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TECHNICAL MEMORANDUM

To: Greg Johnson, PE, MCES

From: Uma Vempati, PE, Kimley-Horn
George Sendrey, PE, Kimley-Horn
Petros Paulos, PE, Kimley-Horn
Emily Schabert, Kimley-Horn

Date: January 8th, 2026

Subject: White Bear Lake Comprehensive Plan: Study 11 - Update
Non-/Less-Potable or Potable Water Reuse for Irrigation & Process Water (Vadnais Heights & White Bear Lake)

1.0 EXECUTIVE SUMMARY

Study 11 evaluates the feasibility of supplying non- or less-potable water and potable water (treated surface water) to selected commercial, residential, and industrial users for irrigation, residential, and/or process uses, to reduce groundwater pumping in the Vadnais Heights and White Bear Lake areas. Since the project was kicked off, business surveys were issued in Vadnais Heights and White Bear Lake, initial demand indicators were compiled, preliminary watermain alignments were established for a dedicated distribution system with pressure management (tower/booster) options, and regulatory considerations were documented. Survey results show seasonally peaking demand, mixed willingness to adopt reuse or alternate-source water, and the need for additional outreach and code clarification. Two models were evaluated for the implementation of a new surface water distribution system focused on supplying water for industrial, commercial, and irrigation purposes, as well as select residential communities. The two models were designed as follows: the Infrastructure-Based Model focused on supplying as many commercial and industrial users as possible. In contrast, the User-Based Model concentrates on supplying the largest-volume demand users and other users directly on the distribution path.

The Infrastructure-Based Model and User-Based Model anticipate supplying approximately 1.2 million gallons per day (MGD) and 0.850 MGD, respectively, during irrigation seasons. It is also anticipated that capital costs associated with the Infrastructure-Based model will roughly range between $34,000,000-$39,000,000, with an estimated total operations and maintenance cost between $16,000,000 - $18,000,000 based on a 50-year life cycle. The User-Based Model anticipates a capital cost between $20,000,000-$25,000,000 and an estimated total operations and maintenance cost of approximately $6,000,000-$7,000,000 based on a 50-year life cycle.

When comparing the total infrastructure associated with each model, the User-Based Model captures approximately 73% of demand and requires approximately 46% of the infrastructure, resulting in approximately 38% of O&M costs.

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2.0 PURPOSE AND SCOPE

Purpose of the Study

- Identify and evaluate whether a non-/less-potable or potable reuse system can serve the targeted White Bear and Vadnais Heights area reliably and cost-effectively, thereby lowering groundwater withdrawals in Vadnais Heights and White Bear Lake area and thus improving water elevations in White Bear Lake.

Scope of the Study.

- Analyze the feasibility of non-/less-potable water use and (where applicable) potable reuse for specific user classes.
- Evaluated multiple distribution networks:
    - An Infrastructure-Based Model - Evaluate a robust distribution system network to serve as many commercial/industrial and select residential properties as practical, including large quantity water users (see Attachment A for the distribution network and businesses served).
    - A User-Based Model – Evaluate a targeted distribution network designed to serve large quantity water users (see Attachment B for the distribution network and businesses served).
- Screen potential effects on the overall surface-water/groundwater balance and White Bear Lake management strategies.
- Aid the DNR in the evaluation and modeling of the transitioning of portions of groundwater demand to surface water.
- Evaluate concept-level costs, Operations and Maintenance (O&M) needs, regulatory path, and ownership/management structures.
- Further evaluate the inclusion of the water reuse study and the White Bear Lake Augmentation Study by others. As these studies have separate purposes, during portions of the year or during years when lake augmentation is not needed, the lake augmentation supply and treatment system may be able to supply the industrial water supply to provide continuous use of the lake augmentation system.

3.0 WORK PERFORMED TO DATE

3.1 Stakeholder Survey

- Distribution ~110 businesses in Vadnais Heights (sent Sept 25, 2025) and ~100 in White Bear Lake (sent Oct 2, 2025)
- Responses to date - 18 completed (as of December 18, 2025)
- Content:
    - Current water uses/volumes, quality needs, on-site treatment, pressure/flow/fire-protection, and willingness to accept a separate non-potable service.
- Additional outreach to the White Bear Area Chamber of Commerce was made to raise awareness of the study and potentially aid in responses from various businesses.

Table 1. Summary Table of Survey Responses

Question	Summary of Responses
Usage Type*	**Irrigation (9), Cooling Towers (2), Boilers/Steam (4), Rinsing (4), Sanitation (4), Machinery (2)**
Estimated Monthly Usage	**No Estimate Known (9), Provided Estimate (8), No Response (1)**
Estimated Peak Hour Demand	**No Estimate Known (18)**
Minimum Flow Rate	**No Requirement (17), Provided Minimum (1)**
Water Pressure Requirements	**No Requirement (17), Provided Minimum (1)**
Current Treatment	**None (12), Yes (6)**
Impact of Changes to Water Chemistry	**None (13), Unsure (3), Provided Required Chemistry (2)**
Desired Changes to Water* Chemistry	**Currently Satisfied (11), Desired Changes to Odor (3), Hardness (3), PFAS (1), Iron (1)**
Existing Separate Fire Suppression	**Yes (5), No (8), Unsure (5)**
Desire for Non-Potable Service	**Yes, with Additional Information (4), No (8), Unsure (5), No Response (1)**
Current Wastewater Pre-Treatment	**No (17), Yes (1)**
Interest in Water Reuse/Treated Surface Water Use	**Yes (5), Yes with Additional Information (3), Potentially in the Future (3), No (7)**

Notes: Values within parentheses indicate the number of responses.
** Multiple responses were allowed.*

3.2 Demand Indicators

- Compiled initial annual and peak-season demand snapshots for target areas using recent utility data (WBL 2024; VH 2022–2024) and a simple demand calculator to translate reported uses into preliminary sizing ranges. All data were categorized by usage type (irrigation, residential, commercial, and industrial) to enable more accurate demand forecasting.
- Created two potential model versions and distribution systems for serving customers that would allow for two different demand scenarios –
    1. An “Infrastructure-Based Model,” in which infrastructure is constructed to reach as many customers as feasible,
    2. A “User-Based Model,” in which the distribution network is built to reach the largest users and other users on the same distribution routes.
- The City of Gem Lake was included in this study as it is situated along the proposed water main route and has been in discussions with White Bear Lake and Vadnais Heights to potentially provide potable water to the community, which would make logistical sense to evaluate its inclusion in the study. Gem Lake also potentially has more suitable locations for a proposed water tower that have been assessed.

3.3 Annual Water Demands

- Tables 2 and 3 outline the annual demand associated with the Infrastructure-Based Model and User-Based Model, respectively. The estimated annual water demand for the Infrastructure-Based model is approximately 369 million gallons per year (MGY), and for the User-Based model, it is approximately 299 MGD.
- Both models account for 2050 projections for Gem Lake's residential demands and growth.
- Attachments C – Infrastructure-Based Model and D- User-Based Model outline the various business types and their locations in reference to the proposed distribution networks.

Table 2: Annual Water Demand – Infrastructure-Based Model

	WBL and VH Commercial /Industrial**	Gem Lake Commercial /Industrial**	Irrigation*	WBL Residential	VH Residential	Gem Lake Residential	Estimated Demand Including Irrigation	Estimated Demand Excluding Irrigation
Total Annual Water Demand* (GPY)**	216,890,893	25,206,900	70,075,404	35,616,750	2,738,216	18,269,345	368,797,508	298,722,104
Average Water Demand (GPM)	413	48	665	68	5	35	1,234	568
Avg. Daily Demand (GPD)	594,222	69,060	359,361	97,580	7,502	50,053	1,177,778	818,417

**Based on 9 hours of daily usage and 6.5 months of irrigation per year*
***Based on 24 hours of use for commercial users*
****The WaterGem model accounts for the diurnal demand pattern*

Table 3: Annual Water Demand – User-Based Model

	WBL and VH Commercial /Industrial**	Gem Lake Commercial /Industrial**	Irrigation*	WBL Residential	VH Residential	Gem Lake Residential	Estimated Demand Including Irrigation	Estimated Demand Excluding Irrigation
Total Annual Water Demand* (GPY)**	157,769,21	25,206,900	47,691,948	18,559,500	554,162	18,269,345	268,051,06	220,359,11
Water Demand (GPM)	300	48	453	35	1	35	872	419
Avg. Daily Demand (GPD)	432,244	69,060	244,574	50,848	1,518	50,053	848,298	603,724

**Based on 9 hours of daily usage and 6.5 months of irrigation per year*
***Based on 24 hours of use for commercial users*
****The WaterGem model accounts for the diurnal demand pattern*

3.4 Current Annual Reduction in Water Demand

To further evaluate the effect on the local groundwater table, the reductions in pumping from various supply wells and private wells are outlined in Tables 4 and 5. Additionally, a visual representation of the wells affected is shown in Attachments E and F. Based on current demands, the infrastructure and user-based models would yield groundwater pumping reductions of 341.8 and 249.8 Million Gallons per Year (MGY), respectively, if implemented based on current infrastructure demands.

Table 4: Estimated Annual Aquifer Reduction from WBL and VH Water Demand – Infrastructure-Based Model

Well	City	Establishments	Commercial and Industrial Demand (GPY)	Irrigation Demand (GPY)	Residential and Mixed-Use Demand (GPY)	Total GPY Reduced
Vadnais Heights Supply Wells	Vadnais Heights	Businesses and Domestic	64,068,809	20,165,45	--	341,808,310
White Bear Lake City Supply Wells	White Bear Lake	Businesses and Domestic	68,548,000	13,503,75	--	
White Bear Lake City Supply Wells	Gem Lake[1]	Existing Residential Services	--	--	9,986,400	
Vadnais Heights Supply Wells	Gem Lake[1]	Existing Residential Services	--	--	18,706,250	
151584	Vadnais Heights	Gem Lake Hills Inc.	--	14,589,000	--	
127293	White Bear Lake	Manitou Ridge Golf Course	--	21,817,200	--	
151562	Vadnais Heights	H. B. Fuller	4,721,250	--	--	
233149	White Bear Lake	Saputo	105,702,000	--	--	

[1]The City of Gem Lake is currently supplied by both the City of Vadnais Heights and the City of White Bear Lake. The numbers shown are current average yearly demands. The projected 2050 demand totals 43,476,245 GPY, with an estimated 22,857,395 GPY from White Bear Lake supply wells and 20,618,850 GPY from Vadnais Heights supply wells.

Table 5: Estimated Annual Aquifer Reduction from WBL and VH Water Demand – User-Based Model

Well	City	Establishments	Commercial and Industrial Demand (GPY)	Irrigation Demand (GPY)	Residential and Mixed-Use Demand (GPY)	Total GPY
Vadnais Heights Supply Wells	Vadnais Heights	Businesses and Domestic	24,443,572	4,550,748	--	249,781,720
White Bear Lake City Supply Wells	White Bear Lake	Businesses and Domestic	36,520,100	6,735,000	--	
White Bear Lake City Supply Wells	Gem Lake[1]	Existing Residential Services	--	--	9,986,400	
Vadnais Heights Supply Wells	Gem Lake[1]	Existing Residential Services	--	--	18,706,250	
151584	Vadnais Heights	Gem Lake Hills Inc.	--	14,589,000	--	
127293	White Bear Lake	Manitou Ridge Golf Course	--	21,817,200	--	
151562	Vadnais Heights	H. B. Fuller	4,721,250	--	--	
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3.5 Water Distribution Network Overview

A detailed hydraulic distribution system model was developed to adequately evaluate the water distribution network. The watermains were modeled with WaterGEMS software to assess the distribution system's performance and storage. The model used three diurnal demand patterns based on AWWA reference patterns to emulate 24-hour demand variation, to model varying demand estimates, and to account for daily variations. The distribution network was developed in the model to predict and evaluate maximum daily water demands during the irrigation months. Additionally, storage was sized to hold approximately a single day's demand, which equates to approximately 1.2 MGD for the Infrastructure-Based Model and 0.850 MGD for the User-Based Model. The diurnal demand patterns used to evaluate the residential, irrigation, and commercial/industrial demands over 24 hours are shown in Figures 1, 2, and 3, and are based on average demand patterns presented by the American Water Works Association (AWWA). Fire demands were not modeled as the existing distribution systems and hydrants would continue to provide fire protection for all customers.

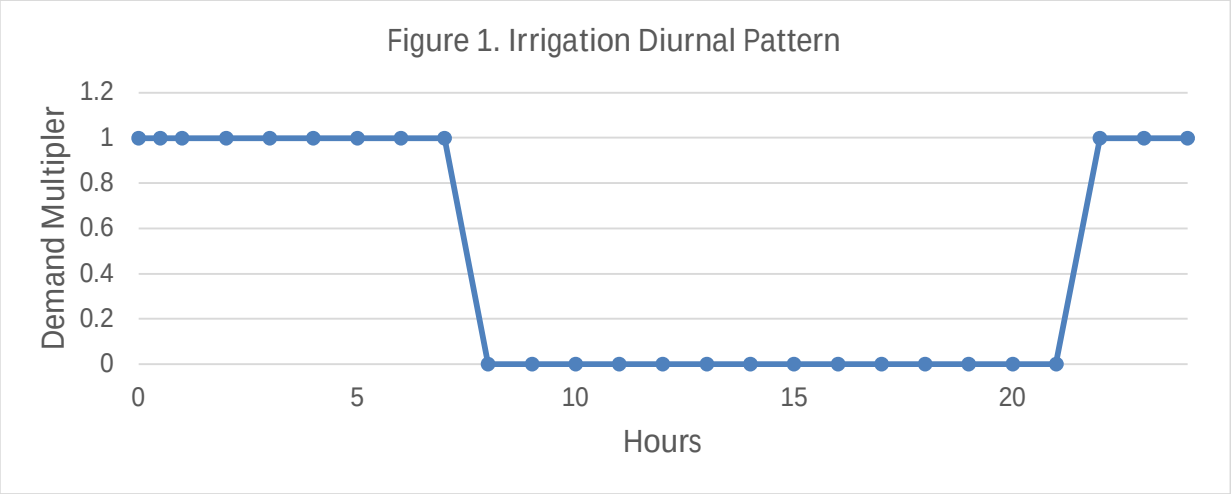
Figure 1. Irrigation Diurnal Pattern
Demand Multipler
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0.6
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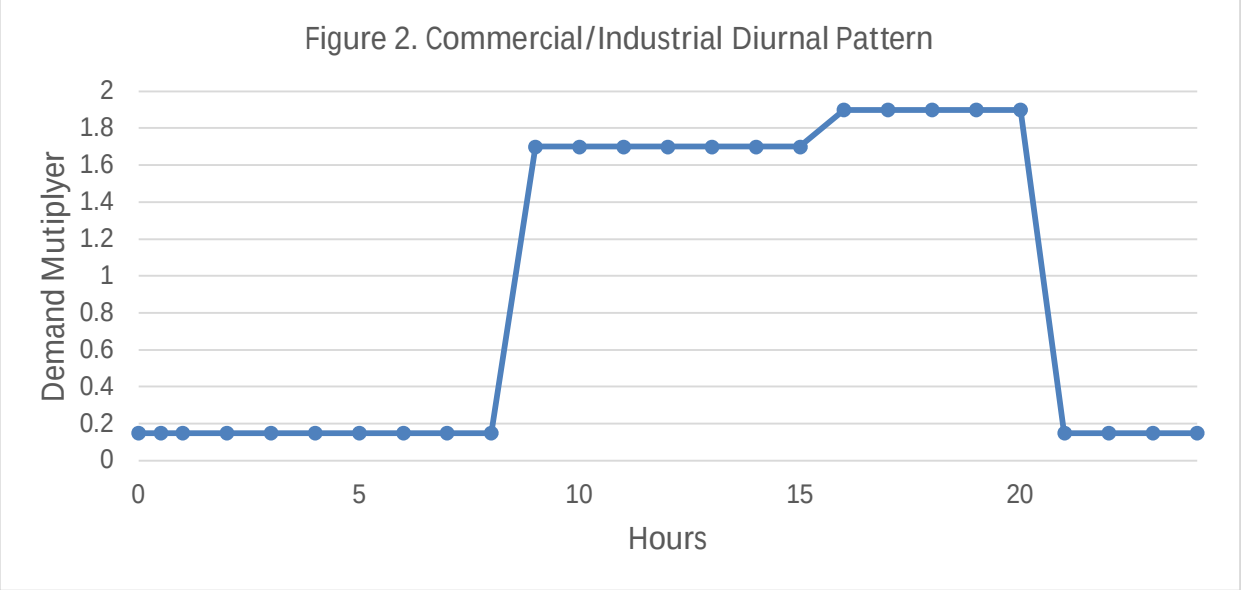
Figure 2. Commercial/Industrial Diurnal Pattern
Demand Mutiplyer
2
1.8
1.6
1.4
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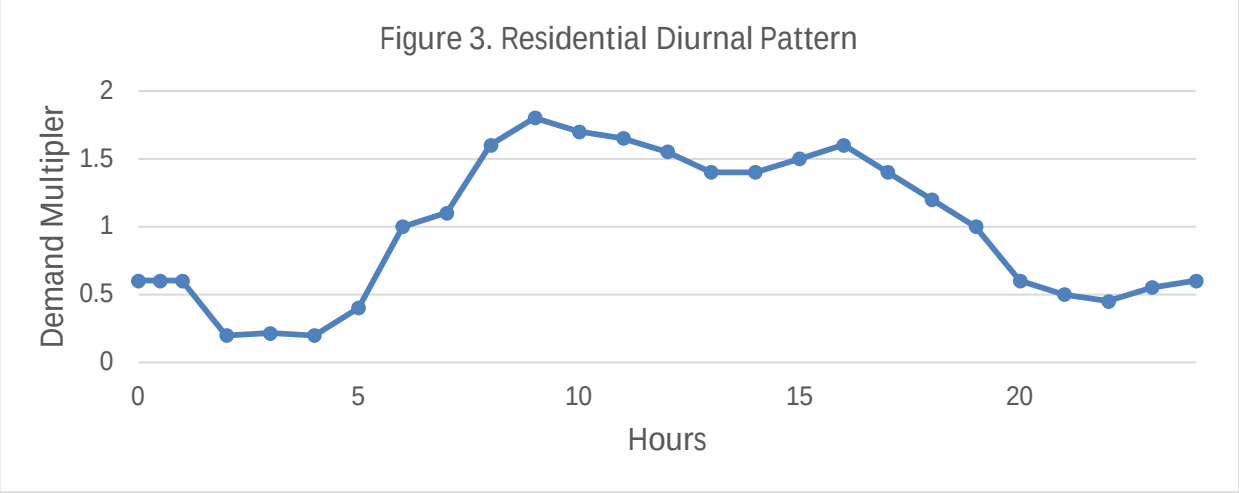
Figure 3. Residential Diurnal Pattern
Demand Multipler
2
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Hours

Table 6: Estimated Distribution Network Design

	8-Inch Water Main	12-Inch Water Main	16-Inch Water Main	Water Tower Height	Water Tower Capacity	Pressure Zones	Pressure Zone 1 Range	Pressure Zone 2 Range
	(Linear ft)	*(Linear ft)*	*(Linear ft)*	*ft*	*Million Gallons*	*#*	*PSI*	*PSI*
Infrastructure-Based Model	53,423	24,446	7,721	170	1.25	2	46-84	68-78
User-Based Model	2,653	33,209	573	170	1.5	1	48-83	--

Table 7: Model Comparison

	Commercial Industrial Demand (GPM)	Irrigation Demand (GPM)	Residential Demand (GPM)	Average Annual Water Demand (Gal)	Average Day Demand (Gal)	Total Water Main Length (ft)
Infrastructure-Based Model	445.2	670.8	98.4	368,797,508	1,177,778	85,905
User-Based Model	337.4	493.4	49.1	268,051,065	848,298	36,706
Percent served by User-Based Model	**76%**	**74%**	**50%**	**73%**	**72%**	**43%**

3.6 Opinion of Probable Costs

An overview of the opinion of probable construction costs (OPCC) associated with the distribution network and storage system is outlined in Table 8. The annual maintenance is based on an estimated lifespan of 50 years. The OPCC does not include the cost for treatment or the treatment system design. The OPCC shall consist of the following components:

- **Infrastructure Capital Costs**
- **Engineering & Design Costs**
- **Easements & Land Acquisition Costs**
- **Annual Operations and Maintenance (O&M) Costs**

Table 8: Preliminary Opinion of Probable Cost

	Infrastructure-Based Model	User-Based Model
Capital Costs	**$ 34,000,000- $ 39,000,000**	**$ 20,000,000- $ 25,000,000**
Total O&M Costs*/**	**$ 16,000,000- $ 18,000,000**	**$ 6,000,000- 7,000,000**
Annual O&M Costs*/**	**$ 450,000**	**$ 150,000**

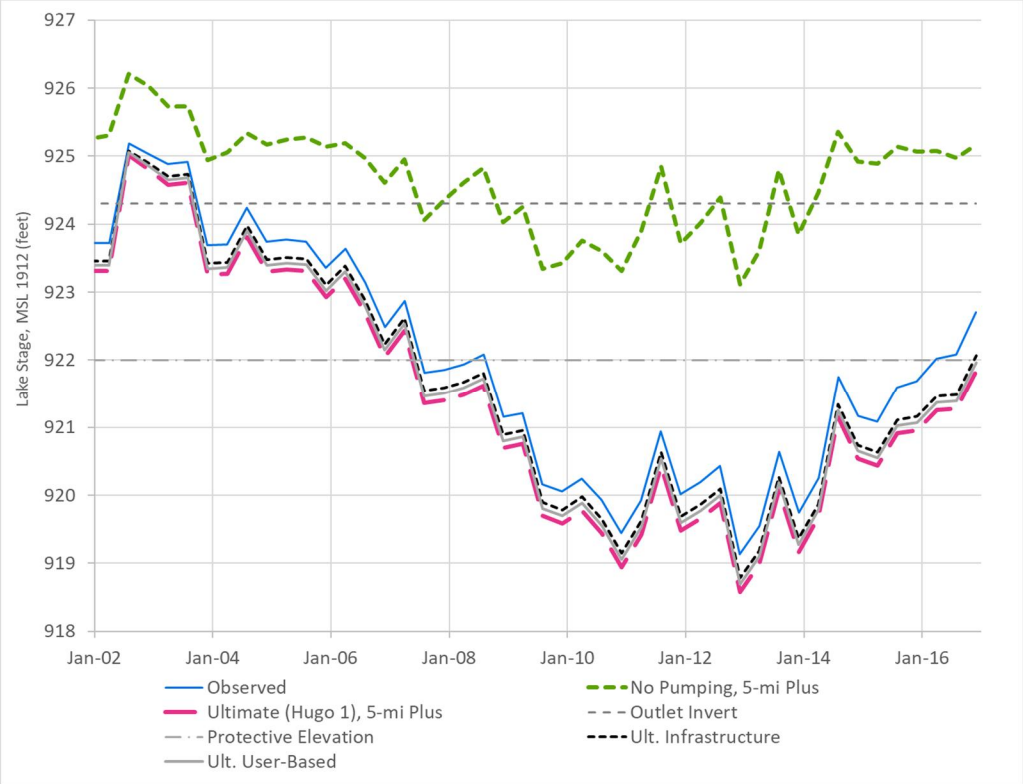
Notes: The Engineer has no control over the cost of labor, materials, equipment, or the Contractor's methods of determining prices or over competitive bidding or market conditions. The opinion of probable construction costs provided herein are based on information known to the Engineer at the time and represents only the Engineer's judgement as a design professional familiar with the construction industry. The Engineer cannot and does not guarantee that the proposals, bids, or actual construction costs will not vary from its opinion of probable costs.
**Based on a 50-year Life Span*
*** The Operations and Maintenance costs are based on Present Worth Evaluation with a 3% interest rate*

3.7 Estimated Improvements to White Bear Lake Surface Water Elevations

The DNR conducted groundwater modeling to estimate the improvements to White Bear Lake's water elevations if either the Infrastructure-Based or User-Based water distribution system was implemented. For these modeling scenarios, the projected water demands for the businesses and high-capacity well customers connected to these systems were removed (subtracted) from the projected municipal water demands for Vadnais Heights and White Bear Lake in the groundwater model. The Ultimate (Hugo 1) development scenario for the White Bear Lake area was used as the starting point, reducing pumping in Vadnais Heights and White Bear Lake from that baseline. The calculated hydrographs for these two scenarios are plotted below. The differences between the Ultimate scenario and the two new scenarios over the period 2008 through 2015 are also summarized below. In general, the impacts of reducing groundwater pumping from the Prairie du-Chien aquifer decrease as the overall pumping impacts are reduced as follows:

- Infrastructure-based vs. Ultimate (Hugo 1): 0.19 to 0.21 feet increase in White Bear Lake water elevations.
- User-based vs. Ultimate (Hugo 1): 0.10 to 0.12 feet increase in White Bear Lake water elevations.

Figure 4. Modelled Effects of Groundwater Pumping Reduction on White Bear Lake's Water Elevation



3.8 Distribution System Ownership

The cities of White Bear Lake, Vadnais Heights, and Gem Lake are being consulted over the watermain design and storage sites. These cities could consider the creation of a partnership agreement over the maintenance and operation of the facilities, as well as additional discussion over service rates.

3.9 Network & Siting (GIS)

A working basemap with candidate customers, Infrastructure Based (Attachments A & C) and User Based (Attachments B & D) model scenarios, potential locations for major infrastructure, and proposed pressure zones were evaluated and prepared. Mapping of areas suitable for reuse is currently in progress as survey data arrives.

3.10 Regulatory Scan

- Core principle - Maintain complete separation between existing potable and proposed non-potable or potable systems.
- Plumbing Code - Minnesota's Universal Plumbing Code Chapter (reuse standards) has not yet been adopted statewide. The Plumbing Board is currently evaluating the adoption of Chapter 15 non-potable standards with input from relevant local state agencies. This limits the viability of a solely reuse-based system. This study evaluated the option for alternative sources of water in addition to reuse.
- Special Discharge – There are twelve special discharge permit holders in White Bear Lake and Vadnais Heights, with three that are located within the current reused footprint. These users will need to be investigated further if included in wastewater interception and reuse technologies, as their discharge may exceed the standard discharge concentration.

4.0 FINDINGS & IMPLICATIONS

1. Seasonal peak demands matter**.** Reuse/Alternative demand is strongly seasonal (irrigation and wash water), which affects the sizing of watermains, tower/booster needs, and storage turnover. A tower can buffer peaks, but it must be balanced with wintertime operations when water demands are lower.
2. Adoption will require more engagement. Survey returns suggest mixed willingness to switch to reuse or alternative water sources. Targeted follow-ups with high-volume users (dealerships, R&D/manufacturing) are needed to define quality/pressure thresholds and conversion hurdles.
3. Regulatory pathways are pivotal. The plumbing code's adoption of reuse standards and local enforcement details (backflow, dual plumbing) will drive schedule and cost.
4. Integration with the augmentation study**.** Treatment requirements and conveyance options may tie to the lake-augmentation study work by others. Reuse could include sharing facilities to benefit from the same source-water treatment facility. Additional data is expected in the spring of 2026.
5. Irrigation runoff constraints**.** MPCA requires irrigation practices that prevent off-site runoff when using recycled water; this affects site-level design standards and outreach messaging.
6. Improvements to White Bear Lake surface water elevations. The modeled and estimated increases to the surface water elevations in White Bear Lake ranged from 0.10 to 0.21 feet.

5.0 IN-PROGRESS/NEXT STEPS *(through April 15th meeting)*

- Regulatory coordination: Document the current status of reuse standards and summarize separation/cross-connection requirements for a corridor system.
- Ownership Model: Further discussion is required with the various municipalities that would benefit from the proposed system, and discussions over O&M requirements and funding will need to occur.

6.0 RISKS & DATA NEEDS

- Low survey response rate could bias sizing; mitigation is to continue outreach to top water users identified by billing data.
- Code adoption timing is uncertain; the team will present a compliance path and contingencies.
- Source-water treatment: until the East Vadnais Lake water quality model results are published by others, treatment levels for reuse will be presented as scenarios (e.g., clarity/solids control only vs. higher treatment).

7.0 DRAFT CONCLUSIONS

- A reuse / alternative source water distribution system serving targeted corridors remains feasible in concept, but regulatory confirmation, and customer readiness are the controlling factors.
- Additional survey returns and preliminary treatment guidance (from the ongoing lake studies) are needed to finalize sizing, costs, and adoption strategy.
- The modeled and estimated increases to the surface water elevations in White Bear Lake ranged from 0.10 to 0.21 feet depending on the model implemented.

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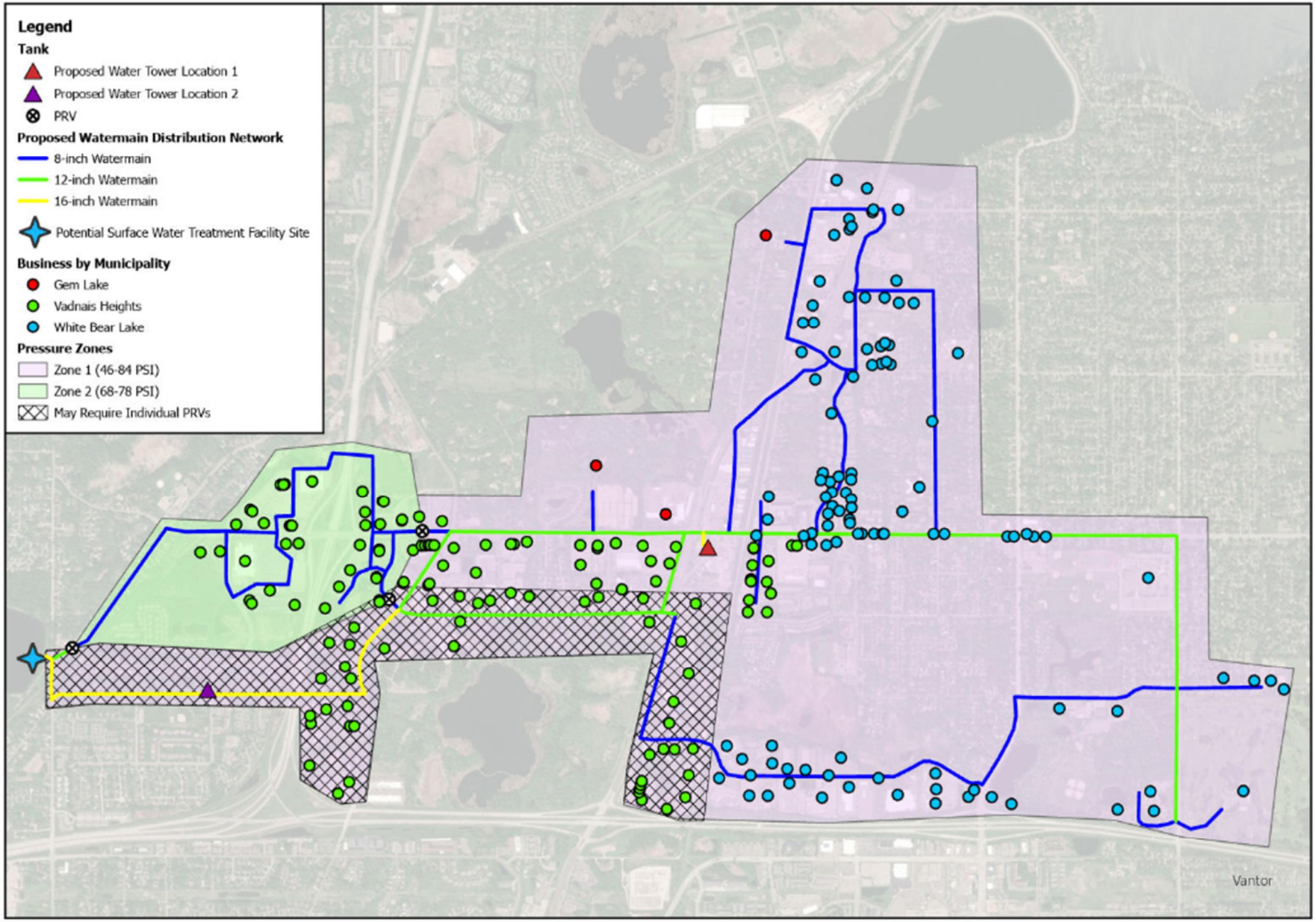
8.0 Recommendations

- Based on Table 7, the User-Based Model supplies approximately 268 MGY compared to the 369 MGY, which equates to approximately 73% of the service demand of the Infrastructure-Based Model.
- The total capital costs associated with the Infrastructure-Based Model and User-Based Model are between $34,000,000 - $39,000,000 and $20,000,000- $25,000,000, respectively.
- The operations and Maintenance Costs associated with the distribution system are approximately $450,000 and $150,000 annually for the Infrastructure-Based Model and User-Based Model, based on present worth value.
- The increased annual maintenance costs associated with the Infrastructure-Based Model are primarily due to the increased linear feet of the distribution network.
- Based on the capital costs, O&M costs, and percent of demand captured by the User-Based Model, it is the most cost-effective model with limited O&M needs and infrastructure oversight required.

ATTACHMENTS

- Attachment A – Infrastructure-Based Model with Watermain Sizing Map
- Attachment B – User-Based Model with Watermain Sizing Map
- Attachment C – Infrastructure-Based Model with Business Type Map
- Attachment D – User-Based Model with Business Type Map
- Attachment E – Infrastructure-Based Model with Well Locations Map
- Attachment F – User-Based Model with Well Locations Map



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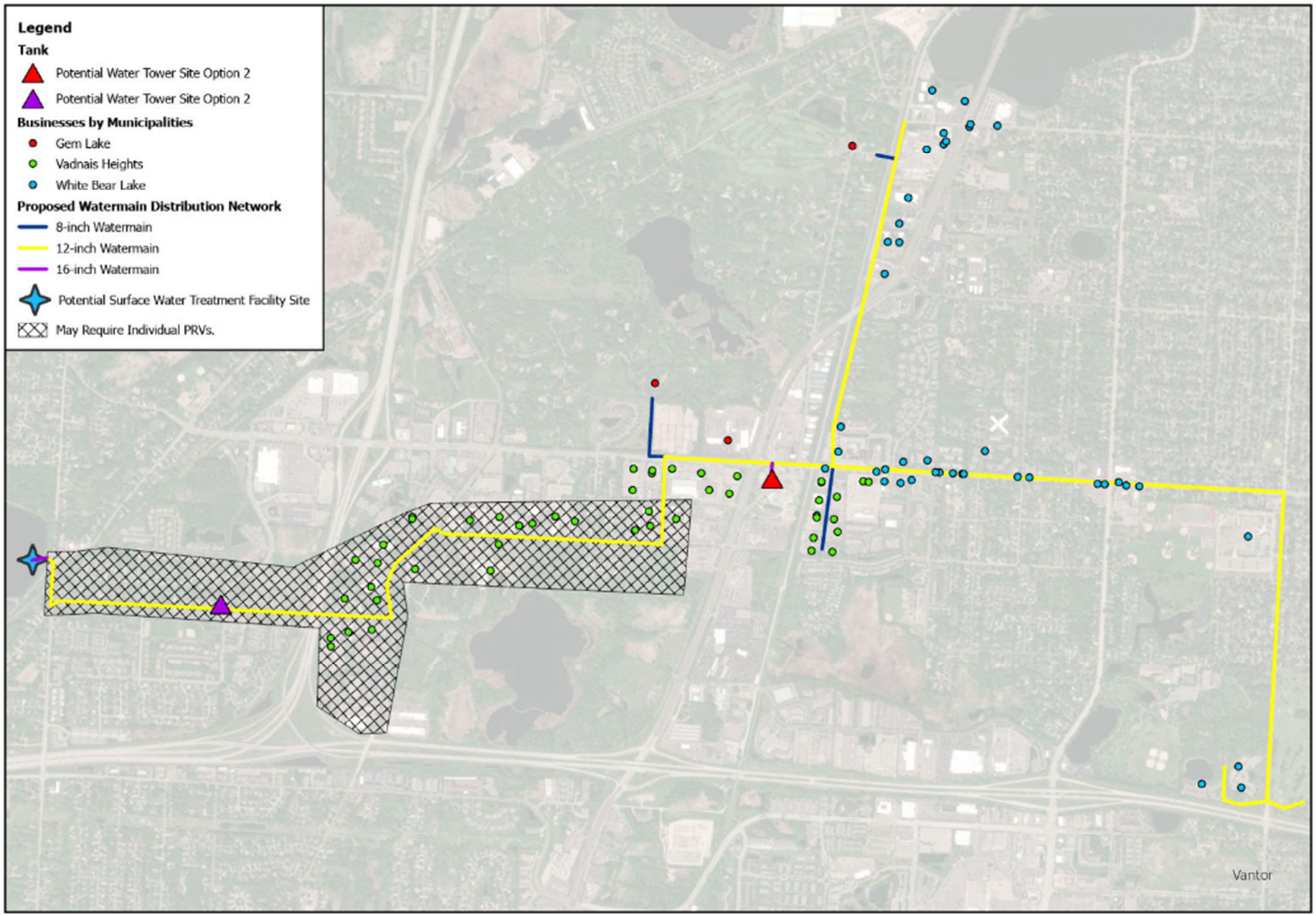
Attachment A. Infrastructure Based Model with Watermain Sizing
White Bear Lake and Vadnais Heights, MN
White Bear Lake Study 11

Attachment A: Infrastructure-Based Model with Watermain Sizing



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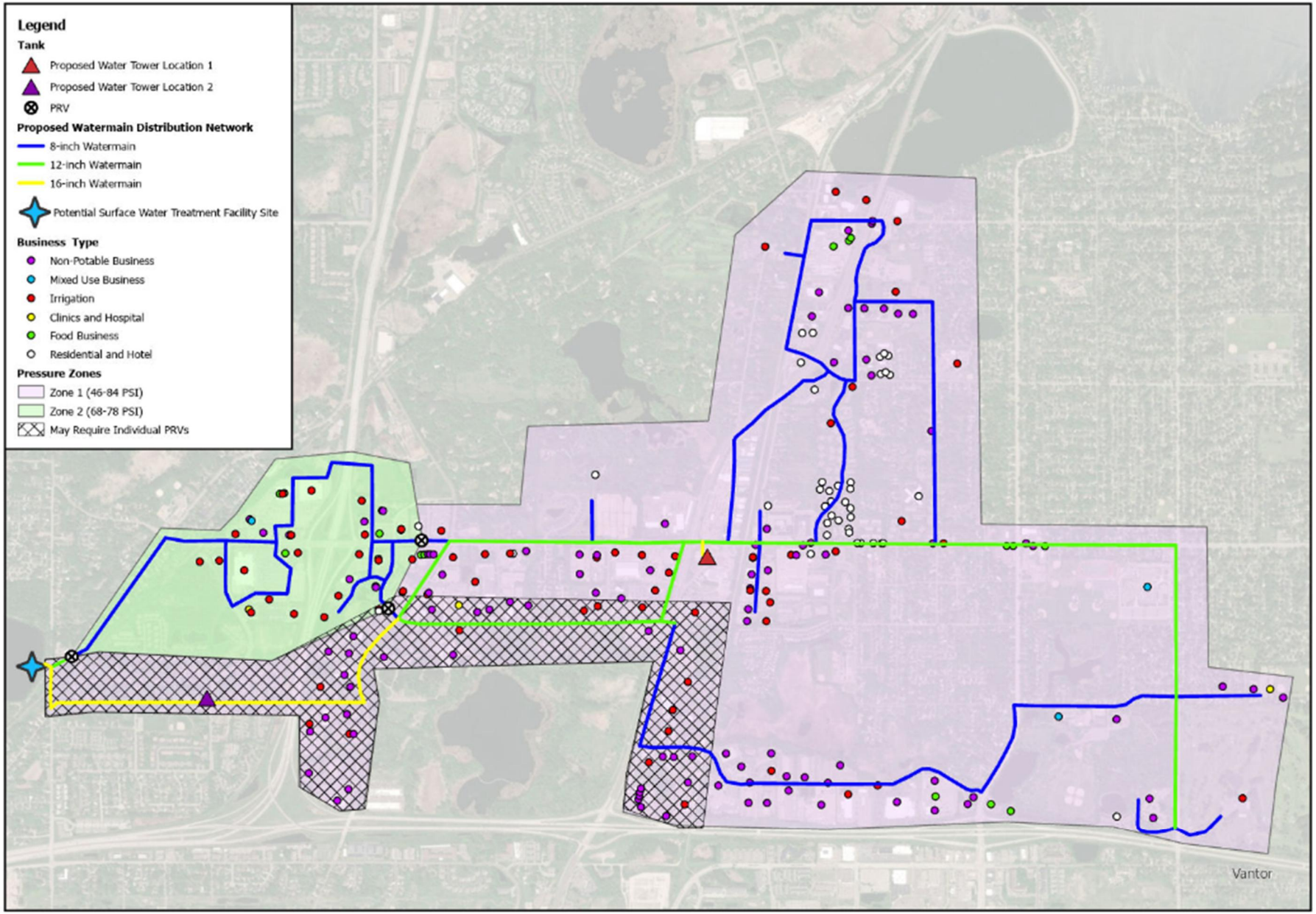
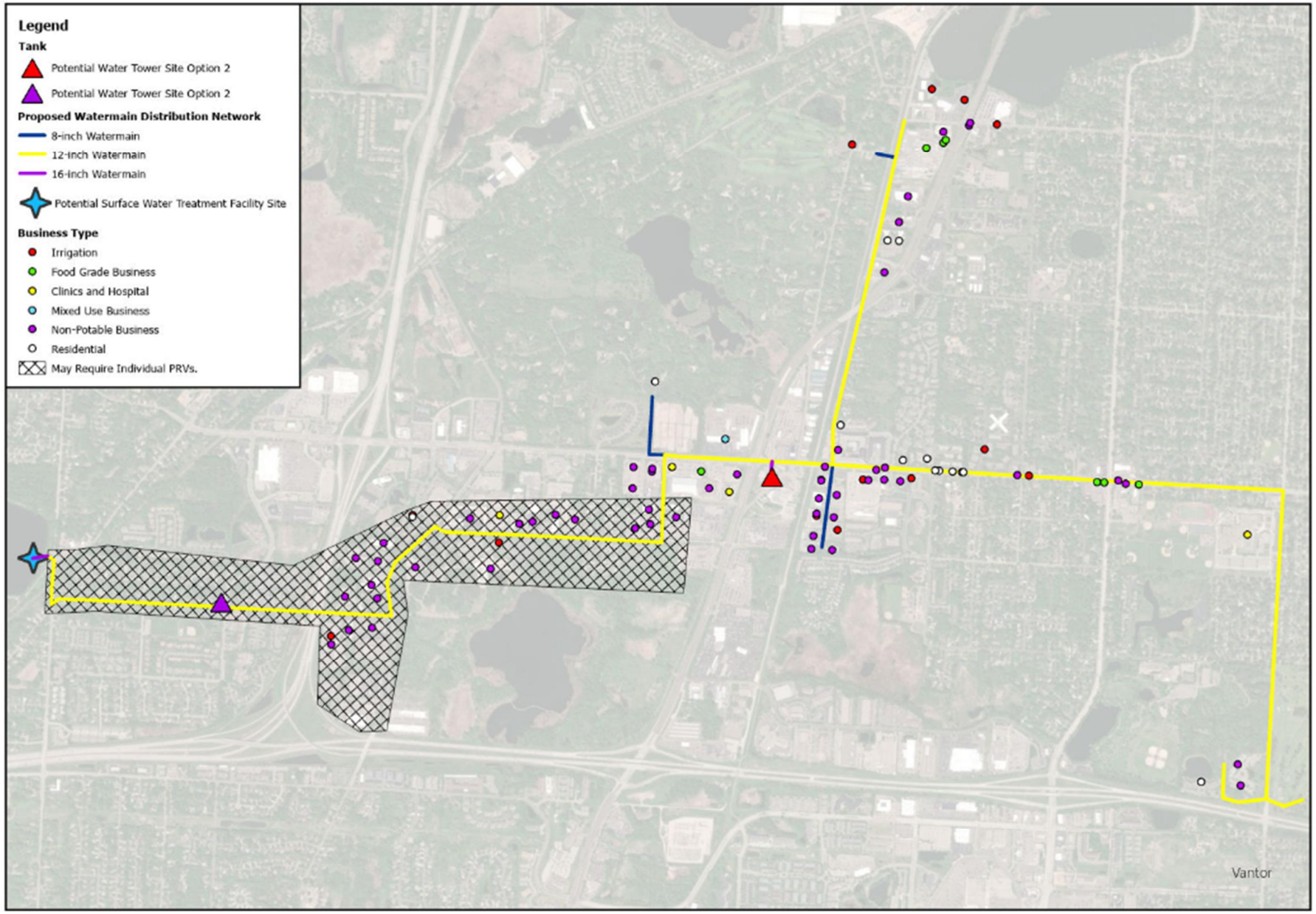
Attachment B. User Based Model with Watermain Sizing
White Bear Lake and Vadnais Heights, MN
White Bear Lake Study 11

Attachment B: User-Based Model with Watermain Sizing



Attachment C: Infrastructure-Based Model with Business Type



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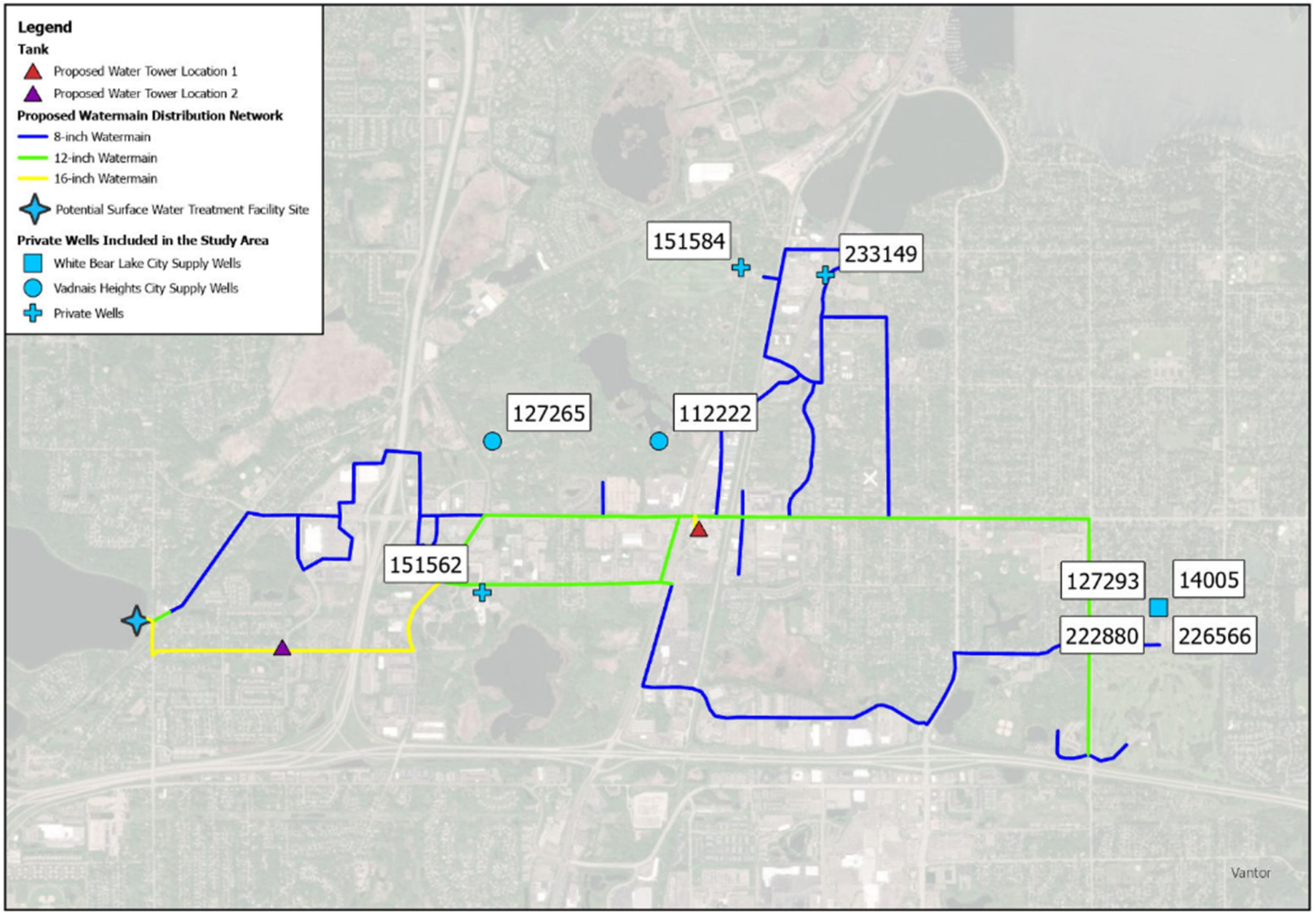
Attachment D. User Based Model with Business Type
White Bear Lake and Vadnais Heights, MN
White Bear Lake Study 11

Attachment D: User-Based Model with Business Type



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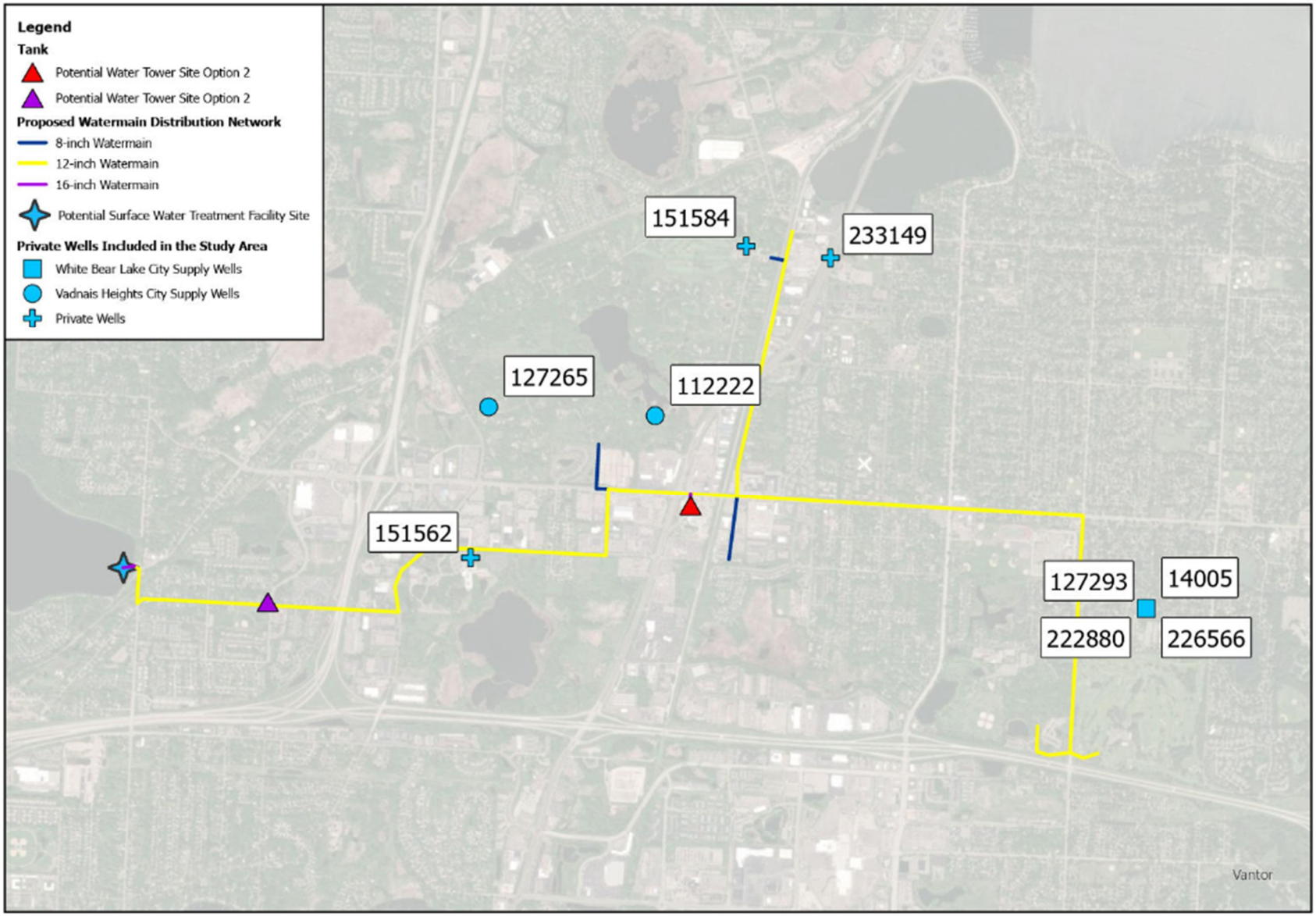
Attachment E. Infrastructure Based Model with Well Locations
White Bear Lake and Vadnais Heights, MN
White Bear Lake Study 11

Attachment E: Infrastructure-Based Model with Well Locations



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Attachment F. User Based Model with Well Locations
White Bear Lake and Vadnais Heights, MN
White Bear Lake Study 11

Attachment F: User-Based Model with Well Locations