is potential for the water quality in White Bear Lake to not be fully maintained if surface water treatment is provided for aquatic invasive species and suspended solids only and not provided for nitrogen, phosphorus, chlorophyll, total organic carbon, and manganese. Surface water pumped from East Vadnais Lake would be treated for aquatic invasive species, suspended solids, nitrogen, phosphorus, chlorophyll, total organic carbon, and manganese before pumping to White Bear Lake.	High water quantity - Improvements should maintain surface water elevations in White Bear Lake at or above elevation 922.0 ft and supply all future drinking water demands for existing and future municipal groundwater wells in the White Bear Lake area through ultimate development. Average reliability - The Mississippi River, which provides pumped surface water for the chain of lakes, provides average reliability during most extreme drought conditions. Moderate risk - Nitrogen, phosphorous, chlorophyll, total organic carbon, and manganese concentrations in the Mississippi River and chain of lakes exceeded the maximum recommended discharge concentrations into White Bear Lake at certain times as determined by Study 7A. There is risk that White Bear Lake's water quality could be affected if these contaminants are not treated by the lake augmentation system. The system could be designed to add additional treatment processes in the future to treat these contaminants if needed to help reduce the risk. The lake augmentation system would be maintained by licensed operators and potentially managed by a joint powers commission to help reduce risk.	Standard regulatory approvals required - DNR and RCWD approvals required. Construction right-of-way permits required by counties and cities. MPCA and Met Council permits required for wastewater discharges.
7B-4	Augment White Bear Lake from East Vadnais Lake with up to 1 billion gallons per year (BGY) of surface water treated for suspended solids and aquatic invasive species with a facility that is designed to be expanded up to a 2 billion gallons per year pumping and treatment capacity in the future if needed (Study 7B Amendment)	2.9 (*)	\$87,413,000	\$30,142,414	\$925,000	\$105,913,000	There is potential for the water quality in White Bear Lake to not be fully maintained if surface water treatment is provided for aquatic invasive species and suspended solids only and not provided for nitrogen, phosphorus, chlorophyll, total organic carbon, and manganese. Surface water pumped from East Vadnais Lake would be treated for aquatic invasive species, suspended solids, nitrogen, phosphorus, chlorophyll, total organic carbon, and manganese before pumping to White Bear Lake.	Moderate water quantity - Improvements should maintain surface water elevations in White Bear Lake at or above elevation 922.0 ft and supply all future drinking water demands for existing and future municipal groundwater wells in the White Bear Lake area through ultimate development although with lesser pumping and treatment capacity. Average reliability - The Mississippi River, which provides pumped surface water for the chain of lakes, provides average reliability during most extreme drought conditions. High risk - Nitrogen, phosphorous, chlorophyll, total organic carbon, and manganese concentrations in the Mississippi River and chain of lakes exceeded the maximum discharge concentrations into White Bear Lake at certain times as determined by Study 7A. There is risk that White Bear Lake's water quality could be affected if these contaminants are not treated by the lake augmentation system. The system could be designed to add additional treatment processes in the future to treat these contaminants if needed to help reduce the risk. There is also risk in which a 1 BGY pumping and treatment system may not be adequate to maintain the surface water elevations in White Bear Lake at or above elevation 922.0 ft at all times through ultimate development although the system could be expanded in pumping and treatment capacity in the future if needed. The lake augmentation system would be maintained by licensed operators and potentially managed by a joint powers commission to help reduce risk.	Standard regulatory approvals required - DNR and RCWD approvals required. Construction right-of-way permits required by counties and cities. MPCA and Met Council permits required for wastewater discharges.
7B-5	Augment White Bear Lake with up to 2 billion gallons per year (BGY) of partially treated surface water purchased from Saint Paul Regional Services (SPRWS) with no additional clarifier and recarbonation/ozonation basin (low range cost estimate) or with an additional clarifier and recarbonation/ozonation basin (high range cost estimate), water booster station, and transmission main (Study No. 7B Amendment)	2.9 (*)	\$116,005,000- \$163,750,000	\$56,465,517	\$8,240,600	\$280,817,000 - \$328,562,000	Water quality should be maintained in White Bear Lake. Partially treated surface water pumped from the SPRWS McCarrons WTP would be treated for aquatic invasive species, suspended solids, nitrogen, phosphorus, chlorophyll, total organic carbon, and manganese before pumping to White Bear Lake. Drinking water quality provided by SPRWS meets all EPA/MDH drinking water quality standards.	High water quantity - Improvements should maintain surface water elevations in White Bear Lake at or above elevation 922.0 ft and supply all future drinking water demands for existing and future municipal groundwater wells in the White Bear Lake for area through ultimate development to help reduce risk. Average reliability - The system would be designed for redundancy. The Mississippi River, which provides pumped surface water for the chain of lakes and McCarrons WTP, provides average reliability during most extreme drought conditions. Low to moderate risk - SPRWS is an established public drinking water system with full operation and maintenance services. Choosing the alternative to not construct an additional clarifier and recarbonation/ozonation basin at the McCarrons water treatment facility to provide additional redundant treatment capacity would increase the risk level to moderate risk; however, a temporary reduction in treatment capacity caused by equipment failure should not last more than 1-5 days before a repair could be made. This temporary disruption in augmenting White Bear Lake should not have a significant effect on the lake elevations since the seasonal augmentation period could last 4-8 months and this lost pumping volume could be made up later in the season.	Standard regulatory approvals required - MDH, DNR, and RCWD approvals required. Construction right-of-way permits required by counties and cities. MPCA and Met Council permits required for wastewater discharges.

7B-6	Augment White Bear Lake with up to 1 billion gallons per year (BGY) of partially treated surface water purchased from Saint Paul Regional Water Services (SPRWS) with no additional clarifier and recarbonation/ozonation basin (low range cost estimate) or with an additional clarifier and recarbonation/ozonation basin (high range cost estimate), water booster station, and transmission main and with a pumping facility that is designed to be expanded up to a 2 billion gallons per year (BGY) pumping capacity in the future if needed (Study 7B Amendment)	2.9 (*)	\$115,069,000- \$162,814,000	\$56,142,759	\$4,560,100	\$206,271,000 - \$254,016,000	Water quality should be maintained in White Bear Lake. Partially treated surface water pumped from the SPRWS McCarrons WTP would be treated for aquatic invasive species, suspended solids, nitrogen, phosphorus, chlorophyl, total organic carbon, and manganese before pumping to White Bear Lake. Drinking water quality provided by SPRWS meets all EPA/MDH drinking water quality standards.	Moderate water quantity - Improvements should maintain surface water elevations in White Bear Lake at or above elevation 922.0 ft and supply all future drinking water demands for existing and future municipal groundwater wells in the White Bear Lake area through ultimate development although at a lesser pumping capacity to help reduce risk. Average reliability - The system would be designed for redundancy. The Mississippi River, which provides pumped surface water for the chain of lakes and McCarrons WTP, provides average reliability during most extreme drought conditions. Moderate risk - There is risk in which a 1 BGY pumping and treatment system may not be adequate to maintain the surface water elevations in White Bear Lake at or above elevation 922.0 ft at all times through ultimate development although the system could be expanded in pumping capacity in the future if needed. SPRWS is an established public drinking water system with full operation and maintenance services. Choosing the alternative to not construct an additional clarifier and recarbonation/ozonation basin at the McCarrons water treatment facility to provide additional redundant treatment capacity would increase the risk level; however, a temporary reduction in treatment capacity caused by equipment failure should not last more than 1-5 days before a repair could be made. This temporary disruption in augmenting White Bear Lake should not have a significant effect on the lake elevations since the seasonal augmentation period could last 4-8 months and this lost pumping volume could be made up later in the	Standard regulatory approvals required - MDH, DNR, and RCWD approvals required. Construction right-of-way permits required by counties and cities. MPCA and Met Council permits required for wastewater discharges.
Study 8 - Stormwater collection and infiltration to raise groundwater elevations and Examined collecting stormwater and raising groundwater elevations through infiltration of stormwater into the aquifer.									
8	Work group decided not to evaluate infrastructure solutions due to stormwater runoff contaminants and a vulnerable aquifer if stormwater was allowed to infiltrate into the aquifer to raise groundwater elevations.	NA	NA	NA	NA	NA	NA	NA	NA
Study 9A - Raise outlet elevation of White Bear Lake - Evaluate potential water storage and downstream hydraulic capacity Evaluated raising the outlet elevation of White Bear Lake to increase water storage in the lake and predict how it could impact flooding to property owners located around and near the lake.									
9A	Evaluated potential increase in lake storage and downstream hydraulic capacity which lead into Study 9B.	NA	NA	NA	NA	NA	NA	NA	NA
Study 9B - Raise outlet elevation of White Bear Lake - Evaluate impacts to properties and infrastructure improvements Evaluated potential impacts from raising the outlet elevation of White Bear Lake including impacts to infrastructure and properties, flood risks, and estimated cost.									
9B	Raise outlet elevation of White Bear Lake by 6 to 12-inches and purchase existing properties in and near the flood plain that could be impacted from flooding (Study 9B)	Unknown	\$184,675,000 - \$270,439,000	Unknown	\$1,000	\$184,695,000 - \$270,459,000	Minimal to no effects on White Bear Lake surface water quality.	Increased water quantity - Raising the lake outlet elevation by 6-12 inches would provide 400 to 800 million gallons of additional lake storage that could be utilized during times when the lake elevations are significantly higher than normal. Average reliability - A higher lake outlet elevation would increase reliability and potentially reduce the amount of surface water needed to augment the lake during extended dry periods. During periods with lower surface water elevations in White Bear Lake, the higher lake outlet elevation would not provide additional reliability and benefits. Moderate risk - Although this potential solution includes purchasing existing properties in or near the flood plain around the lake that could be impacted by a raised lake outlet elevation, there could still be moderate risk involved from flooding.	Standard regulatory approvals required - MDH, DNR, and RCWD approvals required. Construction right-of-way permits required by counties and cities. MPCA and Met Council permits required for wastewater discharges.
Study 11 - Implement/require/encourage non- or less-potable or potable water reuse for irrigation and process water Evaluated reusing and treating surface water from East Vadnais Lakes for non- or less-potable or portable water for irrigation and process water in Vadnais Heights, White Bear Lake, and Gem Lake (via Vadnais Heights).									
11	Implement/require/encourage non- or less-potable water or potable reuse for irrigation and process water in Vadnais Heights, White Bear Lake, and Gem Lake (Study 11)	0.39 - 0.48	\$49,000,000 - \$105,000,000	\$125,641,026 - \$218,750,000	\$760,000 - \$964,000	\$64,200,000 - \$124,280,000	Water quality should be maintained in White Bear Lake. Surface water pumped from East Vadnais Lake would be treated for aquatic invasive species, suspended solids, nitrogen, phosphorus, chlorophyll, total organic carbon, and manganese before pumping to White Bear Lake. Drinking water quality should meet all EPA/MDH drinking water quality standards for the option that includes providing potable water.	Moderate water quantity - Improvements would be designed to meet all future drinking water demands with non or less potable water or potable water for businesses and large irrigation systems in Vadnais Heights and White Bear Lake and potentially supply drinking water for the City of Gem Lake if a potable water treatment option is selected. Average reliability - The Mississippi River, which provides pumped surface water for the chain of lakes, provides average reliability during most extreme drought conditions. Moderate risk - Although the lake augmentation system would be maintained by licensed operators and potentially managed by a joint powers commission, this potential solution would need to be done in conjunction with another potential solution since there is inadequate volume to recharge White Bear Lake beyond 0.48 feet in lake elevation	High regulatory challenge - Water reuse from treated surface water to supply non or less potable water businesses and large irrigation systems is currently not allowed in Minnesota. A potable drinking water system option would require MDH approval. Construction right-of-way permits required by counties and cities. MPCA permit required for wastewater treatment system improvements.
Study 14A - Evaluate future community impacts from PFAS groundwater contamination with groundwater modeling Minnesota Department of Health (MDH) modeled groundwater flow path lines for future groundwater pumping conditions for PFAS contamination and how PFAS could travel over 50 years in the White Bear Lake area communities if select communities stopped pumping groundwater and switched to a surface water supply source.									
14A	MDH study determined that most areas induce minor changes to the direction of flow and areas near altered, added, or removed wells showed the greatest impact although minor. Based on the groundwater modeling results, it was determined to be unnecessary to proceed with Study 14B to evaluate the infrastructure and estimate the costs to implement drinking water treatment for PFAS (Study 14A)	NA	NA	NA	NA	NA	NA	NA	NA
Study 15 - Serve City of North Oaks with potable drinking water supplied from City of Shoreview Evaluated constructing two additional municipal wells in Shoreview and expand the city's existing water treatment plant capacity to serve North Oaks' projected ultimate development with treated drinking water supplied from groundwater.									
15	Serve City of North Oaks with treated drinking water supplied by Shoreview in lieu of treated surface water from Saint Paul Regional Water Services or a new regional surface water treatment plant (Alternatives 4 and 5) (Study 15)	0	\$16,100,000 - \$31,300,000	Not applicable	\$573,000 - \$873,000	\$27,560,000 - \$48,760,000	No effects on White Bear Lake surface water quality. Drinking water quality provided to North Oaks from Shoreview's municipal water system should meet all EPA/MDH drinking water quality standards.	High water quantity - Improvements would be designed to meet all future drinking water demands in North Oaks. High reliability - An expanded or second water treatment plant in Shoreview would be designed with redundancy to serve North Oaks. Moderate risk - There is potential for groundwater contamination from the western TCAAP site to migrate towards two new wells constructed in Shoreview, but the second plant could be expanded with additional water treatment to treat these contaminants if they were ever detected in the city's municipal wells. Shoreview has an established public drinking water system with full operation and maintenance services to help reduce risk	Standard regulatory approvals required - MDH approval required for water system improvements. Construction right-of-way permits required by counties and cities. MPCA and Met Council permits required for wastewater discharges.

Notes

(*) The estimated increase (2.9 feet) to White Bear Lake surface water elevations is based on groundwater modeling with an annual augmentation rate up to 780 million gallons per year (MGY). Higher augmentation rates are assumed to provide an increase of at least 2.9 ft in surface water elevation.

Studies for Potential Water Savings Solutions

Potential Water Savings Solution	Estimated Increase to Surface Water Elevation to White Bear Lake at Ultimate Development (feet)	Estimated Capital Cost	Estimated Capital Cost Per Foot of Increase to Surface Water Elevation in White Bear Lake	Estimated Annual Operation & Maintenance Cost	Present Worth 20-Year Capital and Operation & Maintenance Cost	Water Savings, Reliability, and Risks Summary	Regulatory Requirements Summary
Study 10 - Lawn watering restrictions (day of week and time) Estimated potential water savings from implementing lawn watering restrictions and enhancing existing watering restrictions based on days of the week and implementing irrigation smart system controllers.							
10 Install smart controllers on all lawn irrigation systems (day of week and time) (Study 10)	0.1 - 0.22	\$1,192,000 - \$4,469,000	\$11,920,000 - \$20,313,636	\$0	\$1,137,000 - \$4,261,000	High water savings - Estimated annual groundwater savings of 23 to 167 million gallons per year. High reliability - Irrigation controllers are very reliable. Low risk - Irrigation controllers have a low risk.	No regulatory approvals required
Study 12 - Lawn watering restrictions (day of week and time) Evaluated potential water savings from tiered increasing block water utility rates.							
12 Increase tiered increasing block water utility rates (Study 12)	Unknown	\$0	Unknown	\$0	\$0	High potential water savings - Estimated annual groundwater savings are unknown but increasing tiered water utility rates will save additional water. High reliability - Increasing tiered water utility rates has high reliability to reduce groundwater savings. Low risk - Increasing tiered water utility rates has a low risk.	No regulatory approvals required
Study 13 - Potential water savings from alternative low input turf grasses Evaluated potential water savings from implementing alternative low input turf grasses that require significantly less irrigation water for the 14 White Bear Lake area communities.							
13 Implement alternative low input turf grasses (Study 13)	0.16 - 0.42	\$4,379 - \$4,527 per acre	Unknown	\$3,453 - \$6,851 per acre	\$73,439 - \$141,547 per acre	High water savings - Estimated annual groundwater savings of up to 66,300 gallons per acre per year. High reliability - Irrigation controllers are very reliable. Low risk - Irrigation controllers have a low risk.	No regulatory approvals required

Financial Analysis Study

Financial Analyses Study Developing a financial water rate model to estimate potential water utility rates to implement each of the potential solutions being evaluated by the technical consultants as an alternative funding method. Potential funding methods being evaluated include the Minnesota State Bonding Bill, Federal Congressional Funding, Environment and Natural Resources Trust Fund, DNR Water Use Fees (local and statewide), sales tax (local and statewide), and Water Availability Charges (WAC) for future development.
